



Cities as Assemblages

These three volumes contain the proceedings of the XXVI International Seminar on Urban Form, Cities as Assemblages, which took place from the 2nd to the 6th of July 2019 in Nicosia, Cyprus. The conference explored how different theories and approaches can be embedded within the methodologies analysing the urban form. These theories provide a relational perspective for the analysis of the physical and social processes underpinning the shaping of cities, and address the inherent complexity of the urban form. The Cyprus Network of Urban Morphology (CyNUM), which organised on behalf of ISUF the XXVI International Seminar on Urban Form, was founded in 2015 as a bicommunal organisation involving actively researchers from both sides of the divide.

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Cities as Assemblages

vol. 3

tabedizioni

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Proceedings of the XXVI International Seminar
on Urban Form 2019

2-6 July 2019, Nicosia, Cyprus

Vol. 3

edited by
ILARIA GEDDES
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UNIVERSITÀ

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ILARIA GEDDES
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ALESSANDRO CAMIZ

tab edizioni

© 2022 Gruppo editoriale Tab s.r.l.
viale Manzoni 24/c
00185 Roma
www.tabedizioni.it

Prima edizione febbraio 2022
ISBN volume 1: 978-88-9295-328-4
ISBN volume 2: 978-88-9295-356-7
ISBN volume 3: 978-88-9295-357-4
ISBN opera completa: 978-88-9295-329-1

Stampato da The Factory s.r.l.
via Tiburtina 912
00156 Roma
per conto del Gruppo editoriale Tab s.r.l.

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Table of Contents

p.	11	<i>Preface</i> by Ilaria Geddes

Theory: Emergence, Relational Theories, the Social Sciences and Urban Morphology

15	<i>Comparative Study on the Gated Communities of Suzhou Industrial Park and the Non-gated Communities of Singapore within Their Urban Form</i> by Yuan Sun & Jiawen Han
29	<i>Residential Fortified Enclaves. The Influence of Tall Buildings on Socio-Spatial Segregation in Londrina, Brazil</i> by Amanda Carvalho & Michel Guenet
39	<i>The Auto-Poesies of Urban Emergence</i> by Niki Xenia Alygizou
49	<i>Shared Inference of Urban Morphology</i> by Chi Zhang & Zhen yu Li
57	<i>Assemblages or Multiplicities. The Heredity of Urban Emergence</i> by Besnik Murati
69	<i>Design with Non-Urban Planners</i> by Chi Zhang
75	<i>Sociospatial Reading of Favela. A Comparative Analysis from Organic Portuguese Cities</i> by Vânia Raquel Teles Loureiro, Valério Augusto Soares de Medeiros & Maria Rosália da Palma Guerreiro

Methods: Embedding Different Approaches into the Study of Urban Morphology

91	<i>A Cultural Perspective on the Typo-Morphological Approach. A Planning Proposal for Hehua Tang, China</i> by Xiaoxu Liang & Giovanni Cavaglion

- p. 101 *Analyzing Recent Morphological Evolution in Central Beijing during Relocating Non-Capital Functions Based on POI Data and Digital Maps*
by Yishan Chen & Mingbo Wu
- 115 *Study on Vitality of Small Open Space Based on Behavior Observation Techniques*
by Xu Haoran
- 123 *Territories and Frontiers in Inconclusive Concepts within the Schools of Urban Morphology*
by Staël de Alvarenga Pereira Costa, Maria Cristina Villefort Teixeira,
Maria Manoela Gimmler Netto & Henrique Vianna Lopes Teixeira¹²⁵
- 131 *Applicability of Morphological Tessellation and its Topological Derivatives in the Quantitative Qnalysis of Urban Form*
by Martin Fleischmann, Ombretta Romice & Sergio Porta
- 143 *Intensity Mapping: a Non-Essentialist Approach to Methods in Urban Morphology*
by Milica Muminovic
- 155 *A Typological Interpretation of Urban Design Method for Intensive Development Area*
by Fang Rong, Wang Enqi & Dr. Han Dongqing
- 163 *Urban Tridimensional Special Fabrics: Formative and Transformative Process*
by Vincenzo Buongiorno
- 177 *The Street as a Three-Dimensional Urban Form*
by Mateo Neira & Laura Narvaez Zertuche
- 189 *Cultural Heritage in Conflict Narratives in Urban Development Plan. The Case Study on Shezih Region, Taipei City*
by Calvin Hung
- 197 *Conceptual Modalities of Architectural Rewriting Techniques*
by Domenico Chizzoniti & Flavio Menici
- 209 *Quantitative Study on Perception of the Public Space's Morphological Characteristics of Urban Existing Residential Neighborhoods in China Based on Psychophysics*
by Wang Lijun & Lu Shan
- 221 *A Quantitative Approach to Morphological Research Based on Public Space*
by Huimin Ji & Wowo Ding
- 233 *Beyond Building Envelop: Urban Form of Cultural Public Space*
by Melody Hoi-Lam YIU

- p. 243 *Social and Environmental Function of Urban Space*
by Denise Antonucci & Lucas Gaspar Bueno
- 255 *Frontage Rules. How Societal Ideas of Legal Regulation Affect Micro-Morphological Solutions at Street-Level*
by Anja Standal
- 269 *Urban Morphological Changes in Hangzhou from the 1950s to the 1990s. An Approach Integrating Oral History*
by FU Shulan & JIN Panpan²⁷¹

Urban Design: Urban Morphology, Building Typology and Design

- 287 *Research on Typology of Traditional Chinese Gated Community Sharing Space in Urban Design. Taking Beijing HUIZHONGLI Community Spatial Redesign as Example*
by Haoty Wang & Zhenyu Li
- 295 *Use and Appropriation of Open Urban Environments: a Brazilian Case Study*
by Vanessa Casarin & Paula Gabbi Polli
- 305 *Form, In-between, City. Analysis of the Urban Street Corner of the Poché- public Space of the Building Interface: Three Case Studies*
by Anqi Wang & Ting Sun
- 317 *Mechanisms for Vitality in Public Spaces*
by Juliana de Souza e Silva Arrais, Rômulo José da Costa Ribeiro & Valério Augusto Soares de Medeiros
- 329 *Compacts Typo-Morphologies by Use of Local Search Methods*
by Isabelle De Smet, Quentin Meurisse, Vincent Becue, Thomas Brihaye, Jérémy Cenci, David Laplume, Hadrien Mélot, Cédric Rivière
- 339 *Compact & Collage: a Spatial Morphology Research on Xi'an Old City*
by Wang Ruikun
- 351 *Exploring the Morphological Process of New Districts in China: the Case of Nanjing*
by Shuo Guo, Qian Li & Wowo Ding
- 373 *The Evolution and thoughts Based on Urban Form of Guangzhou*
by Xinting Gao & Fei Lian
- 383 *Typo-Morphology of Transportation. Looking at Historical Development and Multimodal Futures of Swedish Streets and Roads*
by Todor Stojanovski
- 395 *Using Axial Analysis to Examine the Effectiveness of Reserved Road Development in Tainan City, Taiwan*
by Yi-Siang Cheng & Tzu-Chang Lee

- p. 403 *Centrality as a Tool for Sustainable Mobility. Building an Evidence-Based Spatio-Functional Planning Strategy for an Athenian Suburb*
by Yannis Paraskevopoulos & Stefanos Tsigdinos
- 415 *Multi-Scalar Mapping of Transit-Oriented Assemblages. Metropolitan Mobilities, Neighbourhood Morphologies and Station Design*
by Elek Pafka & Nastaran Peimani
- 427 *Spatial Pattern Evolution and Industrial Characteristics of Economic and Technological Development Zones and High-Tech Industrial Zones in China*
by Jingxian LI, Qing Liu & Ian MacLachlan
- 439 *Planning Sustainable Urban-Industrial Configurations. The Influence of Industrial Complexes Morphology on Industrial Placement*
by Diego Altafini, Andrea da Costa Braga & Valerio Cutini
- 451 *Urban Industrial Zone Renewal and Spatial Game in China. A Case Study of Eastern Suburb Industrial Zone in Chengdu*
by Ke Deng & Feng Song
- 463 *Morphological Comparison Study of Mainland Industrial Port Area of Island Cities. Marghera in Venice And Haicang District in Xiamen*
by Xia Liu
- 473 *Optimisation of Building and Road Network Densities in Terms of Variation in Building lot Sizes and Shapes*
by Hiroyuki Usui
- 485 *The Frontage. Uncovering the Public-Private Interface through Sampling and Categorization of Micro-Morphological Solutions at Street Level*
by Anja Standal & Elin Børrud
- 495 *The Impact of Neoliberal Economy on the Urban Morphology of Rafidia Neighborhood in Nablus City-Palestine*
by Ala' Qawasmi, Zahraa Zawawi & Shaden Awad
- 509 *Houseboat Communities as Floating Neighbourhoods for Degrowth how Living Afloat is Reshaping the Urban Morphology of European Metropolises*
by Martina Callegaro
- 521 *Watershed: the Transformation and Interrelationship of Urban Tianjin and its Water Environment in China's Planned Economy Era*
by Rui Ma

- p. 535 *Researching and Mapping on Waterfront Industrial Heritage. The Urban Morphology Study of Suzhou Creek, Shanghai*
by Yichen Zhu, Zhenyu Li & Jianjian Song

Focus: Mediterranean Port Cities in a Global Context

- 545 *Comparative Analysis of Public Space Among Mediterranean Port Cities Utilizing Remote Sensing and Street View. Valencia And Genova As Study Cases*
by Run He & Meiqin Che
- 561 *From hospitality to Urban Conflict. Morphologies in Transformation in Mediterranean Ports*
by Rosalba Belibani & Deborah C. Lefosse
- 573 *Cities of Collages: a Comparative Study of Urban Morphology Evolution between Macao and Monaco*
by Wang Yuchen & Tan Zheng
- 587 *Morphological Characteristics of Traditional Residential Districts in Chinese and Southeast Asian Port Cities*
by Han Wang & Beisi Jia

Preface

by Ilaria Geddes, Member of the Conference Organising Committee
University of Cyprus

This Conference Proceedings volume contains the written versions of contributions presented during the 26th International Seminar on Urban Form Conference, held in Nicosia, Cyprus, July 2nd – July 6th, 2019, hosted by the Cyprus Network of Urban Morphology (CyNUM).

The Conference provided a setting for discussing theoretical and methodological transdisciplinarity in urban morphology. The topic of the conference, *Cities as Assemblages*, encouraged deliberation on the processes of urban emergence and transformation from a relational perspective, as well as consideration, in research methodologies and design approaches, to the relationship between physical and human elements. The aim of conference was to address the challenges currently faced by urban morphology: bridging the gaps between different approaches, developing cross-disciplinary studies, and integrating research and practice. The themes of the conference covered theory (emergence, relationality, social sciences, and the scope of limits of urban theories), methods (embedding and combining different approaches), urban design (urban morphology and building typology) and contextual topics (conflict, divided cities and port cities) relating to the location of the Conference. Approximately 220 presentations were delivered in 45 parallel sessions.

This present volume includes 49 contributions from all themes, focusing on specific sub-themes: emergence, relational theories, the social sciences and urban morphology (theory), embedding different approaches into the study of urban morphology (methods) and Mediterranean port cities in a global context (focus). The papers included in this volume were, in most cases, presented within the same sessions.

Under the theme of theory, the papers discuss the notion and mechanisms of emergence in the formation of socio-spatial relations, debate the idea of cities as assemblages for the description of emergence and also discuss the contradictory and multi-faceted nature of urban design.

The papers within the theme of methods present a variety of mapping techniques focusing on quantitative approaches, applications of concepts and narrative tools through critical analysis, and diachronic analyses of urban development. There is a strong focus on three-dimensional form, the relationship between built and open spaces, and public space more generally. The socio-cultural dimension of form in the relations between building typology and urban space features prominently as a key to analysing the impact of design and everyday life on the public realm.

In the urban design theme, public space and its use remain core elements of analysis, but with a stronger focus on the impact of the design of recent development projects, in particular transport projects, including road systems, public transport and walkability. New and subur-

ban neighbourhoods, gated and houseboat communities, industrial and waterfront areas were also subjects of research

Finally, in the focus theme, a small number of papers cover comparative analyses of port cities and their evolution in the Mediterranean and in Asia.

This volume offers a variety of the different papers that were presented at the Conference, providing a permanent record of the fruitful knowledge exchange that took place during the four days of the event, touching upon many important aspects of urban morphology and producing insights, which I believe will be invaluable for the future development of the field.

I would like to thank all participants for their contributions to the Conference programme and to these Proceedings. My special thanks go to the keynote speakers: Prof. Wendy McClure, Prof. Alan Penn, Prof. Giuseppe Strappa and Prof. Anne Vernez Moudon, who shared their latest research insights through highly engaging and stimulating presentations, reported in the journal *Urban Morphology* 23(2). Finally, I would like to express my sincere thanks to the International Seminar on Urban Form (ISUF) Council for their continuous support for the organisation and delivery of the Conference.

Theory: Emergence, Relational Theories,
the Social Sciences and Urban Morphology

Comparative Study on the Gated Communities of Suzhou Industrial Park and the Non-gated Communities of Singapore within Their Urban Form

by Yuan Sun & Jiawen Han

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Keywords: gated community, cross-cultural comparisons, Singapore, Suzhou Industrial Park.

Abstract: The State Council of the People's Republic of China made an official suggestion for future city planning in 2016 that, on the basic principle, suggests the gradual opening up of residential gated communities. This means that China is facing a new round of urban reform in which non-gated communities will inevitably become the morphological code in future China. Suzhou Industrial Park (SIP) is a new district located on the east side of Suzhou and is the first national development town created through a collaboration between China and Singapore since the early 1990s. The new town planning system and the urban model from Singapore were widely adopted and further adapted into SIP's development from the beginning. Therefore the urban forms look similar, yet they are in essence different owing to their completely different approaches to massive housing compounds: most of the housing compounds in SIP are private gated communities developed by private developers, while over 80% of people in Singapore living in public non-gated communities developed by the government. This paper focuses on the changing urban fabric coming out of the proliferation of gated communities in SIP and non-gated communities in Singapore, and also investigates the social, political and economic forces underlying the gated and opened communities respectively. The comparison between them aims to provide new insights into the housing compound liberalisation reform by gradually integrating existing residential gated communities with the public and developing a new mode of open housing compound.

1. Introduction

In the past three decades, gated communities have stood as the predominant residential settlement in Chinese cities. However, in 2016, the Chinese government suggested that existing gated communities should gradually dismantle their gates while new emerging residential communities should be constructed without gates. According to the government, gradually removing gates can open up the internal transport network, improve the layout of the urban transport network, promote land use, and thus alleviate the burden of urbanisation (The Central Committee of the Communist Party of China and the State Council, 2016). As a result, China will face a new round of urban reform that will make non-gated communities the prevalent residential settlements in Chinese cities.

This paper focuses on Suzhou Industrial Park (SIP) as a representative community to clarify the impact of China's urban reform on the fabric of Chinese cities. Located on the eastern side of the ancient city of Suzhou, SIP is a collaborative project involving the governments of China and Singapore that commenced in 1994. Drawing upon knowledge from Singapore, SIP entailed constructing hardware and software facilities while adapting a Singaporean planning system and model at the primary stages of development. Although the Singaporean model and SIP exhibit comparable urban forms, they differ profoundly in terms of their housing communities. In SIP, gated communities emerged primarily by private developers, whereas 81% of residents in Singapore live in public non-gated communities (HDB, 2018).

In the last few decades, China's gated communities have been discussed quite frequently in the academic realm where researchers have primarily focused on the historical formation and sociological study of these communities as residential settlements. Yao and Wei (2012), Xu and Yang (2009) introduced the history and formation of gated communities in China, while Xu (2009), studied the socio-cultural and political-economic forces which impacted the design of gated communities, and analysed design issues of these settlements from the perspective of neighbourhood public space and urban life. Xu (2013) studied the formation mechanism and operation status of gated communities in China and discussed the development prospect of gated communities. In parallel, the emergence of non-gated communities was also closely analysed. Wu (2018) used both quantitative and qualitative inquiries to investigate the social implications of opening up gated compounds and outlined the positive implications on society as well as in terms of security. Huang (2018) compared a non-gated community, which was previously enclosed with a gated one to propose suggestions for the extensive transformation. Despite those efforts, scholars have rarely examined the relationship of gated and non-gated communities with their forms from a transnational perspective.

This paper presents two districts – in SIP, China and Toa Payoh, SIP Singapore – as representative cases of gated and non-gated communities.

Linglongwan district is a large housing community located in SIP's second-phase development with an area of approximately 465,000 m². The town is built under the *neighbourhood principle* which was adopted from Singapore. In this context, *neighbourhood principle* refers to the urban redevelopment of Europe in the post-war period. Singapore adopted this model in its urban redevelopment after the 1960s to support the public housing policy and to organize the local residential communities (Wong and Guillot, 2005). This three-tier hierarchical principle of 'new town – neighbourhood centre – residential precinct centre' emphasizes the comprehensive infrastructure. The principle aims to ensure residents' use of infrastructure within walking distance.

Linglongwan district is a gated community developed by a private developer. Developed from 2002 to 2014, the town emerged in the context of the official marketisation of housing in China from a land auction held in 2002. Taking 12 years to complete, the project has involved adapting construction patterns from residential communities built in SIP's first-phase development for a more mature housing pattern comprising several housing typologies with relatively comprehensive facilities within their premises. The district consists of nine plots with 57 residential blocks ranging from 10 floors to 36 floors.

On the other hand, construction for Toa Payoh started in 1960. The first government department in charge of housing development is the Singapore Improvement Trust (SIT) established under the colonial administration (Teh, 1975). However, SIT primarily focused on urban construction rather than housing developments. After the planning authorities in Singapore dissolved the SIT, the Housing and Development Board (HDB) was formed to address the urgent

housing shortage in Singapore. Toa Payoh became the first town to be fully planned and built by the HDB. Developed according to the neighbourhood principle, the project's construction emphasised the effective use of land and involved system development stages in improving facilities that support residential areas as well as raise the standard of housing. The area of the district is approximately 340,000 m² and consists of 45 residential blocks ranging from 10 floors to 40 floors.

Despite their differences, the two districts exhibit certain similarities. Firstly, both are under similar urban planning model following the frameworks of New Town principle. Secondly, since the completion of the exploration period of planning and construction, the two towns have remained in the stage of systematic planning, particularly with large planning frameworks for housing and urban developments. The two districts share a relatively similar area, location and land use as they are both residential districts next to a neighbourhood centre.

The districts demonstrate a variety of high-rise mass housing and a growth pattern in time which have developed and adhered to the local context.

2. Methodology

This paper documents and maps the gated communities in Linglongwan district and non-gated communities in Toa Payoh. By compares the residential blocks in Linglongwan with those in Toa Payoh and its surrounding areas in terms of permeability and accessibility, peripheral facilities and public spaces. Further analysis is planned to elucidate how the underlying forces of social, political and economic dynamism have affected urban forms in Singapore and China.

3. Analysis and Results

Located in the second-phase development of SIP, Linglongwan was the first of a series of residential projects in 2002 that were transacted via land auctions launched nationally that year. Referring to Singaporean neighbourhoods as a model, Linglongwan adopted the former's neighbourhood principal with only minor changes – largely due to differences in density, scale, local services and facilities in the Chinese context (Chen, 2006).

The initial developer of Linglongwan was Suzhou Nandu Genway Ltd. Co. (hereafter Nandu Genway), founded on 15 October 2002 before the land auction. Nandu Genway is a corporation involving Zhejiang Nandu Ltd. Co. and the government-affiliated SIP Genway Housing Development Group Co. Ltd. Although Nandu Genway initially owned 70% of the company, Vanke acquired Nandu Genway in 2004 and formally began taking part in the Linglong Bay project the following year. Before its acquisition by Vanke, Nandu Genway independently planned and developed plots 1-3; however, since Vanke began participating in the project, the two firms have partnered in the development of Plots 4-6, and Vanke has independently developed Plots 7-11.

The initial plan for Linglongwan in Nandu Genway's proposal had 11 blocks. Due to the presence of Jinji Lake to the south and high-voltage powerlines to the north, Nandu Genway identified the southern part of the site as a high-grade residential area and the north as middle-grade residential area that could be sold at a lower price. The pattern of development has proceeded from east to west and from north to south. After Vanke's involvement in the initial development of the project, Plots 7-10 were merged to be sold and, in turn, increase housing

prices. No public housing compounds are near Linglongwan, and except for one independent apartment building, residential buildings on the site are clustered in the gated community.

By contrast, Toa Payoh, located in the middle tier of Singapore, is the first new town fully planned and developed by HDB under the neighbourhood principle (Housing & Development Board, 2019). Buildings on the site were constructed mostly between 1960 and 1982, while additional building works and redevelopments remain in progress today. The residential buildings within the two selected Plots are public housing except for one gated community developed by a private developer on the north-western of the plot 1.

4. Accessibility and Permeability

The following paragraphs compare two elements of both communities: *access control* and the *road system*.

4.1. Access control

Access control in Linglongwan has three components: enclosure, a gate system for access to the plot and a security system for access to the building. As for the first component of the enclosure, all nine Plots in Linglongwan are enclosed with a fence of approximately 2 metres high rendered denser with green belts of 2-10 metres wide facing the roads to prevent people from crossing.

The second component is each Plot's gate system, which has two primary types of gates. The first type serves both vehicles and residents and controls access by using an automated system and guards. Residents can swipe their security cards to gain access, whereas internal vehicles can transit automatically by having their license plates scanned. By contrast, non-internal vehicles and individuals need to be registered by the guards before they may gain internal access. The second type is an unguarded pedestrian door with a swipe access control system that may be used only by residents, bicyclists and e-bike users with security cards. As shown in Figure 1, the community does not have a gate open to the main roads (i.e. Linglong Street, Suhong Middle Road, Fengming Street and Modern Avenue); the gate system is placed inside the Plot and affords no direct vehicular access to those roads, which prevents traffic congestion on the roads due to vehicles entering and leaving the community. Doors for residents are generally placed on the far side of the large gates, which reduces the inconvenience caused by the closure. Each Plot is equipped with two large gates and one door for residents depending on its size. For example, Plot 1, with two towers, is equipped with only one door for residents.

The third component is the security system of each building. The entrance of each building has access control that requires residents to swipe their security cards to enter the building. Visitors may access the building by calling occupants who can (digitally) open the door for them. Built-in later stages, Plots 7 and 8 and Buildings 59, 62 and 66 in Plot 11 have access control provided by lift systems that bring residents who swipe their security cards directly to their apartment floors.

Located in Plot 3, Qinying Apartment (i.e. Building 25) is unique among the community's buildings in terms of access control, for it was built during the first phase of Linglongwan's development. Building 25 is located outside the enclosed area of Plot 3 and affords access control on the ground floor, as visible at the entrance, in the lifts and with the presence of guards.

To provide affordable housing, Toa Payoh has no enclosures or gates around the buildings on its two plots except several public car parks. No access control is provided at the entrance of

the buildings, meaning that access to housing units is open. The sole exception is a private gated community with three towers, in the north-west of Plot 1 developed by a private developer. It also comprises an enclosure of approximately 2 metres high with double vehicular and pedestrian entrances, one of which is equipped with a guard booth. Unlike the gated community in Linglongwan, Toa Payoh provides no access control at the entrances of buildings or in lifts.

4.2. Road system

Each community's road system has three components: roads around the district, roads across the district and roads within the plots.

In Linglongwan, the road system narrows as it enters the district, and the shift in road length indicates a soft boundary between the outside and the inside of the district. Given hard boundaries already present around the districts, the width of the main road providing access to the inner areas usually does not change. The flows of residents and vehicles are mostly separated in the Plots. Except for parking for fire trucks, most of the car parks are located in the basement, which brings most of the flow of vehicles underground and, in turn, allows the road network to be a continuous loop. The internal vehicle road on the ground are mostly ring roads and parallel to the external traffic system. Some parts of internal and external roads are next to each other and only separated by fences and green belts.

By contrast, as shown in Figure 2, the road hierarchy in the selected plots of Toa Payoh is highly distinguishable. The roads gradually narrow from main roads to within-plot ones where they are usually directed towards buildings and often terminate in dead ends. The private community on the north-western side of plot 1 consists of an underground carpark. Due to the size of the complex, no road system is accommodated except for a carpark located under the elevated ground floor of the towers.

In conclusion, Linglongwan provides access control to prevent non-residents from entering districts and properties – a situation which has been reinforced in the later plots completely planned and developed by Vanke. Meanwhile, the road system is in the form of a continuous loop. Since some parts of internal vehicle roads run parallel to the external, this situation causes repeated functions within a short perimeter. Conversely, the plots in Toa Payoh have no access control for buildings but instead permit public access. The only private community on-site is gated and has only one form of access control instead of two or three. The lack of such measures is partly supplemented by the road system in the plots, which follows a clear hierarchy that terminates in dead ends and acts as a threshold to deter non-residents from entering the property. Another component that acts as a soft boundary is a series of public housing buildings that are arranged to form an enclosure. In that sense, Linglongwan uses several hard boundaries to control access for non-residents, whereas Toa Payoh uses soft boundaries (e.g. road hierarchy and building forms) to control internal access for non-residents.

5. Services and Facilities

The overall planning of SIP involved adapting a Singaporean model in which facilities are distributed according to the neighbourhood principle. Although a few changes were made to accommodate local habits, population density and housing density, the model framework remained mostly intact. This section discusses the facilities on and near SIP's Linglongwan and Singapore's Toa Payoh.

A narrow strip of land in the central area of the district separates plot 5 and 6 from plot 7-8. The northern part hosts facilities for neighbourhood committees, whereas the southern part includes a park, and between them is an outdoor swimming pool that residents may use for free.

SIP has two commercial buildings: one among Plots 1–4 and another among Plots 6-8. One or two storeys high, the commercial buildings accommodate convenience services (e.g. food courts, snack shops, salons and coffee shops). Meanwhile, Linglong Neighbourhood Centre to the east of the district offers services to both Linglongwan and other districts.

Each of the nine plots is equipped with outdoor fitness equipment and a children's playground. Although Plots 7, 8 and 11 have landscaping involving bodies of water, all space in the other plots are filled with vegetation.

Free basketball courts, volleyball courts, tennis courts and a private gym with an indoor swimming pool are also available on the site.

Compared with Linglongwan, plots in Toa Payoh have more mixed-used facilities. Between them, the two plots have only one park – namely, Toa Payoh Sensory Park – located at the south-east of Plot 2. Comprising a sensory garden, a community garden, a bird viewing area and a space for intergenerational activities, the park is approximately three times as large as Linglongwan's garden.

All of the facilities in the gated community, including a swimming pool, green space and a gym, are private, whereas the rest of the area is publicly accessible. Since the ratio of all services and facilities follows the facilities distribution guideline, the swimming pool, gym and basketball courts shared between the plots are all within walking distance. Ample space for commercial activities is available on the plots, and some ground-floor space of the HDB-affiliated houses is joint commercial-residential space. Moreover, the commercial and residential areas of the plots encompass a church and a petrol station.

Altogether, both communities provide various facilities according to the neighbourhood principle despite the slightly different parameters of their local contexts. Singapore continues its planning principles from the larger urban scale down to the ground floor of the residential complexes, whereas the planning principles of SIP cease at the enclosure of the residential compounds. Compared with gated communities in traditional cities, Linglongwan saves land and facility costs by distributing some facilities across the entire community. However, redundant facilities and landscapes inevitably appear in each plot, and clearly a large, centralised large park would offer more comprehensive services.

6. Building forms

Linglongwan consists of towers and slab buildings ranging from 10 to 36 floors. To make full use of southward sunlight and natural ventilation, the living and major bedrooms in China are suggested facing north-south, while each building is required to keep a certain distance to prevent over shading (Xu, 2009; the PRC Ministry of Construction, 2005). It shows on Linglongwan that all buildings are facing north-south and evenly distributed within the plots.

A void deck is a left open sheltered space on ground floor level and it refers to the ground space for HDB blocks from Singapore (Cairns, 2014). Space was introduced as an idea of shelter for children, and then was used for residents as a gathering space, and retails for the convenience of the surrounding neighbourhoods, event space for parties, weddings, funerals and so forth (Ibid). The void deck in Linglongwan is drawing upon the building form of Singapore. Due to its enclosure and gate system, the void deck in Linglongwan do

not retain the multi-functions from the one in Singapore. Space is often filled with equipment or other devices to support the community. Either keep empty or a ground floor filled with equipment rooms.

Unlike Linglongwan, the district in Singapore does not face similar sunlight orientation requirements for buildings due to its tropical climate. Toa Payoh comprises a variety of urban forms of buildings: towers, multi-oriented slab buildings, L-shape constructions and many others. Instead of serving as living spaces, the ground floor of buildings which built after 1969 has void decks. The layout of the building forms also varies. For example, buildings located in the middle of Plot 1 are arranged to form an enclosure, whereas those of Plot 2 is arranged in a mostly linear fashion. Based on images from the site, the commercial area includes shops, clinics, training institutions, food courts and other establishments, whereas the services area is divided into bicycle parking lots, mailboxes, leisure space with chairs and tables, an area with fitness equipment and a space for ceremonies (e.g. weddings and funerals).

7. Discussion/Conclusion

The previous sections compared access control, road systems, services, facilities and building forms on two selected residential communities in China and Singapore. This section discussed the underpinning forces that produced gated and non-gated communities.

8. Land Ownership and Design Regulations

Residential districts are owned by the central government in Singapore and China. However, land development is managed by the government agency HDB in Singapore (HDB, 2019), and mainly by private developers in China (Chen, 2013). The different modes of residential land development contributed to the shaping of gated and non-gated communities.

Public housing in Singapore is a government-subsidised project. After Singapore gained independence in 1965, the demand for residential units was increased due to the rapid growth of the population. As the only and the sole developer under the national housing scheme, HDB unified the planning and design regulations in developing residential communities. Systematic planning and construction code adopted by HDB from the city level to the building level. Therefore, on plots such as in Toa Payoh, the building styles, accessibility and building services and facilities are uniforms.

Residential land development in China is privatised after central government auctioning the land to real estate developers. Market-driven mechanism played a key role in this stage of development as a response to economic sustainability. Because land sales are the chief source of revenue for the local government (Chen, 2013) and SIP is currently experiencing rapid urbanisation, land auctions will continue to sustain the prosperous local economy. Moreover, the developer of the plot is private, which further reduces the government's financial burden due to urbanisation. Therefore, the means of developing residential plot help to promote urbanisation and economic growth. Because the planning and development inside the plots are managed by various real estate developers, the internal building forms vary in location, design style and price.

9. Welfare Housing and Free-market Housing Schemes

Public housing in Singapore is a government-subsidised project with certain requirements for applicants. Citizens buy flats with government subsidies, and they may not sell the property during the first 5 years of ownership. With such a steep requirement, prices for public housing are two to five times lower than those for private apartments, depending on their location. Public housing residents do not have to pay to use the public spaces, including the ground floor that forms part of the housing's urban form. Therefore, no hard boundary separates the residential area from the public ones; instead, only building enclosures and changes in road width remind people of the boundaries between the areas.

After China ended its welfare housing system in 1998, it officially announced its foray into residential marketisation in 2002. Since then, commercial housing has been traded in the free market, meaning that housing and its services and facilities are not subsidised by the government. After 2002, the floor area will encompass the building area and the shared area, and residents will be required to pay for the public area in the building (i.e. the area affiliated with the owners). Residents are also subject to expensive property fees to cover community security, facilities maintenance and express delivery services. They also consider the internal environment of the community to be owned by the owners of the property, meaning that an enclosure and a security system are needed to protect their rights as residents.

This paper provides new insights into the housing compound liberalisation reform by transnational comparison of gated and non-gated community. Focuses on the residential blocks in Linglonwan and Toa Payoh and its surrounding areas with comparative study in terms of their permeability and accessibility, peripheral facilities and public spaces. And also investigates the social, political and economic forces underlying the gated and opened communities respectively.

10. Funding

This work was supported by Xi'an Jiaotong-Liverpool University's Research Development Fund (RDF-16-01-31).

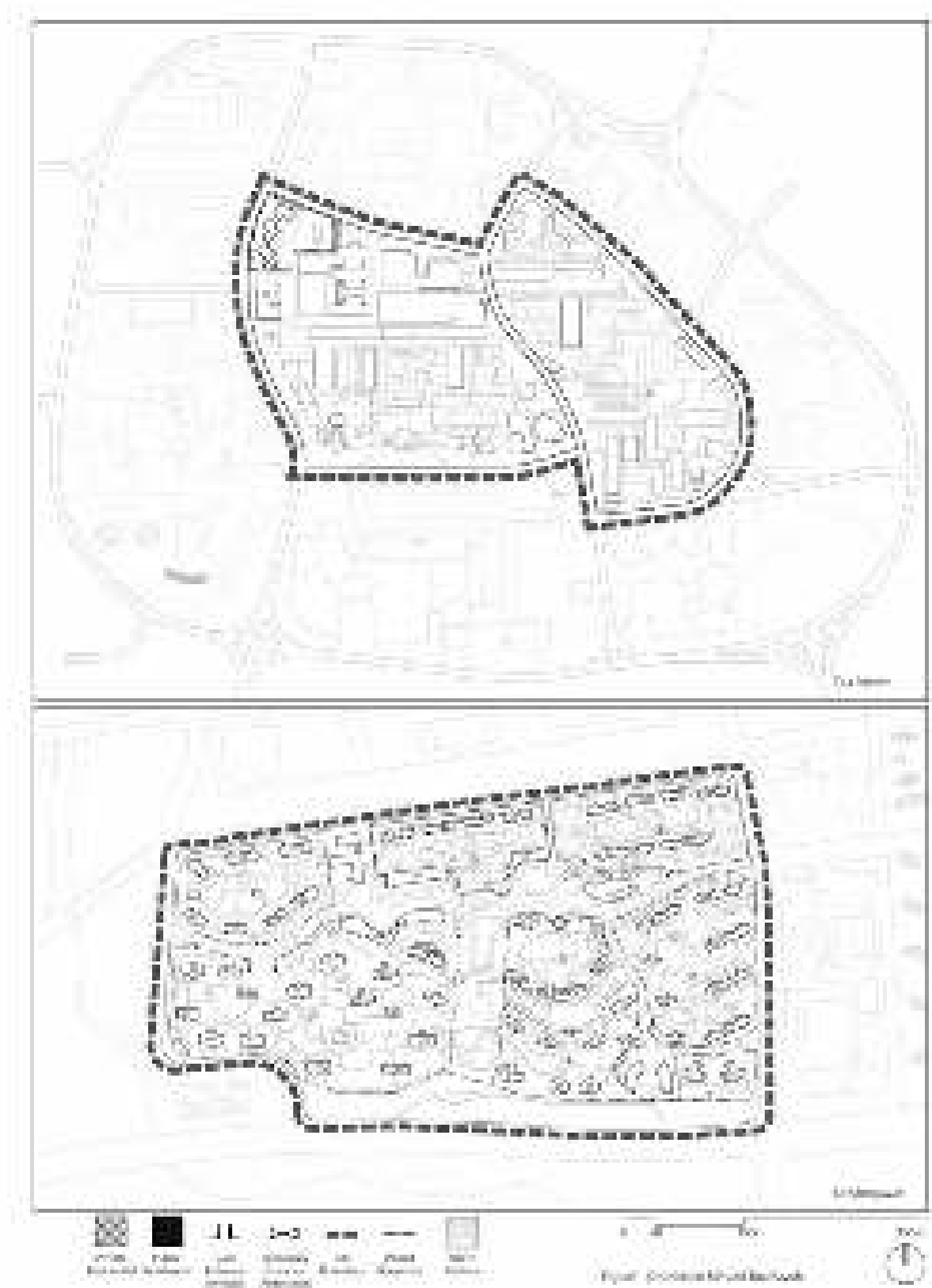


Figure 1. Districts in SIP and Toa Payoh.

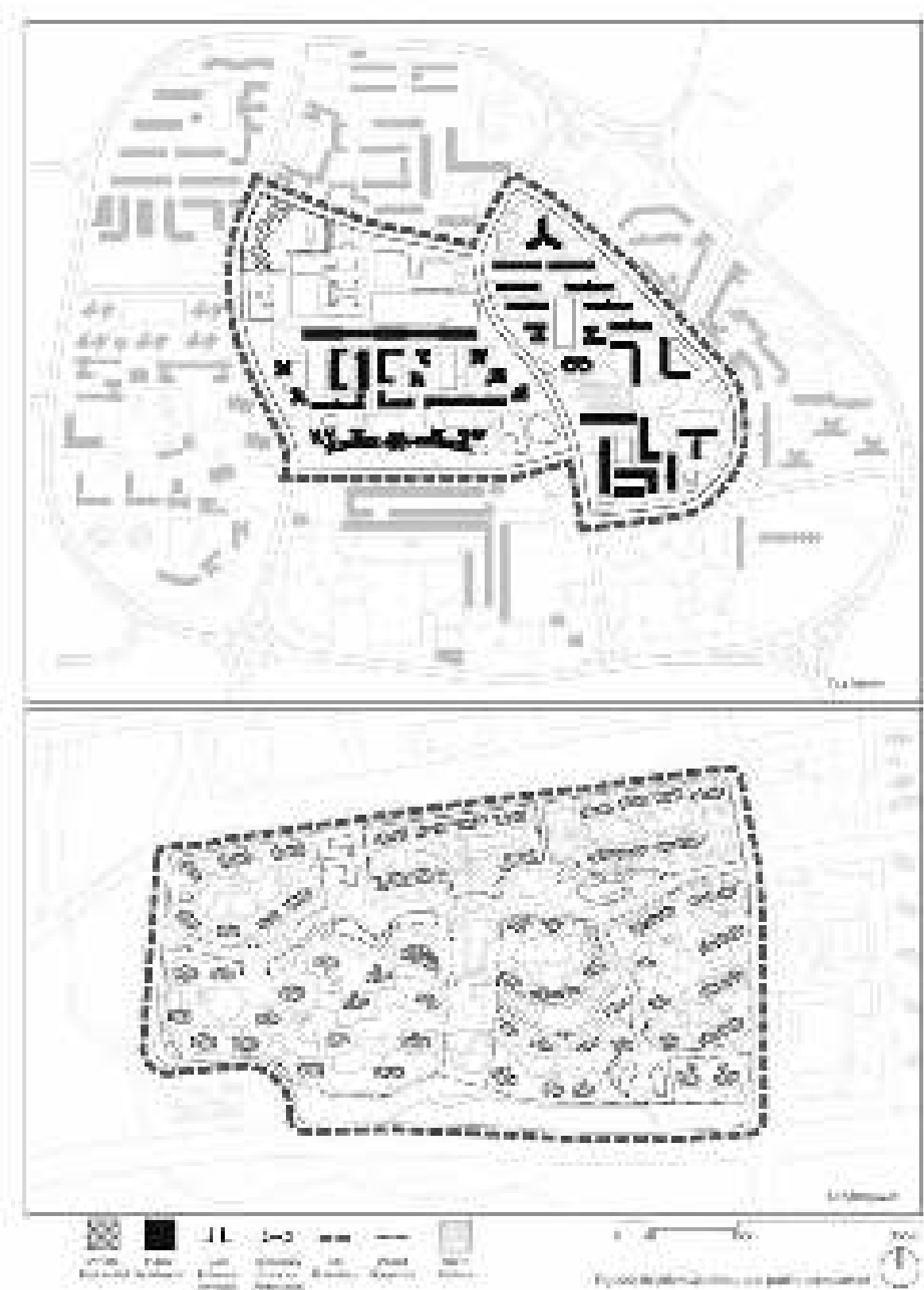
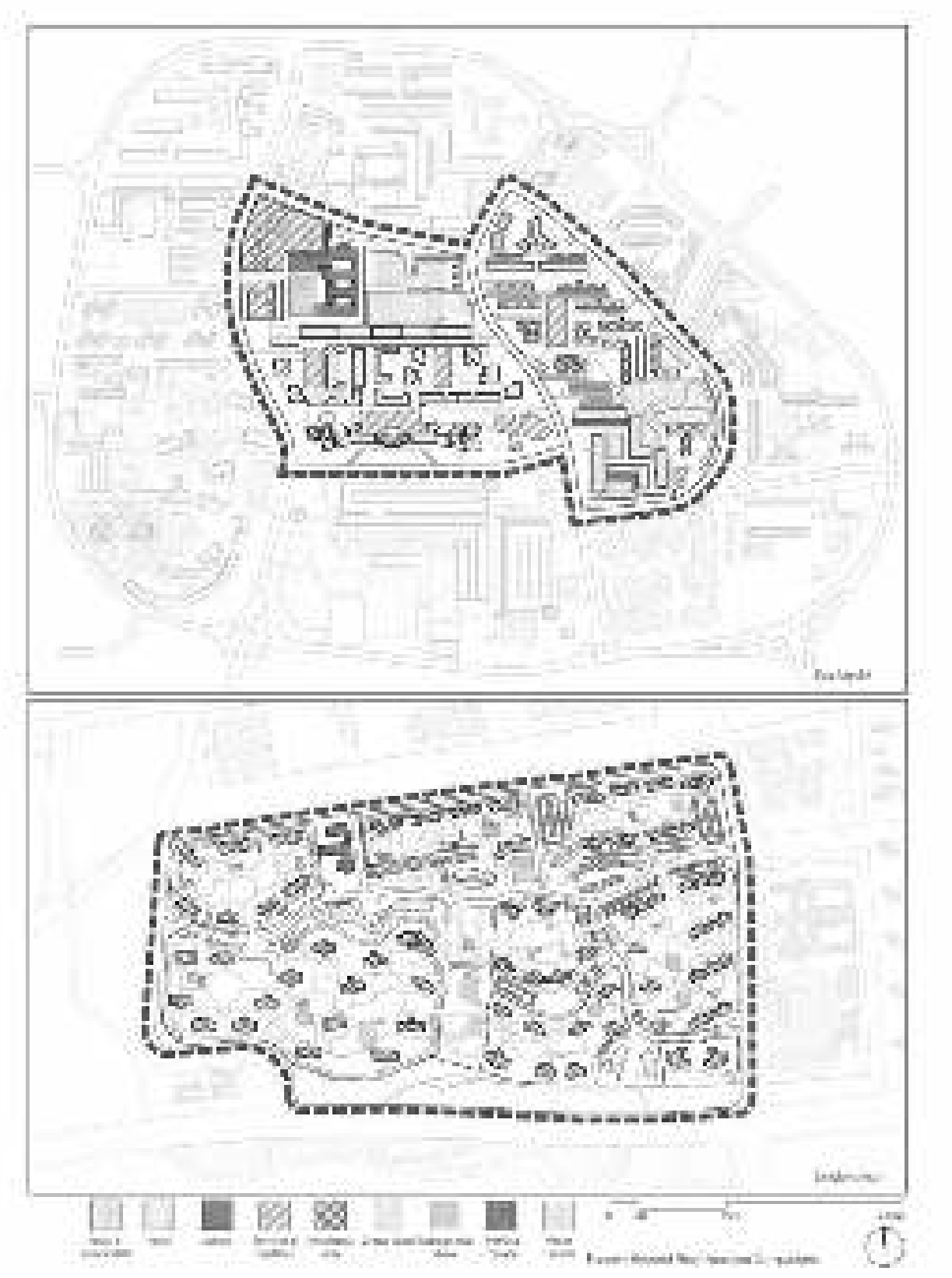


Figure 2. Residential Private and Public Comparison.



Figure 3. *Road System Comparison.*



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Residential Fortified Enclaves

The Influence of Tall Buildings on Socio-Spatial Segregation in Londrina, Brazil

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Keywords: Urban form, Segregation, Fortified enclaves, Tall building.

Abstract: The aim of the study is to understand the relationship between socio-spatial segregation and urban form, those of residential fortified enclaves, more specifically, tall buildings. We observe the proliferation of residential enclaves in the upper middle classes due to the fear of urban violence which segregates them in their highly secure neighborhoods. However, this closure, instead of solving the problems of insecurity of the privileged classes, intensifies even more a historical process of inequality and inserts into the urban space several problems such as the discontinuity and the fragmentation of the road network and the intensification of the traffic. This urban form can reinforce spatial segregation between different social groups. In Brazil, residential fortified enclaves occur specially in forms of towers, between 1980 and 2010 they increased by 46%. Different from the gated communities, the neighborhoods of towers are open and have no visible border to access. However, they seem to produce a different border that is socially, historically and mentally constructed in the unconsciousness of the population, that is, neighborhoods of towers do not conform enclaves that are physically closed but are socially closed. Our hypothesis is that neighborhoods of towers accentuate social disintegration between residents, and this can be observed in three scales of residential segregation. To verify these hypotheses, we will study the case of the Neighborhood Gleba Palhano in Londrina – Brazil, which since the late 1990s has been developing in an intense way without considering the urban problems of social inequality that ensues.

1. Introduction

There is an increasing number of closed residential enclaves known as “gated communities”. The latter are nourished in particular by the fear of urban violence. As a result, the middle and upper classes segregate themselves in their closed quarters, secured 24 hours a day, with electric fences, high walls and private alarm systems. This residential model is therefore the ideal option for a population concerned about their safety and well-being. Thus, this urban form ultimately reinforces the spatial segregation between the groups that have access and those who do not have access to a private security system (Caldeira, 2000).

The urban form of closed enclaves thus constitutes a new model of urban segregation based notably on the privatization of security, which profoundly transforms the character of the pub-

lic space. In fact, the fear of crime ends up modifying all sorts of social interactions in the urban space. This urban form creates a space that directly contradicts the ideals of heterogeneity, accessibility and equality that have made it possible to organize both public space and modern democracies. In other words, the construction of closed enclaves alters the character of public space, as well as the participation of citizens in public life (Caldeira, 2000).

In Brazil, this enclosing process is increasingly taking the form of high-rise construction, which is a remarkable feature of the landscape of Brazilian cities (Souza, 1994). Between 1980 and 2010, the number of condo towers increased by 46%, altering the landscape and the way of life of the citizens (Ferreira, 2006; Herzog, 2015; Töws & Mendes, 2011).

Unlike gated communities, the neighborhoods of the condominium towers are open and have no visible barriers to access, that is, they are not physically enclosed enclaves. However, they form huge corridors of empty, lifeless streets with highly secure walls and fences giving access to towers that deny the presence of pedestrians in the streets. These zones of forced surveillance, according to Jacobs (1991), contribute to spatial segregation and discrimination through deserted streets where people from outside the neighborhood do not feel invited or comfortable to go.

The general research question is therefore to understand how the urban form of co-ownership towers could influence the social practices of the residents of this type of neighborhoods leading to sociospatial segregation.

At first glance one can not imagine that towers can generate sociospatial segregation and dysfunction in the urban fabric, given its open neighborhood character. However, within the block, residents' behavior and social practices can lead to segregation and insecurity.

In order to understand this phenomenon, it is proposed the case study of the "Gleba Palhano" district, located in Londrina in the southern region of Brazil. Since the end of the 1990s, the neighborhood has developed in an intense and unbridled way, without considering the urban problems that derive. The "Gleba Palhano" is a predominantly residential area for the middle and upper classes, and currently has a high concentration of condominium towers

2. Closed enclaves: the materialization of the "generic city" in Brazil

What emerges from the reflection on the concept of sociospatial segregation is that social cohesion is weakened by the emergence of the "gated communities" and by the materialization of the "generic city". The latter contradicts the very idea of a city defended by Merlin & Choay.

The city is born of people's need for interaction and the benefits that it provides; it is limited by the constraints on a life of relationships, or by the disadvantages it creates. The city is therefore basically born of central functions of exchange, confrontation or collective meeting (Merlin & Choay, 2000, p. 939).

Thus, the city has a relationship with the democratic emergence. It is born from the idea of creating a space that makes possible the expression of conflicts. However, the discourses around today's cities lead to a world of constitutionalism that dodges conflictuality and produces spaces that are increasingly distinguished by individuality (Mongin, 2003). By observing these new dynamics, Rem Koolhaas defines it as the "generic city".

The generic city is the liberated city of enslavement to the center, stripped of the straitjacket of identity. The Generic City breaks with the destructive cycle of dependency: it is nothing but a reflection of the necessities of the moment and the present capacities. It is the city without history (Koolhaas, 2011).

The “generic city” is the result of a functionalist and neoliberal urbanism, which seeks the aesthetic standardization and commodification of the land, generated in a savvy manner by its multiple actors. It exists everywhere in the world and defeats the right to the city.

In Brazil, from one city to another, it can be seen very clearly the manifestations of the “generic city” that are more manifest in the shape of closed enclaves. Their closure seems to be the spatial materialization of new social boundaries resulting from the increase of inequalities since the 1960s, when the distribution of the urban population exceeded that of the rural population (Santos, 2005).

The “condomínios fechados”, as they are called in Brazil, constitute the new urban desires that are no longer confined to the house as private property, but extend to the privatization of its environment. In addition to a desire for exclusivity, the search for social distinction with foreigners and social homogeneity within the framework of the co-ownership, the possibility of lodging in large properties, contact with nature and especially the concern for security are other important factors leading to the spread of closed communities (Melgaço, 2012).

In Brazil, increasingly more closed communities are produced in the form of a tower of condominiums. According to Elguezabal (2015) neighborhoods of condominium towers do not constitute closed enclaves as Caldeira (2000) asserts, once they do not have a physical boundary to access it as in the case of “gated communities”. However, these neighborhoods of towers seem to produce in the urban space a certain social boundary. Thus, it can be stated that neighborhoods of condominium towers produce closed social enclaves.

The “condomínios fechados” combine the function of housing with a high level of comfort, quality of life and safety. Through their walls and controlled access to their space, they constitute a real defense against the city by creating an “artificial” community among the residents, taking into account, above all, the socio-economic level. The proliferation of privatization of urban spaces (places of coexistence in shopping centers, deserted places in large business complexes, leisure and social spaces in closed condominiums) therefore produces “cities” in the city. From this privatization, the notion of “open and collective city” is changed by a sense that favors an ideal of exclusivity, where collective goods (security, recreation, education, health, transportation and housing) become accessible only to those who can afford them. Thus, this phenomenon generates an exclusive urban form of exclusion that reinforces and accentuates the historical process of socio-spatial segregation (Leitão 2005; Levy 2010; Melgaço 2012).

3. From the ground up: the urban evolution of Londrina

Segregation – social and spatial – is an important urban phenomenon of cities, which are organized fundamentally according to the rules of social differentiation and separation. These rules, culturally and historically different, reveal the principles that structure public life and show how social groups have linked in the space of the city (Caldeira, 2000).

In this section, the author does not claim to describe the city of Londrina historically, but rather to weave a condensed discussion of the trajectory of the city, from its genesis to today, especially concerning the occupation of the residential urban space that has been segregated since its foundation as it will be demonstrated. Founded in December 10, 1929, Londrina is a city located in the north of the state of Paraná, southern region of Brazil, in a strategic geo-economics position (Figure 1) (Polidoro *et al.*, 2011).



Figure 1. Location of Londrina city. Source: IPPUL – Londrina. Compiled by: Authors.

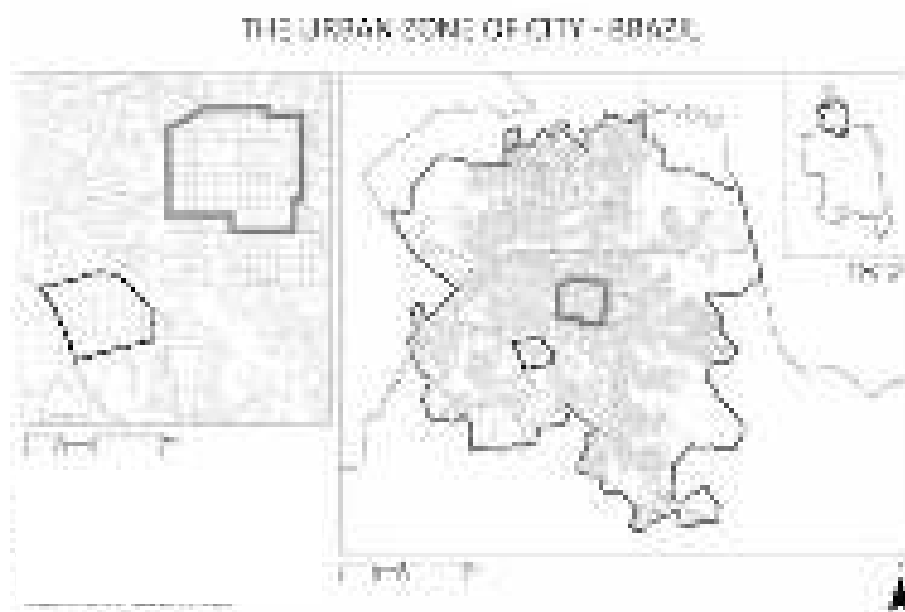


Figure 2. The urban zone of Londrina. Source: IPPUL – Londrina. Compiled by: Authors.

The urban occupation of the city of Londrina initially occurred in the central zone, which had an orthogonal urban form designed to facilitate the subdivision of urban lots by making them as regular as possible (Figure 2) (Linardi, 1995; 2009).

The different social strata who lived there have influenced the conception of the city since colonization. The wealthy class consisted of real estate developers, farmers and bankers, while the middle class consisted of merchants, self-employed professionals and small landowners. On the other hand, the working classes were composed mainly of rural workers and the self-employed in general. By the end of the 1930s, the city already had the first settlements outside the original grid, located in the northern part of the territory, intended for a more disadvantaged population (Linardi, 1995; Silva, 2009).

The first concerns regarding the use and occupation of the land date back to the late 1940s, when the city began expanding outside the original plan. The expansion towards the agricultural periphery gives rise to subdivisions serving the interests of landowners without a general orientation. In this context, the city of Londrina produces its first instrument of urban regulation after the original plan of colonization of the city, the Law n.133. Although it had detailed regulations, this law divided urban areas according to social classes. The central region was considered as the commercial and politico-administrative center, which allowed the local ruling classes to settle in this quadrilateral. The plan divided the city into three concentric zones in relation to the city center: in the first one, only masonry houses were allowed. In the other two areas, it was allowed to build wooden houses, which until now were the vast majority in the city's landscape (Linardi, 1995; Silva, 2009).

It can therefore be seen that this urban planning by-law has in a certain way contributed to the sociospatial segregation of the various social classes in the city by legislating on the type of construction equipment authorized in each zone. It is important to mention that in Brazil, masonry construction is a very common technique and wood construction is generally used as an economic alternative used by the underprivileged. Thus, the construction material used for the residential building is also an element of social stratification.

In the decade of 1950, Londrina underwent the greatest territorial, demographic, physical and economic expansion of its recent history. This expansion occurred quickly and disorderly, without following the initial urban plan. It is mainly due to the expansion of the economic and social dynamics of small commercial production (first commercial establishments) and not only to the production and marketing of coffee. During this period, the appearance of the first buildings in height also testifies the wealth of the city (Fresca, 2002; Linardi, 1995; Silva, 2009).

The 1960s further aggravated Londrina's urban problems caused by the beginning of a process of regional urban disorganization. Among the factors that determined this new reality is the crisis in the coffee economy, which led to the eradication of coffee from 1962, contributing to the migration of the rural population to the urban area. At the same time, the government stimulated industrialization, to the detriment of the agricultural sector, which has produced profound socio-economic transformations in the region. The city of Londrina has since changed its original characteristics, from an agricultural center to a center of tertiary activities, particularly in the sectors of trade and services in the fields of health and education (Linardi, 1995; Silva, 2009).

In the 1970s, sociospatial segregation was already consolidated between Londrina's social classes: the dominant classes in the south and in the valley floor, and the workers located north of the city, following a historical trend. At the same time, there is an accelerated process of high-rise construction in the city center and the periurbanisation of a considerable part of the population (Linardi, 1995; Silva, 2009).

With a population of 300,000 in the 1980s, Londrina is known for its strong tertiary sector of structured economy and external market influence, as well as an increase in the service sector. An important element of this period is the construction of the "Catuaí Shopping". A large shopping center of approximately 80,000 m² built in the southern part of the city that changed the consumption patterns of the population and has had direct influences on urban growth (Fresca 2002; Silva 2009).

For approximately a decade, areas adjacent to this real estate development have been integrated into the urban network and intended for a population able to pay for high-end properties, including residential condominiums (Fresca 2002). The appropriation of this sector was initially done through the construction of "gated communities" or "condomínios fechados", with

high quality buildings, in which there are natural or artificial amenities, a regular topography, access transportation and infrastructure for a high-income population.

Since the 1990s, there is a strong occupation in the sector in the form of vertical towers, especially in the district “Gleba Palhano”, currently one of the most valued areas of the city. Until then, its occupation was almost exclusively for small rural properties (Silva, 2009). The new form of occupation of the neighborhood takes place in a differentiated way, and both real estate developers and new residents share the desire and search for social homogeneity, associated with privacy and security. In this sense, sociospatial segregation extends across the sector in a vertical and horizontal form.

Given the initially agricultural nature of the area, property developers were pushing public authorities to undertake road infrastructure in the area to ensure smooth traffic flow on their previously acquired land. They justified their actions by the discourse of development and progress of this region. However, it is clear that their main objective was the private ownership of the benefits of the public resource infrastructure (Fresca 2002; Silva 2009).

Added to this, the environmental image associated with the sector, is another factor contributing to its valorization, thanks to the proximity to Lake Igapó, a public space of recreation and leisure. Built in the early 1960s, revitalized and improved successively during the 1960s and 1970s, Lake Igapó was the target of the development strategies of real estate developers, especially on its southern bank, now “Palhano” (Fresca, 2015). Some developers have incorporated it as an additional attraction for the acquisition of a high-rise building. However, due to the occupation of its environment, several processes of erosion, siltation and continuous degradation have occurred at Lake Igapó (Fresca 2002; Silva 2009).

It can therefore be observed that a series of factors contributed to the development of the second largest concentration of high-rise buildings in Londrina after the city center, the “Gleba Palhano” district. Since its colonization, the higher income layers have established in the southern portion of the territory, bringing elements of valorization to their region, such as: the construction of Lake Igapó in the 1960s; the development of the large shopping center “Catuaí Shopping” followed by improvements in road infrastructure financed by the government; and finally the establishment of wealthy classes in “gated communities” from the 1990s.

4. Towers and segregation: a method of analysis

As presented in the previous section, the different social classes living in the city of Londrina, have been unequally organized in the territory. The richest layers were established in the central and southern districts, and the working classes in the northern part of the city, following a process of historical spatial organization.

Thus, the development of the “Gleba Palhano” district is not a driver of sociospatial segregation, but rather the reflex of an existing process of social inequality. In this way, the hypothesis of the assimilation of this field of study to enclaves and its inclusion in the transformations of large social and segregated structures precedes the qualitative surveys of the present case study.

This area has attracted the attention of real estate developers since the early 1990s, in order to develop a district of ideal and idealized condominium towers for the middle and upper classes of Londrina. With a strong and intense growth in the number of buildings, the area composed almost exclusively of condominium towers, had until the year 2000 only seven apartment towers (Paula, 2006). However, between 2004 and 2014, the multiplication of this urban form is

remarkable on the territory, presenting a growth of more than 300% on the number of towers, as evidenced by Figure 3.

Despite the fact that the neighborhood shows a significant increase in the density of the population and housing, it suffers, according to Mauá *et al.* (2017) a strong process of depopulation of the streets because of the non-diversity of uses and a flow of vehicles much more important than that of the pedestrians. There is also a trend towards the privatization of common spaces, located almost exclusively on the ground floor of buildings contributing to the visual closure of streets. The only common area open to the public is the square “Pé vermelho” (red foot) located in an isolated cul-de-sac of the main avenues that serves only as space for integration of adjacent towers.

However, unlike in the “Gleba Palhano” neighborhood, predominantly residential areas are expected to have a variety and mix of uses, as well as proximity to workplaces in order to allow an autonomous organization for vehicle reduction and increased pedestrian movement (Carmona, 2010; Gehl, 2011; Jacobs, 1991).

The urban morphology of the neighborhood, that is to say, the way the towers have arranged one with respect to the other and with respect to the mesh, does not take into account pedestrian circulation, and the possibility of visual interaction between people becomes limited (Mauá *et al.*, 2017). Thus, there is little evidence of interaction and social participation between residents on the streets which ends up reinforcing sociospatial segregation by not taking into consideration public spaces that trigger social cohesion amongst the population.

The tower is not a sufficient criterion of residential valorization nor is considered as an enclave by the residents. On one hand, because the main criterion of the residential hierarchy is not the fence, but the location. On the other hand, because it is not a question of socially homogeneous spaces, in other words, the boundaries of the fence do not spatially translate into a new social boundary separating “winners” and “losers” (Elguezabal, 2015).

Therefore, rather than addressing the towers as “enclaves”, they must be considered as places

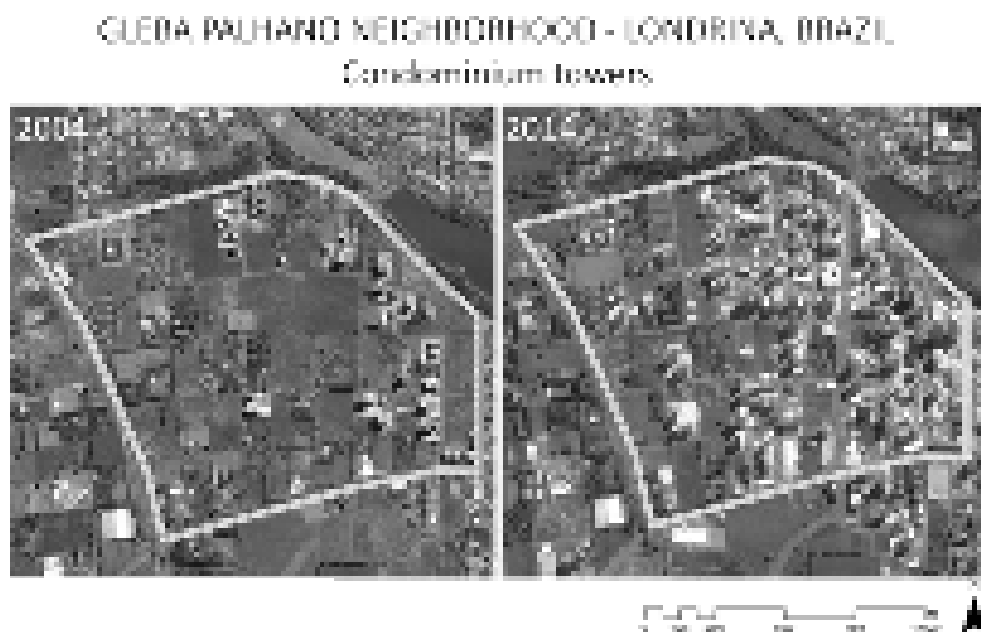


Figure 3. *Quartier Gleba Palhano – construction de tours de copropriété | 2004-2014.*
Compiled by: authors

subject to a “privatization process”, once social practices are – apparently – exclusive and exclusionary common spaces that end up reinforcing and accentuating socio-spatial segregation. Very little research has explored the relationship between urban form, including tall building and sociospatial segregation. Work on the relationship between the closed enclave and sociospatial segregation focuses on horizontal “gated communities”, presenting a particularly different dynamic from open neighborhoods of condominium towers. Having a physical barrier to access the interior of condominiums creates, among other things, discontinuity in the urban fabric and forced separation between the residents who live there and those in the surrounding neighborhoods. However, neighborhoods of condominium towers are open and do not present physical barriers, but in a way they seem to produce a social barrier, which is socially constructed, historically and mentally in the unconscious of the population. In other words, neighborhoods of condominium towers do not conform to enclaves physically closed, but socially closed.

In this sense, several questions guide this research: How then the urban form of the condominium towers in the district of “Gleba Palhano” generates social practices that lead to sociospatial segregation? Do these social practices change depending on the scale of the analysis? Is segregation a conscious thought among residents or is it an involuntary phenomenon? What are the urban intervention strategies that could lead to greater social cohesion among the population?

The main hypothesis lies in the fact that the urban form of condominium towers in the “Gleba Palhano” neighborhood accentuates social disintegration between residents, and this would be observed on three different scales: (1) internal-external segregation, that is to say, a weak social relationship between those who live in the neighborhood of towers and those who live in the immediate neighborhoods; (2) a segregation within the neighborhood itself, that is to say a social hierarchy that differs the residents of the neighborhood either by the location or by the architectural quality of their building, thus contributing to the weakening of social cohesion in the neighborhood; (3) and finally, intra-building segregation, that is, a social hierarchy in the tower, either between residents according to the inhabited floor or between residents and service staff.

In order to test these hypotheses on the case study, the research strategy will be based on a methodology with an inductive approach based on an action-research in the field that will take place from May 2019.

The research methodology adopts an empirical approach that mobilizes both the quantitative and the qualitative approach. As a first step, the quantitative approach consists of identifying the socio-economic profile of the population residing in the “Gleba Palhano” neighborhood from federal census data, and developing an inventory that describes the growth in the number of buildings in the area. The data will be processed quantitatively in order to characterize the phenomenon. In a second step, the qualitative approach mobilizes, in order to grasp – in depth – the relationship between socio-spatial segregation and urban form, 4 phases of operationalization: (1) field observation; (2) the mental map; (3) the semi-structured individual interview; and (4) Focus Group.

5. Final considerations

The closed residential enclave is a phenomenon of self-segregation of the middle and upper classes, favored mainly by the fear of urban violence. This residential model is associated with an urban form that reinforces a historical process of social inequality and generates, among other things, the discontinuity and fragmentation of the urban fabric (Caldeira, 2000; Melgaço, 2012).

It is observed that more and more the processes of residential isolation in Brazil occur in the form of co-ownership towers, which unlike “gated communities”, are in open neighborhoods and have no physical barriers to access them. Although these neighborhoods are open, they have empty street corridors, consisting of walls and fences, which deny the presence of pedestrians in the streets and contribute, according to Jacobs (1991), to spatial segregation. In other words, neighborhoods of co-ownership towers are not physically closed enclaves, but rather socially closed enclaves.

At first glance one cannot imagine that condominium tower neighborhoods can generate sociospatial segregation and a dysfunctionment in the urban fabric, given its open neighborhood character. However, within the neighborhood, residents’ behavior and social practices can lead to segregation and insecurity.

Thus, the objective of this research is to understand how the urban form of condominium towers, which is not a physically closed enclave, generates social practices that lead to sociospatial segregation. The hypothesis thus lies in the fact that the neighborhoods of the condominium towers accentuate the social disintegration between the residents in three different scales: 1) internal-external segregation; 2) segregation within the neighborhood itself; 3) and finally, intra-building segregation.

These hypotheses will be verified through the analysis of the case of the “Gleba Palhano” district in Londrina, southern region of Brazil, which between 2004 and 2014 showed a growth of over 300% in the number of condominium towers intended for the middle and upper classes. The development of the “Gleba Palhano” district is not the lever of sociospatial segregation in the city of Londrina, but the reflection of a process of historical social inequality. Since the period of colonization of the city in the 1930s, the different social strata settled unequally on the territory, concentrating the higher income strata on the southern part of the territory, the current “Gleba Palhano”.

Data collection will take place from May 2019.

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The Auto-Poesies of Urban Emergence

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Keywords: Urban Emergence, Socio-form Patterns, Adaptation, Christopher Alexander.

Abstract: This paper examines the notion of emergence as a dualism of the urban and social system. The intent is to facilitate a deeper understanding of urban and social theories that use emergence as a tool for the systematic formation of socio-spatial relations. The approach includes the definition of a socio-form component as the catalyst element of urban emergence. An analytical examination of Christopher Alexander's pattern theory is explored, and it is used as a parallelism of social and urban morphogenesis. The argument is that for urban emergence to occur, the process of social engagement is necessary. The analysis of this dialectical relation brings Niklas Luhmann Social Theory and Evolution to the foreground and highlights the role of communication as the main principle of change. The change, and therefore emergence, happens as the system gradually adapts to environmental dynamism. This process of adaptation and the structural flexibility of the system is the mechanism that incorporates the urban and social systems. The efficiency of the urban space to correspond to the social need as change occurs, is highlighted. Therefore, the importance of adaptable social and urban emergence is seen as a theoretical model that auto-generates and leads to urban autopoiesis.

1. Introduction

This paper attempts to unfold theories of urban emergence and urbanism, the creation of human settlements, as a parallel process to the creation of human societies. Urban emergence most often is described as the process of morphological change that is associated with computable or comparable definitions ("the city expanded", "the city densified", "the city shrunk", etc.). When referring to change, urbanism tends to perform as a pragmatic quantitative science that measures space as a definite, deliberate act of computation. Thus, urbanists when describing the urban morphology, follow a pragmatic analytical process. On the other hand, in urban sociology, urbanism tends to be presented as an environmental subject, a field of sociological, anthropological, and ethnographic elements.

When Italo Calvino wrote about the 55 Invisible Cities¹ he argued that there are two ways to describe a city; describe its appearance, structure, and form (as you would define an artifact) or explain what you feel and experience while approaching, walking, and exploring it.

1. Italo Calvino, *Invisible Cities*, Giulio Einaudi, 1972.

"There are two ways of describing the city of Dorothea: you can say that four aluminum towers rise from its walls flanking seven gates with spring operated drawbridges that span the moat whose water feeds four green canals which cross the city, dividing it into nine quarters, each with three hundred houses and seven hundred chimneys...Or else you can say: "I arrived here in my first youth, one morning, many people were hurrying along the streets toward the market, the women had fine teeth and looked you straight in the eye, three soldiers on a platform played the trumpet, and all around wheels turned and colored banners fluttered in the wind. Before then I had known only the desert and the caravan routes. In the years that followed, my eyes returned to contemplate the desert expanses and the caravan routes; but now I know this path is only one of the many that opened before me on that morning in Dorothea".²

Calvino's book was one of the few urban writings that intentionally brought places and experiences together. Therefore, this paper deliberately focuses on theories that talk about the importance of human communities, and the society in producing meaning and experience in the urban space. It is an opportunity to recall those urban theories that talk about an urban ordering deriving from social evolution. Emergence is seen as the self-generated process where experience and engagement occur and frame urban morphogenesis as a parallel process to social transformation.

2. Methodology

This paper uses a direct structure between practical observation and theoretical analysis and ultimately concludes by describing the urban and social *autopoiesis*. For this analysis, the urban is considered as a system and emergence its process of transformation. The main research question of how emergence can be urban and social gets highlighted throughout. The definition of *autopoiesis* brings the latter dualism closer and creates connections between practice and theory. In this way, the contemporary urbanist and analyst will be able to approach social problems through the urban course.

The paper begins with an examination of urban emergence as the catalyst of the produced urbanism. There, starting from utopian ideas about urban living, a critic of the current mechanism of space production is attempted. The writing continues with an analysis of Christopher Alexander's urban theory of *Pattern Language*³. His approach to a user-oriented pattern system creates a useful link to the notion of social emergence. For the latter, and the description of the social system, Niklas Luhmann *System Theory* is explained. Eventually, the argument of social change as an autopoietic urban transformation gets stated. Finally, the writer concludes with the importance of adaptable transformation as the theoretical model that contains those physical and social elements which can auto-generate through autopoietic mechanisms.

3. Analysis/Results

3.1. Utopian and Contemporary Approaches to Urban Emergence

Urbanism for theorists and visionaries of the 19th and 20th century was a romantic composition that would inhabit the individuals of the future society; it was the product of a visionary idea that felt liberating. Usually, in the ideological models, the ideal way of living and the spatial

2. Italo Calvino, *Invisible Cities*, Giulio Einaudi, 1972, p. 16.

3. Christopher Alexander, *A Pattern Language: Towns, Buildings, Construction*, Oxford University Press, 1977.

parts of the urban composition would be formed by the society. The opposite concept that the urban system can form social relations was represented through the architectural ideal of modernism; by organizing social behavior. Mainly, the modern city was illustrated as a system of functional hierarchies that indicated roles and structured mechanisms. Instead, historic utopians used as a defining factor and essential element of their utopian structure, an evolving replicable component capable of pursuing the individuals' decision, a structure complementing the social desire.

For a contemporary practitioner, that would be a challenge. Nowadays, the urban environment is often over-defined because of economic and political pressures. In most cases, change happens predictably as explicit meanings dominate. In the current system, urban emergence is a transition from one mode to another due to shifts in economics, politics, and demographics; it is a venue of economic, political, and international will. Thus, urban space is used primarily as a medium, an environment that defines those economic and demographic relations and, secondly, as an ideal and a sociological subject.

However, when sociology, anthropology, and urbanism need to be discussed, the subject of urban space needs to shift and become a place of encounter, assembly, and simultaneity. Indeed, David Harvey has asked us to relate more to a utopianism rather than the spatial form. He asked us to see the production of space as a spontaneous action where an endless possibility of phenomena can occur. He suggests an alternate social ordering "*an alternative way of doing things-reveals the process of social ordering to be just that, a process rather than a thing*"⁴. Recently, urban theory and urban sociology started focusing on processes in which urban space appears to occur naturally as a spontaneous human action. However, how is it possible for a planned artifact to arise spontaneously?

Spontaneous order is typically used to describe the emergence of various kinds of social orders from a combination of self-interested individuals who are not intentionally trying to create order through planning⁵. It arises when multiple actors spontaneously adopt a set of actions and behaviors that provide them with a competitive advantage. Specifically, when individuals act in pursuit of something, they create a spontaneous set of patterns and, through the development and evolution of their behaviors, turn into self-sustaining patterns. Interestingly, for Friedrich A. von Hayek, this takes place without any of the actors being conscious of this creation; instead, it is a spontaneous action and a process of self-organization of the social system.

3.2. Christopher Alexander's Pattern Theory

When referring to the description of urban space, the spontaneous formation of patterns is used to describe the process of emergence. Christopher Alexander used a spontaneously emergent pattern theory to enable urban morphogenesis through user engagement. The inspiration for his work was that the buildings of traditional societies are inherently more beautiful than contemporary architecture. This incontinence starts from radically different design approaches between traditional and modern architecture. Within his writings, he analyzed how traditional buildings are the product of a communally-shared value system. They contribute to a piecemeal adaptation under changing circumstances since they are always harmonious with their environmental conditions.

4. David Harvey, *Spaces of Hope*, Berkeley: University of California Press, c2000, p. 54.

5. Friedrich A. von Hayek, *Spontaneous Order*, https://en.wikipedia.org/wiki/Spontaneous_order.

Eventually, Alexander developed the *Pattern Language*, where he redressed the subject of design and presented urban emergence as an occurrence of natural phenomena and the individual's action. His argument was that, for social communities to operate, space must enable multiple overlapping sets of human activities. Space, and therefore its main component, the pattern, should allow the emergence of *human situations* (typicalities) instead of the optical form and the architectural objects (typologies)⁶. Under this approach, the patterns come together and evolve naturally as an inductive approach to incremental morphogenesis. Eventually, they coexist in a semi-lattice environment, in a system that is open to change⁷. This urban system is a composition of intensities of socio-spatial patterns that can be found across different scales of urbanism. However, they are always in a transformable harmonic balance; *it is the structure of living things – of great paintings and symphonies*⁸.

Moreover, Alexander was interested in the process of transforming parts into wholes. He structured a relational theory, where he defined how to implement a part-whole synthesis. He talked about the formation of a complex socio-spatial system with a simple format, a code language. His new language involved an explicit reference between form and context and defined the importance of their coexistence⁹. In his book "*A Pattern Language: Towns, Building and Construction*", he identified 253 patterns as components in which humans can identify the space they live in, and therefore build that system that encourages interaction at multiple levels either among them or with their environment. Specifically, he wrote:

these patterns can never be "designed" or "built" in one fell swoop – but patient piece-meal growth, designed in such a way that every individual act is always helping to create or generate these larger global patterns, will, slowly and surely, over the years, make a community that has these global patterns in it...We do not believe that these large patterns, which give so much structure to a town or of a neighborhood, can be created by centralized authority, or by law, or by master plans. We believe instead that they can emerge gradually and organically, almost of their own accord, if every act of building, large or small, takes on the responsibility for gradually shaping its small corner of the world to make these larger patterns appears there¹⁰.

The above model suggests semi-ordered urbanism, where the design of patterns is an interlocked relation between the need and space. This relation that can be identified, re-combined, and re-used, in a language-like way, and be the catalyst of urban emergence.

To summarize, using the patterns as elements of a new design process was more than a design innovation. It was a responsible approach to generating spaces closely aligned to human need, a participatory design paradigm. However, through their application, Alexander expected that the "*central quality which is the root criterion of life and spirit in a man, a town, a building, or a wilder-*

6. Christopher Alexander, Sara Ishikawa, Murray Silverstein, *A pattern language which generates multi-service centers*, Berkeley, Center for Environmental Structure, 1968, p. 3.

7. "Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice", similar as footnote n. 6.

8. Christopher Alexander, *A Pattern Language: Towns, Buildings, Construction*, Oxford University Press, 1977.

9. "The form is a part of the world over which we have control, and which we decide to shape while leaving the rest of the world as it is. The context is that part of the world which puts demands on this form; anything in the world that makes demands of the form is context. Fitness is a relation of mutual acceptability between these two. In a problem of design we want to satisfy the mutual demands which the two make on one another. We want to put the context and the form into effortless contact or frictionless coexistence", Christopher Alexander, *Notes on the Synthesis of Form*, Harvard University Press, p. 28.

10. Christopher Alexander, Sara Ishikawa, Murray Silverstein, *A pattern language which generates multi-service centers*, Berkeley, Center for Environmental Structure, 1968, p. 3.

ness”, the ‘*quality without a name*’¹¹, as he defined it, would be inherited by the environment. The form, under this model, is not a mere collection of parts that are stamped out and gathered into a composition; rather, it emerges from a continuous transformation of elements, in an unfolding process; *the patterns are evolved solutions for accommodating human needs; they are the connective and configurational prescriptions of human activities rather than geometrical constraints*¹².

In conclusion, Alexander invented a socio-spatial system and used it as a relational system to link spatial and social components to accomplish three goals. Firstly, it has a moral achievement, as it includes the user in the design process and, secondly, it aims for a structural coherence between patterns and users. Thirdly, it is generative as it allows people to create the latter coherence by encouraging this process and emphasizing the assembled whole. It is a process of retaining the urban characteristics that trigger activity and enables the evolution through practical engagement. It is less of a preprogrammed language that alleviates the need to re-discover solutions for every problem. Instead, it justifies the need for a user-specific solution as it embraces both innovation and tradition in an attempt to “*ensemble capable of expressing a unitary description of the varied phenomena we encounter*”¹³.

Finally, besides the theory’s criticism about its applicability, when used to describe urban emergence, his approach retains the collective memory and identity as urbanism emerges; it is a living structure that has a capacity to absorb spontaneous additions, subtractions, transformations without disturbing its sense of order. It accepts and enhances such changes and turns the system into a system of urban and social composition. The evolution of the urban-social occurs naturally as the different components are designed with enough capacity to receive, recollect and extrapolate the inherited information. If we relate it to David Harvey’s ‘*right to the city*’¹⁴ argument, it is a democratic way by which end-users are involved in its formulation.

3.3. Social System and Evolution Theory

The socio-form process suggests a sociological approach to urban emergence and assumes that the production of the built environment is inseparable from larger social processes. Therefore, urban evolution is associated with social evolution as a parallel process. It is possible to see the urban as either a system of built elements or as a system of human activities linked by interaction. How social action gets reflected in the built environment is pointed out further. However, to make the two subsystems more open and explicit and study that reflection, a social systems theory is analyzed. Finally, how society and urban space link through the notion of autopoiesis (a process that links the urban system evolution to the urban system) is analyzed.

One systems theory that supposes the social as a system and describes process of evolution is Niklas Luhmann *Systems Theory*. Luhmann, a German sociologist himself, spent most of his academic time working on a threefold theory connecting societal theory, communication, and evolution. He, a student of Talcott Parsons, continued the tradition of sociological patterns and talked about social systems as systems of communication. *System Theory* is still one of the most influential paradigms of sociological thinking and research.

Luhmann’s System Theory is emphatically a system-environment theory specified by its self-referential character. The selectivity of the relations contains the boundary, the interior, and the undefined exterior. The system’s interior is a defined zone where communication can

11. Christopher Alexander, *The timeless way of building*, Oxford University Press, New York, 1979.

12. Nikos Salingaros A., *The Structure of Pattern Languages*, Architectural Research Quarterly, 2000.

13. Christopher Alexander, *Notes on the Synthesis of Form*, Harvard University Press, p. 29.

14. David Harvey, *The Right to the City*, <https://davidharvey.org/media/righttothecity.pdf>.

happen by selecting only a limited amount of all information. Any social system for Luhmann uses selectivity to produce meanings and specify its relation to its environment. When eventually all the selected information is processed, it can generate the *meaning*¹⁵. Therefore, a social system, according to Luhmann, consists only of communications, and there is no communication outside of social systems. In other words, there is a sharp boundary separating social systems from those environments that do not consist of communications. In this notion, communication is the primary catalyst of change as social systems only process meaning.

Therefore, Luhmann developed a theory describing the emergence of a system through the self-specification of the elements, which are constitutive of the system. That occurs when the system receives information about the environment through communication and determines how the system evolves. Luhmann looked at changes in social structures from a long-term perspective through an evolutionary paradigm. Instead of arguing 'modernization' or 'social change' as relevant theoretical paradigms for the evolution of the social system, he preferred a neo-Darwinist evolutionary approach. Under that, evolution happens in and through communication as a three-step process of variation, selection, and restabilization. Specifically, variation refers to all new communication that introduces change into a system state. Selection refers to the positive or negative selection of specific variations. Restabilization refers to the state of the evolving system after a selection has taken place. In other words, as the system transforms, the environment in which it operates also transforms, producing a spiraling process of change that functions in unity as the system processes itself. That process of transformation Luhmann called autopoiesis. Therefore, an autopoietic system defines itself as being in opposition to its environment; it constantly recreates itself in its elements and processes while maintaining separation. Finally, as it generates meanings, it recognizes its simplicities and redundancies as something it can change.

To summarize, the theory presented above is the most general theory that assumes the social and society as a system. Several other theorists mention that the process of meaning in Luhmann's theory critically distinguishes Luhmann's system theory from Parsons structural functionalism. His functional-structural theory suggests that theorizing does not start with given social structures are subsequently analyzed per their functionality. Instead, for Luhmann, the analyst must begin with social problems, which are understood as functional references. Fundamental social structures should then be analyzed in their capacity to contribute to the resolution of these problems. What becomes visible here is Luhmann's preference for historical and comparative functionalism, which constantly compares alternative structural patterns in their ability to contribute to the solution of relevant social problems.

3.4. *Urban and Social Emergence*

The connection of urban and social establishes a socio-form relationship in the process of emergence. This relationship focuses on social desire and built form and its transversal character. It outlines the meaning of urban emergence, describing the urban space as a shared subject of interest, activity, and production of knowledge. Every city, piece of the urban fabric, and building is a product of emergence identified with information. Urban space, on all its scales, is the pragmatic expression on which the emergent information is encoded. The organization of this information produces meanings, and it results in a network of socio-form communications. Therefore, by reflecting the morphological subject, its creation, and the generation of

15. It is described as *reduction of system's complexity* according to Luhmann.

sociological meaning, the approach can develop transverses of spatiality, and trigger emergence and knowledge.

Looking back at Alexander's and Luhmann's theories, we realize that emergence cannot be understood in terms of its components alone, just as a sentence's meaning cannot be communicated just by knowing all the letters used. In Alexander's theory, structures are twofold; morphological and sociological, sites, and situations and emergence are invariably the product of the evolution of a code-based communication. In Luhmann's approach, evolution is inherited with meanings and achieved through communication. The connection of both seems important when the urban emergence needs to be discussed as a morphological and social change. As with any human-made system, the urban system and the society have an autonomy that allows them to evolve. However, they eventually reach a complexity threshold, in which it becomes difficult to understand how they work as a whole. That should not prevent us from using them. Whether we have a complex modern system, a traditional mixed-use urban fabric, or socio-spatial patterns, such analogies represent an evolved exploration of urban and social emergence.

3.5. Socio-form Adaptation

When urban and social emergence is considered as product of autopoiesis, the question of the system's adaptation takes importance since the change creates a much richer and more complex result. In general, adaptation as a term resembles stability in each part of the system's transformation. An example of an adaptation that shows the importance of the system structure and explains the transformation is the following. Imagine a plant growing around obstacles. Without obstacles, the plant would grow according to its natural pattern. However, its growth will change if there are obstacles around it, as the plant will most likely change its formation¹⁶. However, it will change depending on the arrangement of the obstacles. Eventually, the plant will adapt to its environment.

In more relevant terms, the process of adaptation, primarily when referring to urban adaptation, involves the structure of the system and the system's actor's (or individual's) response to change. An adaptive emergence resembles a process where patterns can pop-up from individual actions by simply engaging local conditions. In Alexander's theory, emergence can develop local increments/patterns that result in unintended long-term effects. The pattern inherits an adaptive design quality that allows evolving according to the reason that triggered the change and continuously satisfied its use requirements. Thus, the social adaptation gets achieved through the interpretation of traditional urbanism into those user-design solutions. A series of patterns make up a rule of creating things as much as the things themselves that get replicated. Therefore, the design-pattern can adapt to changing conditions, replicate and define its relation to internal and external forces. For example, a building's design has the capacity to evolve to satisfy the needs of future occupants. However, a building may also evolve through adaptive structural changes to its fabric driven by the current needs of new occupants.

Under that process, the design suggests a socio-form adaptation to achieve an incremental urban ordering. The wholeness of this order is a sum of all the interactions of the individual actors, or group of actors, with each other and with the environment. Eventually, the socio-urban system can absorb any change as emergence occurs.

16. Stephen Marshall, *Cities Design and Evolution*, Routledge, 2008.

3.6. The Autopoiesis

Autopoiesis is the self-referential activity in which an entity, a collection of things, a mechanism, a system, etc., can produce itself. In recent literature, the concept of autopoiesis is cited the biologists Maturana and Varela, which was borrowed to other fields to describe self-creation. The biologists used an analogy of a living organism to the production process of a machine in order to describe the auto-production of a living system. Back in 1972, they argued that living organisms are like machines that consist of a set of symmetries. Therefore, they communicate meaning in a structured way. Specifically, the term describes when the poiesis (creation) is triggering an eternal auto-creation of living systems; “*Living systems are molecular systems that produce themselves, namely, they are molecular autopoietic systems*”¹⁷. The term has been used to describe a system, a structure, or a conformation that it is self-created. The definition in detail is:

An autopoietic system is organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components that; through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them and constitute it (the machine) as a concrete unity in the space in which they exist by specifying the topological domain of its realization as such a network¹⁸.

Luhmann borrowed the term to talk about the dialectical relationship between the system and the environment in the social systems. He claimed that autopoiesis and self-reference are the essential components of the *Theory of Social Systems* to retain their identity and functionality when in relation to their environments. In his theory, the system and its environment operate continuously through self-reference (*autopoiesis*) as their components keep evolving. This supplementary relation defines the system's structure and function and determines its stability/instability but occurs only as the system evolves in relation to its environment. Within that, communication and meaning can occur as long as the system remains open and transformations get processed through the codes that operate in the system.

In Alexander's theory, communication (although communication is not clearly defined) takes a principle function as it allows through the user/spatial engagement to generate patterns and create *human situations*. Individuals are prompted to experience and change the structure of the pattern and add codes that will enable communication to happen. The autopoiesis in this scenario gets described through the continuous invention of those rules that self-refer to the user. It carefully inverts those rules through incremental changes to adaptive patterns¹⁹. That happens by choice in a great number of situations with consistency. Eventually, combining the two approaches visualizes the correspondence of the built form to the social usage, and isolates the condition that makes it successful. In this sense, urban emergence is seen not only in terms of a long-term urban transformation of components and forms but in terms of a social sustainably change through time.

4. Discussion/Conclusion

Nowadays, the physical environment is embedded by continuous pressure of change. This paper was motivated by this pressure and its consequences and attempted to describe change as a pro-

17. Francisco Varela, *Principles of biological autonomy*, North Holland/Elsevier, 1979.

18. Francisco Varela, *Principles of biological autonomy*, North Holland/Elsevier, 1979.

19. Peter Bosselmann, *Urban Transformations: understanding city design and form*, Washington, D.C: Island Press, 2008, p. 223.

cess of devolution for democratic accountability and empowerment. Motivated by Alexander's and Luhmann's theory, we can put a new understanding urban space production and make the social decision one of the most important environmental change principles. Individuals are urged to try their initiatives. Patterns can range in scale from regional planning to interior design, and adapting solutions to local circumstances can synthesize larger designs. The process can ensure that all forces are balanced and that emergence happens incrementally. Finally, the process follows a pedagogical methodology in which the theoretical starting point is an educational development around the urban emergence.

For architects and planners, it is of utmost importance to identify the built environment as a balanced collective system and explore any active processes as spontaneous sequences of relational rules.

As suggested, urban ordering can start from these small increments of active motivation and, through a complete approach to emergence, connect the morphological outcome with the social activity; an integrated autopoietic activity between the scale of the city, the scale of the neighborhood, the scale of the street, the scale of buildings, and the scale of fine details. It is a process of the assemblage of those socio-form components that can respond to immediate needs. Finally, for there to be any understanding, there must be recognition-loaded by experience, education, patterns, and so on to find citiness. For there to be an engagement or to achieve experience, place or locality needs to be identifiable-place, that is recognizably unique and local but also in continual change, capable of diversity, absorption, and migration.

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Shared Inference of Urban Morphology

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Keywords: Sharing City, Topological Inference, Urban Morpheme.

Abstract: "Sharing" disintegrates the boundaries of urban spatial. According to "graph theory", public is like collection, private is like decomposition and sharing means re-synthesis. As a verb, sharing represents behaviors and as a noun, it's a method of model expression. Meanwhile, sharing is not only a response to sociology as an economic strategy, but also an architectural solution to the critical reconstruction of urban space. From the perspective of spatial topology, the involvement of sharing concept has brought four aspects in interpretation of urban morpheme: embedding and isolation; compounding and transformation; fuzzy and infiltration; collage and reconstruction, interpreting the Urban transformation. Berlin has undergone important changes in urban space due to wars and politics. When society becomes stability again, the involvement of shared culture and life have had various degrees of influence on using and forming Berlin space, and gradually Berlin becomes one of the typical shared cities. The paper expects to explore the meanings of sharing as a virtual urban morpheme by researching the shared place and the case studying.

This paper is subsidized by NSFC project which is named as <Research on Technical System of "Downtown Factory" Community-oriented Regeneration in Yangtze River Delta Region> (Grant No.51678412).

1. Introduction

Sharing research as an urban space strategy discusses the shortage of shared resources. Urbanization is the expansion of the limited spatial extent under limited space resources, which is manifested in the fact that the old stocks are more spatially differentiated, the tenure and use tend to be more specific, and the new incremental self-contained system is complete. aims. However, when the urban boundary has reached its limit, the deeper or closer to the regional core, the increased use rules and costs, and the inability to take more unowned space (natural or public) for their own use, There will be a shared space (private or collective) open to balance the space requirements for demographic changes.

The spatial definition of sharing is affected by a mix of public and private spaces. In 1991, Hans Monderman first proposed "shared streets" with traffic safety design, namely, canceling markers and weakening road boundaries, abandoning the private space and rules of pedestrians and vehicles, returning to the common attributes of public streets, and reducing vehicle speed

by creating psychological barriers, road safety. Although the initial shared street was strategically opposed by the transportation department and the disabled, it realized the change of the urban spatial form in the physical sense and challenged the transition of urban spatial differentiation. In the following decade, the proportion of urbanization in the world accelerated, the developed cities of high-speed developing countries represented by China (e.g. Shanghai) and the major cities of developed countries represented by Europe (e.g. Berlin, Germany). A relatively stable urban form has been achieved, that is, it is no longer and cannot be expanded. Faced with a limited urban environment, the concept of sharing has gradually involved the deployment and use of social resources. This paper will discuss the definition of shared space, and analyze the shared strategy rules and practice design synchronously. In this case, Berlin will be used as an example to summarize the impact of sharing on the type of urban form.

2. Methodology

2.1. *Boundaries & Contents of Sharing*

The shared space is based on the intersection of public and private spaces, and the publicity of spatial services is discussed in preference to spatial ownership. In German, the term “Allmende” (Common Land or Commons in English usage) describes shared ownership stake in a resource. This shared ownership establishes a “Third Space” between public resource space which is potentially freely available and the privatized space used by individuals or corporations. The common goods extracted from or created within this resource space can be both material and immaterial and therefore this third space can be either physical or virtual. As a collectively administrated partition of a resource. However, this third space is always given a spatial organization and corresponds with the sociopolitical organization of the community.

The share has a separate spatial attribute as a container for hosting shared content. The result of shared space, while pointing to set and, is essentially the collective use of private space. People who grow up in the collective society are not aware of the true freedom of the Lord, and have never experienced the private accumulation of space, but have transferred the existing space property through transactions. The personal territory is the original singular private space property, the most intimate feature. National land, including public ownership and partial government ownership, has the broadest collective attributes. For some shared spaces (such as office buildings, shopping malls, cinemas, etc.) of some collectives (enterprises, institutions, groups), people should understand the principles of collective space generation, space usage rules, and spatial ownership definition methods to jointly judge. In this context, we explore shared spatial properties. The narrative about shared space needs to be divided into two categories: one is the difference from the scope of public space collective services, and what are the service objects and service contents of shared space? The second is to define the ownership of the private space. How to clarify all the rights of individuals after sharing the space? These two issues together guide the design of the “sharing rules”. If we build an algorithm to determine the sharing of space. For a broadly free public or non-primary space, by reducing its “indiscriminate collective attribute” requires type differentiation, creating traits in a way that weakens and encloses the space. For a single collective public space and private space, it is necessary to upgrade its “specificity”. The singularity of the singularity, by superimposing the open space to bring it closer to the set, the two ways to clarify the composite situation within the shared

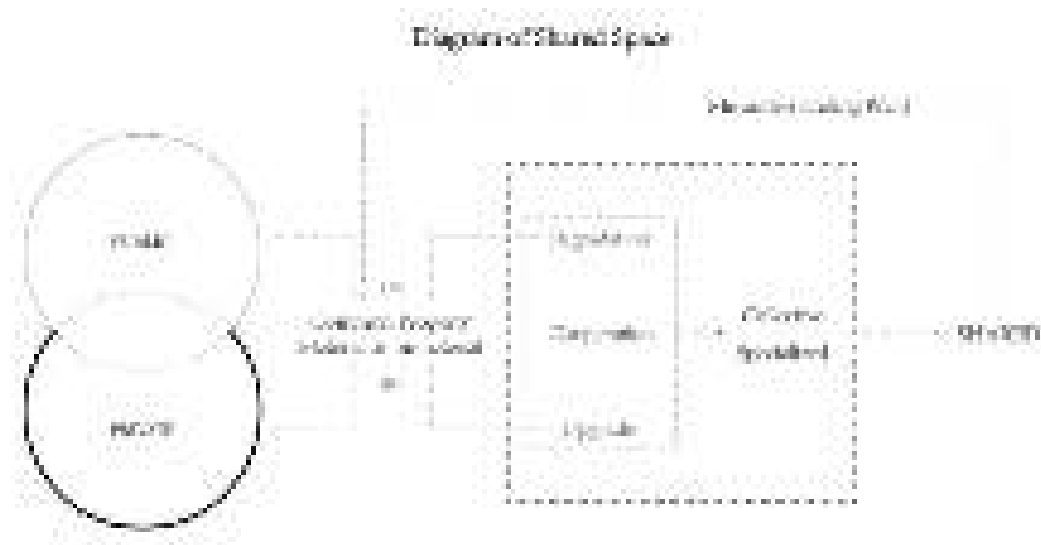


Figure 1. *Diagram of Shared Space*

scope. According to this calculation, the shared space is based on the two basic material spaces, public and private, and cannot be generated separately or in a void.

2.2. *Semantics of Sharing*

In the structure of the shared space, the subject, the object and the way correspond to different urban spatial elements. The author can synthesize the shared elements to express the two semantics of the spatial strategy and the spatial operation level.

- On the level of strategy. The discussion of shared concepts in cities, due to the accumulation of spatial stocks and the vulnerability to socioeconomic and regional political means, is more widely involved in spatial strategy research. Professor Li Zhenyu of Tongji University stated in the abstract of “Towards a Sharing Architecture”: *“This paper proposes three modes of a sharing architecture: the traditional “sharing for all”, “sharing by transfer” in constant development, and the emerging “group sharing”. Four spatial forms of sharing are brought up for discussion: separation, stratification, timing and differentiation. It claims as new forms of space and typology are emerging and sharing architecture becomes more closely connected to social development and technological progress, the new design concept of a sharing architecture will be the driving force in diversifying architectural practices and changing architectural meanings”*. From the perspective of phenomenology, the article discusses the ways of sharing in cities and buildings, and guides the sharing of basic space strategies embodied in cities, aiming at a subject from one of the three categories, can use the each four ways to achieve three different sharing types.
- On the level of Urban space operational. “Sharing” breaks through the boundaries between privacy and public. Sharing is based on the expansion of semi-public and semi-private spaces in the city. First, it is the urban external space, the street system, the square and the idle space, which constitute the shared network of the city; The second is the (enclosed) courtyard, the shared node that transitions from the urban environment into the building; The third is the architectural space level, for the function composite, build-



Figure 2. *Sharing as an Urban Strategy.*

ing interface, volume, transition space (grey space) and etc., discussing on the formation of shared places. The article will summarize the topological into the four types of shared space: 1. Embedment (borrow) sharing, indicating that the private side is partially isolated from the public space, setting up shared use and positive feedback. 2. Compound sharing, means “homeomorphic deformation”. This is a function of composite and superposition of public spaces, through time-sharing and differentiation, changes in spatial form or type, and great potential for development space. 3. Flow sharing or “flow and connectivity”. This is to blur and weaken the boundary of the composite space, and realize the penetration and communication of multiple composite spaces. 4. Collage sharing, that is, “non-homeomorphic changes”. Through the communication of multiple composite spaces, they are spliced together into a whole area and then shared by space.

3. Analysis

3.1. *Model of sharing theory*

The shared space can grow like a cell. If the modern city is likened to a rich petri dish and breeds a variety of nascent spaces, the inner space of the city is rich in nutrients. They are diverse and well-defined, and can be used as the basis for the birth and transformation of any kind of space. The external space, like the cell matrix, supports these contents and flows through them. It can be a bridge for transportation, supplement and connection at any time, with unlimited possibilities. However, there will be no new breakthroughs in a quiet and stable environment. The creation of new things requires external primary stimuli to determine how to use these resources. Although the origin of shared space is difficult to trace, with the rise of the sharing economy, the demand for sharing of space resources has begun to strengthen. As the level of technology has improved, the sharing mode and the physicality of space have been continuously questioned. The challenge, the space limitation of the original material space of the city, by sharing and breaking, sharing may also acquire more space foundation, and the originally deposited shared space is also restarted. After the shared thinking invades (embeds) the urban social life, the concept of isolation itself stands out in the environment and becomes the breakthrough point of the development of shared space.



Figure 3. *Sharing as a space typology.*

Shared behavior and shared space alienate the spatial form. When the original single space in the city cannot meet the sharing needs, the most direct is the “composite and transformation”. In order to achieve collective use, the private space must undergo the first “reconstruction”. The result is that the “sending” is used to superimpose and accumulate different single spaces, and the second is to degrade the original functional space by “degrading”. The implementation satisfies the state of the upper level that can be functionally compounded. For highly developed cities or regions, the spatial differentiation will become more mature. If this is not the case, they can only follow the sharing strategy and open up some private use rights, provided that this highly differentiated space has the potential and potential for sharing. For example, collectively private office buildings, individual private Airbnb, tea restaurants, and more. In addition, for the open space of the city itself, such as the square, it has the strongest openness and publicity, can be used by anyone, is also owned by anyone, and is built on sharing. The scope. For a space to make it share characteristics and how to judge its sharing, it is necessary to make a detailed judgment on the space. In principle, the principle of “upgrading” and “degrading” can be used to make the space different depth and different direction. Space transformation is critical to sharing.

Shared space is not deposited and fixed. When a space has shared attributes, the shared traits are activated, which can lead to more space potential. The shape and boundary of space have always been under artificial constraints. In nature, the original unowned free space is fuzzy and flowing. Sharing allows space to become composite from a single, from private to collective, and similarly stimulates the surrounding space. When the “shared effect” occurs, these spaces are related by an invisible chain. The shared space can accommodate more material space and possibilities, and even break through the limits of physical meaning, realize non-material linkage, and the space boundary will become wider due to blur and flow, and its connotation will be more abundant.

Use space sharing to build a shared city. Human beings have the attributes of social gathering and will bring their belongings together. If we return to the metaphor of comparing the modern city to the petri dish of the shared space, the cells of the shared space will grow rapidly under these effects, and eventually the whole culture fluid will be filled with the shared matrix

and become the nutrition of the next space. In a specific urban space, shared space and sharing strategies will be spliced into various gaps in the city, repairing problems in the city, or supplementing the deficiencies of the city strategy with a sharing strategy. What is more, a sharing-based city can be established. Space and principles provide new opportunities for urban renewal. Starting with urban collages, cautious updates and critical refactorings, the future of the city will be full of challenges.

3.2. *Sharing Axis of Berlin Space*

Among the cities constructed with the concept of sharing, Berlin is one of the representatives, and its sharing in the urban axis has certain typical characteristics. First, Unter den Linden connects all the key nodes in the city. Starting from the city center of the Museum Island, Unter den Linden connects the Die Brandenburger Tor, der Reichstag, der Potsdam Platz, der Ernst-Rurter-Platz from west to east. These nodes correspond to historical culture, city signs, political centers, and economics. The center and the education center have strong sharing traits. Second, Unter den Linden itself acts as a space street. In the daily situation, Unter den Linden is the core trunk road of the city. The sharing of people and vehicles is not reflected. In the National Day, the streets in Tigergarten will be closed to the public, open to the public, and organized. Activities, become a rich activity space, such as parent-child activities, fun sports games, etc., in addition to the daily situation, every weekend, the sidewalk will organize Gebrauchtmart, the composite use of street space makes the weekly line full of vitality. Third, the urban axis and the core nodes jointly construct a skeleton shared by the city. From the connection between the urban axis and the important nodes, it can be seen that Berlin's sharing strategy can continue to radiate to the core of the area along the skeleton, and the sidewalks and secondary trunks on both sides of the main road of the city can also be based on the core axis of the city. The strategy implements different degrees of separation or time sharing. Berlin's shared skeleton can be continuously extended and gradually formed into a network, making the urban external space the most collective sharing place. On the basis of the above, the urban inward-oriented space such as courtyard, building, etc. can also realize the shared connection in steps. The shared fragments can be integrated, and even a shared system mechanism can be constructed to integrate and share all the resources in the city to achieve a comprehensive sharing of cities.

4. Conclusion and Hypothesis

Starting from the public and private spaces, the article explores the nature of shared space, establishes a context for discussing shared spaces, and proposes some basic assumptions about the sharing principle:

- Space property private: personal private, collective private: private individual superposition, or single collective private.
- Collective use: all individuals in the collective have the right to use space, and the original owner of the space still has the right to own.
- Non-profit purposes: shared space is a non-productive space that does not create social value and is only used for resource allocation.
- Dynamic relative: spatial sharing will change with the reference system.

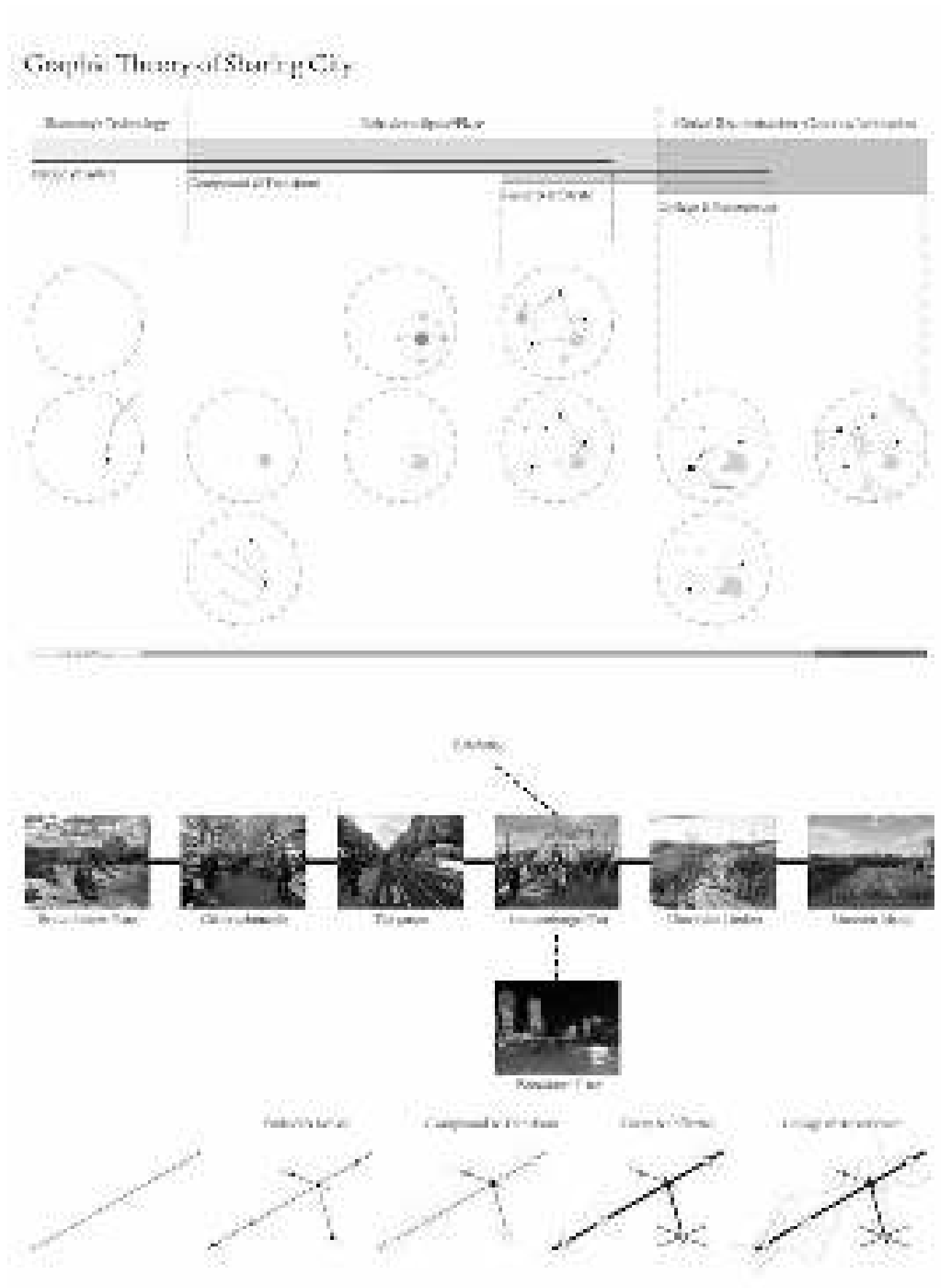


Figure 4. *Graphic Theory of Sharing City.*

The word sharing itself is the product of multidisciplinary intersections and finds its place in the social sciences. But compared to its definition and discriminating, the practice of sharing is more valuable than exploring its significance. In essence, space does not have physical entities, and it needs to be attached to other material spaces to be established. From a strategic point of view, shared thinking has more potential to expand and can be applied in more fields. If you want to ask, is sharing the city the ultimate goal of sharing ideas? The author believes that it can be understood that there is a certain limit in sharing, so that most of the public resources in the city are truly enjoyed by the public. Sharing itself does not have to be a goal, and its proper location is the process of assisting the development of the city.

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Assemblages or Multiplicities

The Heredity of Urban Emergence

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Keywords: Emergence, complexity, systems, assemblages, multiplicities.

Abstract: If present contains nothing more than the past and nothing less than the future, and if what is found in the effect was already there in the cause, then, to understand emergent processes upon the concept of assemblages is nothing more nor less than a political effort to isolate complex reality. How is one to explain them with a concept that is concerned with functional sub-wholes in their end-intervals and not with the processes between them. I challenge the view of cities as assemblages and argue on theoretical and empirical limitation of the concept, as a non-starter to capture neither emergent processes nor contingency of parts. Instead, I elaborate on the potential Deleuze's concept of multiplicity has to grapple with both. In carrying forward Deleuze's concept, this article mediates at boundaries between Space Syntax, Theory of Centres, autopoietic theory, and Prigogine's theory on self-organising order. I find assemblages of insufficient capacity to address emergent processes of natural and man-made structures, unless constructed around multiplicities. I add that multiplicities are to be given the credit for stability of emergent processes, and that nothing will ever change prior to irreversible change of their nature: Prior to a complete reconfiguration of the substance.

1. Introduction

Emergence, that in broad terms describes a condition of the system having properties its parts do not have alone, is assumed highly complex, obscure, and inconsistent phenomenon to address. Complex because we do not know yet its essential features, obscure because it is claimed to occur in biology, physics, chemistry, and in a host of other domains, and inconsistent because it challenges the second law of thermodynamics.

The metaphor of organism, *prima facie*, seemed to have been a resolution for a long time: It is used to explain both, Diachronic emergence¹ – when the process develops over time a pre-existing state of the system as a result of self-organisation of parts in the course of evolution,

1. Diachronic emergence takes emergent phenomena to develop over time a pre-existing state of the system. An example may be the emergence of living organisms as a result of self-organising processes in the course of evolution. But in this type of emergence what counts is the factor of time – the timescale of the component parts. What appears as a systematic unity on a specific level as an event, from another level it is a process. So, the next problem to avoid, after *Ceteris Paribus* principle, is heterochrony. For example: cells may have different lifetime but functional unity of the organ remains the same, or, people live and die but the social body remains a social body.

and Synchronic² – when pattern develops in mutual constitution of local-to-global (upward causality) that produces focused systematic behaviour and the global-to-local (downward causality) that constrains the action of parts in the local level. An example may be emergence of socio-spatial global patterns out of local patterns in cities. But, how is one to explain “self-organisation” and/or “reciprocal causality” if there is so much contingency of parts and the way in which they interact? We do not know what processes or relations they may enter into so we do not know yet their essential features?

But what we do know, as Deleuze puts in *Difference and Repetition* (1968, p. 191), is only a collection of its component’s features at certain point in its incomplete process. An alternative approach to self-regulation and to “reciprocal causality” that is gaining importance in recent years is the concept of *assemblage*, which in broad terms describes a *fragmentary whole*, as Gilles Deleuze and Félix Guattari (D&G) paradoxically names it (1994; p. 16) or as something that is neither a whole nor a part, as Nail (2017, p. 23) interprets. It offers understanding of the wholes as collections of parts which do not fuse into a ‘systematic behaviour’ but rather change their relationship without changing the terms of what they are. Or, as DeLanda (2006, pp. 10–1), Nail (2017, p. 23) interprets, assemblages are more like *abstract machines*, defined solely by their external relations, meaning that it is possible for parts to be added, subtracted, and recombined with one another forever and ever without ever creating or destroying the unity. In this sense, we must agree that city does not exist as one whole or one thing, contradicting thus Hillier’s and Vaughan’s (2007, pp. 216–30), and is not a result of emergent processes, and rather conceptualise it as a mere aggregation of parts. But how a strategy for aggregative explanation, which stipulates that emergence is not a rule-governed process where the previous or actual state does not, and cannot tell the upcoming state, can explain emergent processes and address the question of *becoming* of natural structures?

At present and to my knowledge, this is the first article to challenge D&G’s concept of assemblages as non-starter to explain emergent processes, and rather insist on Deleuze’s concept of *multiplicity*, which in broad terms denotes a complex irreducible structure which cannot change without fundamentally altering its nature. By carrying forward Deleuze’s ontology of multiplicity, this study expands on the potential of Deleuze’s own, and D&G’s collaborative theoretical apparatus to address the question of *becoming* of natural structures.

2. Methodology

This paper first makes an indexical distinction of D&G’s concept of assemblage with common use of the word. Then by using both, D&G’s and Deleuze’s own corpus of work, and in relation to its interpretation, it tries to outline the logic of assemblages. Thereafter, it tries to relate their thinking with complexity theorist’s view on the status of organism, and eventually sketch the limitation of the concept. On such ground, the study aims to enter into a more detailed analysis of Deleuze’s concept of multiplicity (with emphasis on relationship of

2. Synchronically emergent structure is that in which the action of component parts is constrained by a focused systematic behaviour, or, in other words, when a pattern develops in the system and that a pattern is essentially global in the sense of belonging to the system as a whole and being irreducible to the properties of the system’s components (Humphrey 2016, p. xviii) This definition condenses what Thompson and Varela (2001, p. xxx) call “reciprocal causality” – the mutual constitution of local-to-global (upward causality) that produces the focused systematic behaviour and the global-to-local (downward causality) that constrains the action of component parts in the local level.

interiority³) in conjunction to Hillier and Leaman's collaborative work on systems theory and deep structure invariants, as well as with Alexander's concept of *local centres*. In support to a more tendentious strand of my argument: *multiplicities rather than assemblages*, this paper invokes a contemporary work on complexity and autopoietic theory, theory of self-organising order, and non-equilibrium thermodynamics.

3. Assemblages or multiplicities

The concept of assemblage is an ontological framework developed by D&G, originally presented in their book *A Thousand Plateaus* (1987), which when translated from the French word *agencement* (Le Robert Collins Dictionary) means to layout, arrange, or to construct (things and utterances), while English word "assemblage" means to join or gather two or more things, what makes the term semantically different. Therefore, in D&G's terminology, assemblages are not about linking different things together- that would set them far too simplistic, technical, or practical tool for examination of relations, but in contrary, as D&G insists in *A Thousand Plateaus* (p. 142) assemblages are supposed to creatively bring novelty from the shell of the given, and are not only about bringing together self-subsisting components. It follows thus that all assemblages are political (intentional) constructions, whose degree of complexity depends solely on modellers decision what variables to select, how to arrange them, give them roles, and how to relate them? This indexical distinction is of critical importance for to understand D&G's logic of assemblages: Thus, all what follows depend upon accepting it, what in turn invokes at least two ontological questions: 1) What assemblage is? and 2) How it works?

3.1. What is assemblage?

D&G's "*General Logic of Assemblages*"⁴ is based on three major theoretical formations. First, all assemblages are composed of a *basic structure*, including a condition (*the abstract machine*), elements (*the concrete assemblage*), and agents (*the personae*). Second, all assemblages are arranged according to *four basic spatio-political types: territorial, statist, capitalist, and nomadic*: Each type describes a different way in which conditions, elements, and agents in an assemblage are ordered, and each assemblage is always a mixture of these four types to varying degrees. And third, all assemblages are constantly changing according to *four different kinds of deterritorialisation*⁵: *relative negative, relative positive, absolute negative, and absolute positive*. However, this paper explores and examines only the *basic structure* and *typology of change*, and does not take into account the *types of assemblages* (for what one may disagree), but what concerns this study is a theoretical and empirical potential of D&G's concept to address the phenomenon of emergence, transformation, and change of natural structures upon natural processes only.

3. Interiority and exteriority do not refer to spatiality but to intrinsic and extrinsic properties.

4. I use this term to denote D&G's Theory of Assemblages: The fact they have not formalised it (they did not have a reason to: formalisation would have compromised their rhizomatic (multiple lattice) way of thinking and view of the world) does not mean that it is not a fully-fledged theory. In contrast, it rather is – in the sense that it sets the ground for the development of a theory..

5. Deterritorialization is the way in which assemblages continually transform and/or reproduce themselves.

3.1.1. *The basic structure of assemblages*

The first feature shared by all assemblages is that they all have a condition which D&G call the *abstract machine*. It is the network of external relations that holds heterogeneous elements together. It is abstract because it is not a thing but something that lays out relations between things. It is a machine in the sense it is defined only by extrinsic and not intrinsic relations. An example of the abstract machine is the society: the relationship structure between individuals or other discrete entities cannot be seen, but in fact, it is absolutely real in the sense that the relations that arranges them are real. Thus, the abstract machine is the relations between elements.

Next, all assemblages have concrete elements, arranged upon relations set by the abstract machine: a configuration of a machine that gives it its degree of consistency. Since the *abstract machine* has no essence⁶ or a program given in advance of the concrete elements, when concrete elements change so does the set of relations that they are in; a process D&G in *A Thousand Plateaus* (1987, p. 71) names “coadaptation”, or in *What is Philosophy?* (1994, p. 77) a “reciprocal presupposition of the two”. This means that they must co-adapt because none of them can subsist independently of the other. Thus, the continual change makes assemblages always capable of different things, requiring thus constantly renewed examinations.

Third, all assemblages have agents, that D&G call “personae”. Personae are not autonomous rational subjects but rather operators that connect concrete elements together according to their abstract relations. Thus, the personae are neither the origin nor the program of the assemblage given in advance, because one cannot have a persona without an assemblage of which it is part, but also, one cannot have an assemblage without agents that brings it about. Thus, as D&G (1987, pp. 71-5) argue, since relations, elements, and agents are all immanent to one another, all occur together in a mutual presupposition: On the one hand, the persona lays a network of relations of the abstract machine, and on the other hand, it establishes a correspondence between the concrete elements.

3.1.2. *How assemblage works: the typology of change.*

To understand how an assemblage works, one does not ask what its essence is – it has none, but rather what it can do? This is an empirical question. In every assemblage there are four different kinds of change that shows what it can do: 1) *relative negative* processes that change an assemblage in order to maintain and reproduce an established assemblage; 2) *relative positive* processes that do not reproduce an established assemblage, neither contribute to nor create a new assemblage; 3) *absolute negative* processes that do not support any assemblage, but undermines them all; and 4) *absolute positive* processes that do not reproduce an established assemblage, but instead creates new one. Accordingly, alteration of assemblage needs a change of its basic structure, which in turn entails a change of any mutually dependent feature: the abstract machine, concrete elements, or personae.

3.2. *Theoretical, metaphorical, and empirical limitations of assemblages*

From the brief elaboration of *General Logic of Assemblages*, three critically important theoretical, metaphorical and empirical limitation of the concept can be drawn: Immanence – none of the

6. The essence of a thing is what uniquely and necessarily defines it—in other words, what it is about a thing that makes it what it is such that it is not something else, which endures despite all its unessential aspects.

elements from the basic structure is self-subsistent (autonomous) without a presupposition; Metaphorical –no similarity between the concept and the organism can be drawn, and Empirical – they are unstable construction, entirely made of dependent variables.

Theoretical: In *What is Philosophy* (1994), D&G argue that personae are immanent agents or mobile positions, roles, or figures of the assemblage (p. 64). Sometimes they seem to precede the plane, sometimes to come after it – that is, it appears twice; it intervenes twice” (p. 75), and that persona is needed to relate concepts on the plane, just as the plane itself needs to be laid out” (pp. 75-6). This means that the *abstract machine* and *concrete elements* are laid out by, and laid for the *personae*. In this sense, the concept of assemblage cannot explain emergence of the structures – it is not self-explanatory, and cannot side-step the triad of immanence set by it.

Metaphorical: Only the first deterritorialisation type (relative negative) resonates with the recuperative apparatus of living organisms, a property that Varela & Maturana in the *Autopoietic* theory name *homeostatic*⁷. The second type (relative positive) has absolutely no relation with the organisms for it denies both the evolution and the second law of thermodynamics. The third type (absolute negative) is irrelevant to the nature of the organisms since no organism is set to shatter its own structure: in contrary, replication is a biological feature. The fourth type (absolute positive) is the most relevant for it is the *raison d'être* of the concept, i.e. constructions capable to bring novelty, what is in absolute contradiction with hereditary properties of living organisms. In this sense, the concept may eventually stand for a possibility to bring novelty without heredity.

Empirical: The structure of assemblage is composed of three mutually dependent major formation variables: the abstract machine, the concrete elements, and the personae, that in turn makes it unstable, readily or continually fluctuating to change or break. Thus, the only viable method of analysis is by dynamically transposing variables in the model (I have explained and utilised the method elsewhere⁸). This make structure empirically indeterminant and ephemeral: Indeterminate in the sense for they do not have invariants upon which the contingency and behaviour of parts can be approximated, and ephemeral for they do not have neither essence nor teleonomy.

Therefore, for assemblages to become more than just fragmental, temporal, and political isolators of complex reality, concerned with diagnosis of end intervals, and not for the processes in-between and after them, at least one invariant in their structure is needed: An invariant with features upon which the ordering of bodies in emergent processes can be explored and examined. Following the basic structure, the only variant with hereditary properties is a living organism, what ultimately moves the explication into the domain of complexity theory; which treats the organism as an irreducible agent among other active in a morphogenetic process of emergence.

3.3. Deleuze's alternative ontology

For Deleuze, the structure of the whole is conceived as being given in advance of emergence of parts, as a *Body without Organs*⁹ (BwO) which subordinates parts to an organizing principle. He lacks any mechanism with which to explain emergence of organisms (diachronic emergence) as

7. Homeostatic denotes the ability or tendency to maintain internal stability in an organism to compensate for environmental changes.

8. Trialogue on Centrality: Space Syntax, Urban Morphology, and Actor-Network Theory: The paper is accepted for presentation in Space Syntax Symposia – SSS12, Beijing, 2019.

9. BwO denotes the structure that is always ready for restructuration; the being ready to reorganise into becoming,

anything other than pure contingency i.e. as extraneous epiphenomenon of molecular processes. For him, the organism is a centralised, hierarchised, self-directed body, and also a molarised¹⁰ and stratified life form. In other words, the organism is an event (synchronic emergence) of organising organs in a particular way. The *One* (the organism as a whole) in D&G's philosophy is added to the multiplicity only in a supplementary dimension (D&G 1987, p. 21; 265).

Deleuze's devalorisation of the organism, considering it rather a limitation in relation to infinite possibilities BwO offers, makes its status useless as a metaphor: His idea of organism is incompatible with DeLanda's *pari-passu* interpretation of D&G's philosophy with the complexity theory, is also in marked contrast with the treatment of the organism as irreducible whole in the autopoietic theory of Humberto Maturana and Francisco Varela, as well as with the valorisation of species as natural kinds found in the complexity theory biology of Stuart Kauffman (1993) and Brian Goodwin (1994). The concept Deleuze offers as alternative to irreducibility of the *One* is the concept of *multiplicity*.

3.3.1. Deleuze's ontology of multiplicities

While the concept of assemblages is coined by Deleuze's collaboration with Guattari, the concept of multiplicity remains Deleuze's mainstay throughout his career. In the seminal work *Difference and Repetition* (1968), he replaces the concept of *organic* unity in favour of multiplicity, and the concept of *essence* with the concept of *event*. In the most basic sense, as Jonathan Roffe explains in Adrian Parr's *The Deleuze Dictionary* (2005, p. 176-7), multiplicity denotes a complex structure that does not reference a prior unity. It is not part of a greater whole that has been fragmented and it cannot be considered a manifold¹² expressions of a single concept or transcendent unity. Rather, it can be described as something self-contained, which cannot be changed without fundamentally altering what it is. In other words, as Deleuze and Parnet (1987, p. viii) puts, it stands for irreducible singularities where what counts are not the terms or the elements, but what is "between" them, the in-between, a set of relations that are inseparable (intrinsic¹³) from each other. So, multiplicity is not equal to multiple of something, but a thing in its substantiative form.

This is indeed the main difference between multiplicities and assemblages: multiplicities are irreducible sub-wholes, characterized with intrinsic relations, where one cannot unplug any-

already present in the being. BwO, is a metaphor that stands for a possibility to address the question of becoming without heredity. In broad terms, BwO is the 'playground' of assemblages.

10. The difference between the molecular and the molar is not one of size or scale, but rather concerns composition and organization. Molecular is not simply or necessarily being associated or equated with 'small' or molar with 'large'. It is not, therefore simply a distinction between part and whole, organ and organism or individual and society. Rather, there can be molarities of any magnitude. Brian Massumi brings out the fundamental operative difference when he notes that molecular populations are composed in terms of local connections between particles, whereas in the case of a molar population, such as a society, an organism, or a person, the connections have become stabilized and homogenized through rigidification and reification. In a molarity a population of particles is subject to well-defined boundaries and gets stratified as an identifiable whole. In a population that enjoys novel modes of becoming, the particles are correlated but not in a rigidified manner and its boundaries are constantly fluctuating.

11. Organic unity differs from the unity of organism in the sense that the organism, as a whole, is conceived reducible to its organs, and its functioning depends upon the relationship between them, while organs are irreducible discrete entities.

12. Manifold is expression that mathematicians refers when describing differential space: space where distance is measured upon differential rate of change. Some parts of the same space do not change at all, some change more slowly and some more rapidly.

13. Intrinsic relationship is not about stratifications, like crystal's structure – layer after layer, nor as a molarised form (like society) across history but rather as an essential outcome of differentiation of matter and the natural kinds, e.g.: those static, and those that can move. In this sense, it is the movement (the action of the organisms in the environment) what makes socio-spatial relationship intrinsic.

thing from and plug into another one, nor add nor subtract, whereas assemblages are structures characterised solely upon extrinsic relations with plug-unplug, add-subtract features. Moreover, unlike multiplicities which are consistent unities, following J. S. Mill's definition of consistency, assemblages can be riddled with contradictions, as in the case of economic and ethnic divisions that divide cities) while still producing coherence and consistency¹⁴.

3.3.2. *Multiplicities and space syntax theory*

In the early seventies, Bill Hillier *et al.* developed a theory, namely Space Syntax (SS) to address emergent principles of urban structures. SS theory semantises the notion of space upon Chomsky's (1962-3) syntactic invariants in the structure of language to explain socio-spatial relationship structure and patterns. Similar to Chomsky who argues for a very presence and permanence of deep trans-generational, syntactic structure in the language, which never change in the course of evolution, regardless of external influencing factors, Hillier and Leaman (1972-3, p. 48) maintains that that these deep structures are un-foldable invariants, provided to living organisms in the initial condition capable to retain their stability yet contributing their gradual evolution and purpose. In this sense, socio-spatial relationship is intrinsic – given in the “initial condition”.

In “contrast” to Deleuze, the status of the organism, as autonomous (closed) for itself and open to information from the external milieu sets SS's view of intrinsic invariants to resonate with complexity theorist's view on co-evolution; e.g. Goodwin (1994, p. 104) and Kauffman (1993, p. 168) – two leading figures in so-called ‘post’ Darwinian developments which argue that intrinsic invariants limit a possibility for hereditary changes so that variety available for evolution is constrained. However, the transgenerational replication of natural structures, as Hillier and Leaman (1972-73, p. 48) puts, is not about a DNA replication – DNA is a “passive” (it transmits, with great transgenerational stability, information on internal relations only and not the information on a possibility for organisms to change the environment). Thus, the structures *capable to retain their stability* are like those which Varela and Maturana in *Autopoiesis and Cognition* (1980, p. xii) and in *The Tree of Knowledge* (1987, p. 68) name hereditary, which, in broad terms denotes stable or near-to-equilibrium (elastic) state of the system/structure. In this way Hillier and Leaman keeps the door open for variation of the invariants, or ‘invariance under transformation’ as they prefer to name them (1972-3, p. 66).

3.3.3. *Multiplicities and the theory of centres*

Alexander (2011, p. 59; 1968, p. 605) refers to Chomsky's invariants in generative grammar, but he argues that only structures can generated structures, suggesting thus a *system of deep structures* (plurality of sub-structures) and not the invariants one can find in them. Following his argument that “if we want to make functional systems, we first have to invent a generating system to create them”, one may also suggest that the system capable to generate systems is the system itself, or many sub-systems interconnected in a multiple-lattice structure.

Moreover, in the *Theory of Centres* (2002-2005), he argues that wholeness is made of parts – things and spaces – which are made by the wholeness of other parts, also made by things and spaces. Alexander names these local parts as local centres and not as local wholes because

14. The stability describes the property of the systems to stabilize themselves regardless of what disturbed them, including variables that were not part of the structure when the system emerged.

wholeness, he argues, “have property of not-separateness. These parts are structural bearers of the whole – like organs that are the structure bearers of the organism. The ‘existence and strength of centres”, he argues, “depend upon configuration of the structure as a whole” which gets its life according to the density of centres which has been formed in it, while life of the centres depends on their relationships, which intensifies or abate one-another’s (ibid). This implies that higher the density of local centres and higher the intensity in their relationship in a multiple lattice structure of the whole is, or in Deleuze’s terminology, higher the number of multiplicities in the BwO, higher the degree of consistency of the whole, and higher a predictability of contingency and behaviour of parts is.

It follows thus that both SS and the ToC, are grounded on relationships of interiority: Hillier’s and Leaman’s concept of *deep structure invariants*, and Alexander’s concept of *local centres* resonates with Deleuze’s notion of multiplicity. They are like the organs in an organism, which cannot subsist outside the whole they are part of, and whose structure/function cannot change without changing the nature of what they are/do. However, as Deleuze’s philosophy suggest, and on the other hand, as system’s biology and laws of physics maintain, multiplicities are not immutable but rather changeable.

3.3.4. Immutability of intrinsic relations

Deleuze, in *Bergsonism* (1960), notes two kinds of multiplicities: extensive and intensive: The first characterises space, and the second, time. The difference between the two is perhaps the most important point to note here. In contrast to space which can be divided up into parts (as a network of spaces in SS’s jargon), or society into groups of individuals, intensive multiplicity cannot be divided up without changing in nature (as spaces of networks¹⁵). This is important for Deleuze, as he puts in *Difference and Repetition* (p. 188-201), because it means that there is no essence of particular multiplicities which can remain unaffected by encounters with others, thus they must not be considered to be somehow transcendent or essentially immutable but rather changeable. This suggest, moreover, that no multiplicity should be viewed in isolation from other multiplicities but rather in conjunction with them.

Moreover, intrinsic relationship between two or more things does not set multiplicity closed or unaffected by external influences. In contrast, as D&G (1987, p. 21) argue, organs, i.e. multiplicities are a body’s way of negotiating relationship structure with the exterior milieu, appropriating and regulating a matter-energy flow, suggesting thus that the organisms are not immutable autonomous bodies but rather affected bodies (in contrast to SS and ToC): they become affected each time when organs-multiplicities cannot appropriate and regulate, in a very complex feedback loops, matter and energy flow with exterior milieu. This means that to alter a multiplicity, a certain external stimulus capable to displace the autonomy from an organism to ecological niche in an irreversible process of change, is needed. In other words, a constellation of natural forces capable to move invariants beyond their recuperative capacity, i.e. beyond the threshold of reversibility is needed.

15. I use first this term in MRes Dissertation Thesis at UCL Bartlett School of Architecture (2017/2018), *The Trialogue on Centrality: It stands for a primacy of The Abstract Machine (the relations) over The Concrete Elements (Artefacts): No network of relation, no spaces; no spaces of networks, no networks of spaces.*

3.4. Summary

Following the condition for a formation to be qualified as assemblage: to have relations – the abstract machine, artefacts – the concrete elements, and personae – individuals, group of individuals, or society, cities can be viewed as assemblages. But that consents nothing more nor less than the anthropologist's view, which agree that artefacts are not made for the societies to live and depend upon them, but rather to complement the way of life – as embodiment of the abstract machine: If one removes any component: artefacts – the concrete elements, personae – the society, or relations – the abstract machine, the city would cease to exist.

On the other hand, Alexander's argument that a system as a whole is not an object but the way of looking at an object (2011) on the one hand, and Hillier's and Vaughan's (2007, pp. 216-30) view of the city as one thing and the argument that the analysis can be done in separation and then assembled into an aggregative explanation on the other hand, suggests that the concept of assemblage can be used to describe "fragmentary wholes" only. In this sense, it rather resonates with Alexander's notion of *Set*¹⁶ than with the concept of a whole. Consequently, the concept of assemblage thinking can be utilised to analyse only specific and context-based situations, eliciting thus fragments of reality, which one cannot put back into a coherent and consistent whole, however.

As a result, it seems that what counts in emergent processes are intensive rather than extensive multiplicities. If this holds true, then multiplicities are not about to change their nature upon internal difference in degree of intensity (the point in which Deleuze breaks with Bergson) but rather, as laws of physics suggests, upon resultant configuration of all multiplicities one can find in a BwO. This coincides with Deleuze's 'what counts in the nature of multiplicity is differential relations of forces (Parr, 2005; p. 192) for what they substitute a substance, and their independence to the *One*', suggesting that for a change in emergent processes, a change in the nature of multiplicity is a must but not sufficient condition: Rather, their total reconfiguration is needed.

4. Discussion

From the brief elaboration of their thinking, it follows that D&G leaves substantialist thinking – the tendency to think of the world as consisting of isolated, discrete objects, instead of an interconnected system, as Alexander's multiple lattice structures suggests: Perhaps the biggest paradox in a dialogue between science and nature is the rejection of Man-Environment Paradigm – which isolated the man instead of bringing it closer. Thus, insofar cities are not isolated situations with well-defined boundaries, stratified as identifiable wholes (unlike crystal whose structural stability can be maintained in the vacuum) but rather open systems (they would die if one isolates them because structure is inseparable from the function) as Prigogine argue in *The End of Certainty* (1997, p. 62), then, sooner or later, the structure-function immanence will be compromised: The question is When? How? and, In what order?

Moreover, no natural structure evolves otherwise than in downward direction, and no biological and social structure evolves otherwise than in upward direction. This suggests, moreover, that most of reality, instead of being orderly, stable, and in equilibrium, is pulsating with change, disorder, and is in evolutive process. From the physicist's perspective, the very exist-

¹⁶ A *Set* is a collection of elements, which for some reason we think as belonging together (Alexander, C. 1965, pp. 58-62).

ence of living organisms constitutes a paradox, or a miracle, because it violates the second law of thermodynamics. On the other hand, from a biological stance, the organisms are deeply conservative, impervious to any environmental stimulus, i.e. between them and environment there is an entirely one-way relationship, implying thus that heredity can resist all external changes and processes. But for how long? Insofar there are two oppositional forces running the phenomenon of life (different in scale and intensity: downward – macroscopic “stronger”, and upward – microscopic “weaker”) sooner or later, as a result of transgenerational accumulation of perturbations in microscopic within a macroscopic system, the structure will certainly break or change.

It means that macroscopic processes will always, necessarily, drive all microscopic systems/structures from a stable or near-to-equilibrium (elastic-reversible) to a far-to-equilibrium (plastic – irreversible) state. Accordingly, a structure can change only in a far-to-equilibrium state of the system, as Ilya Prigogine and Isabelle Stengers (The so-called Brussel’s School) argue in “Order out of Chaos” (1984, p. 140). For them, reversibility still applies, at least for sufficiently long times and in small scale, but in closed systems only. Irreversibility, on the other hand applies to the rest of the universe. Insofar biological and social systems are not simple and closed, and on the other hand irreversibility and randomness plays an essential role in the nature and lies at the origin of most processes of self-organisation, at certain point in time heredity will not reproduce a pre-established structure nor its variances but instead create new one.

But, as Deleuze puts in *Difference and Repetition*, for a multiplicity to change there must be an internal difference in the degree of intensity. If one considers space and society as one multiplicity, society and the language as another, and if one is explicable upon the other, then, for change of any there must be an intensive difference in the other for to mutually become inexplicable. In this sense, one cannot account only on one independent variables in the process of emergence, but rather, as Alexander suggests when explaining the concept of *local centres*, but in many of them. The limitation of a single invariant is also, acknowledged by Hillier himself when saying that ‘space syntax gives a partial and incomplete view of the relations between human beings and their created environments, and,... what we do show is that there are very deep two-way structural links between the forms that created environments take and human ways of “being in the world”, both as bodies and minds’ (Hillier 2005, p. 12). In this sense, a proper analytical model should rather contain a dozen of invariants.

However, insofar we live in stable or near-to-equilibrium state of the system, no revolution in the natural organisation of structures – emergence is expected to occur, as Varela and Maturana puts (1987, pp. 53-71), no novelty in the structure, or as D&G argue, no Absolute Positive Deterritorialisation can occur. The autopoietic structures can transcend from one to another state (Varela’s and Maturana’s homeostatic shift or Hillier’s evolving invariances) but never into another stratum: until a condition for a fourth type of a structure’s deterritorialisation that D&G describes in the *General Logic*, is met, i.e. “change that does not reproduce a pre-established assemblage, but instead creates a new one...whose goal is to ‘prefigure’ a new world” (1987, p. 142).

In this sense, a prime example for the concept to address may be: What configuration of interior and exterior forces triggered the irreversible change of spatial arrangement of *concrete elements* (the network of spaces) on the one side of immanence, and *the abstract machine* and *the personae* (the spaces of networks) on the other side, of Çatalhöyük settlement from honeycomb like spatial structure to a beady-ring¹⁷?

17. Beady ring is a ring or rings of space formed like beads on a string by the orientation of dwelling entrances. What can

5. Conclusions

In carrying forward Deleuze's concept of multiplicities, in the light of its ultimate implication on the natural emergence of structures, and in support of more tendentious strand of my argument: *multiplicities rather than assemblages*, this article concludes:

Assemblage are constructions of insufficient capacity to address emergent processes of natural and man-made systems and structures. For them to be more than descriptive tool, their basic structure should be constructed around multiplicities. However, following Spinoza's that "for every effect there must be a cause", and "if the present contains nothing more than the past and nothing less than the future", then Yes: The concept can be used to describe reality, thus in this way address the question of *becoming*. If one is about to properly describe the real.

On the other hand, intensive multiplicities are to be given the credit for the stability in contingency and behaviour of component parts in emergent processes, which is not about to change until a constellation of disparate forces, running in the opposite direction in space and time, moves the system into a far-from-equilibrium state. In other words, if interiority is only a selected exterior, and the exteriority, a projected interior, as Deleuze (1981, p. 168; 1988, p. 125) says, then, for a change of interiority, a total reconfiguration of the substance is needed. Until then, emergent processes will be preserved by heredity and driven by multiplicities.

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explain this family likeness? Hillier argues 'None of the usual candidates- climate, topography, defence, land tenure systems, and so on – seem to begin to explain the spatial peculiarities -of this form. So perhaps we should explore what might seem, on the face of it, a more natural possibility: that the beady ring form arises from some process of organic growth'.

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Design with Non-Urban Planners

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Keywords: TU Berlin, Urban Design, UN-Studio.

Abstract: Urban design is a contradictory discipline. Its contradiction lies in that the city itself is both an aggregation of complex and contradictory. Even the single (special) research of urban morphology is complicated, therefore, it is unscientific to establish a so-called “urban design” discipline to unify. Consequently, scholars who study urban design can’t avoid saying that “Urban Design is multidisciplinary”. When the problem of urban design exists, the discipline is not established, therefore, the question is how to establish the research foundation. This article aims at the postgraduate degree of the Berlin University of Technology: Urban Design discusses UN-Studio(teaching) methods of the urban transformation, mainly concentrate on: 1. The definition and liberation of Multidisciplinary. Establish four discipline system frameworks, and mix background students 2. The mutual support of the curriculum, based on the theoretical curriculum assistance under the core studio practice. 3. Simulating reality: sociological charette and Fast-Works 4. Future Scenarios and Urban Territories 5. Actor-Network and the PlanSpiel Game 6. Contradictions and failures in the process

This paper is subsidized by NSFC project which is named as <Research on Technical System of “Downtown Factory” Community-oriented Regeneration in Yangtze River Delta Region> (Grant No.51678412).

1. Introduction

There is no other discipline like urban design has a firm foothold in college teaching before it is recognized in academics and before its achievements. People are even questioning and criticizing the definition of urban design. It first recognizes its teaching status and the facts that can be taught. This is inconsistent with the teaching reform of the Texas Mounted Police in 1950 in the face of “building can teach or not”. Compared with traditional architecture and urban planning, the urban design currently involved in teaching is more from the perspective of the city to judge the mutual constraints and influences of a design in a region and the environment of the region, not limited to single Before the implementation of individual research, the relationship between the body and the overall situation is often preceded by regional planning, to the later stage of design, or even to housing design. The rest of the structural devices, event planning, planning strategies, etc. can occupy important. The proportion is to explain the relationship,

and the urban design pays more attention to the relationship between planning and construction elements, rather than one of them.

In October 2018, the author participated in the joint double degree training of the School of Architecture of the Technical University of Berlin and Tongji University of Shanghai, namely the urban design degree. The urban design of the Berlin University of Technology is a relatively new project. It is based on the superposition of four disciplines: architecture, urban planning, landscape architecture and sociology. Each school draws out its own teaching group to form a city. Designed teaching group. Therefore, the professional courses and the basic courses have been specially designed, which has considerable reference value for the teaching of urban design. The basic course part mainly supplements and adds research-based design methods and theories, especially the newly added social sciences contributes a large number of design support methods for the project. Students need to supplement the relevant literature and homework training to master the basic social survey methods, combined with the academic background of its own architecture, but there is no clear goal or even a unified direction. In the professional curriculum, the project has gathered more than half of the students with multidisciplinary background, such as space geography, Future Science, law, etc. The research group has formed a multi-communication environment, which virtualizes a real social research environment. Secondly, based on the theme of urban regional change, the sociological reasons for the change of urban spatial form are analyzed from all aspects of society, and the narrative is carried out by means of space. Furthermore, among the important nodes of the curriculum, social decision-making will be restored through realistic simulation and rapid decision-making to jointly discuss the spatial problems of the city. All in all, in the urban design teaching experience, urban design is no longer a single spatial decision-making problem, the background of environmental change, the principle of spatial design, and the way of verification all need to interact through multidisciplinary and social decision-making mechanisms. The author's goal in writing this article is not to get an exact answer to urban design, but to explore a new possibility for urban design by discussing the research methods of urban design, broadening horizons, summarizing the interrelationships with other disciplines.

2. Methodology Analysis

The urban design project of the Berlin University of Technology is the product of interdisciplinary interactions. In addition to the architecture, urban planning and landscape architecture involved in urban infrastructure construction, sociology is also included as the overall context of construction. Compared with the basic material space teaching, TUB pays more attention to the content and curriculum structure of sociology. The design course is taught in parallel with the basic course for 4 months. The subject of the author's participation is "The Great Transformation", and the discussion range is from three stages, from large to small, followed by one. Pick a specific topic that describes the world's developments in the field for decades before and after the node. B. After the investigation of the original theme, describe the vision of Berlin's future development in this field, and imagine the future urban landscape of 2050. Before that, the teams will conduct a special analysis of Berlin's historical time and events, and sort out the elements of urban spatial change over the past 50 years. After understanding the basic methods and background, the research team will conduct theoretical and practical operation experiments for specific design bases to study its rationality. Each group will be based on a specific community competition transformation, according to their respective subjects, design the

system logic of their own operations and transform the space nodes, and combine the changes in the future development of the city and the world in the previous two stages, and propose relevant Future design. The discussion form of the course node is set according to the course content, including report, meeting, seminar and so on. The course results present and organize campus and social exhibitions in drawings, models.

Among the specific curriculum arrangements, the following five aspects are the most representative features, and the authors respectively comment on the course records and participation experience:

2.1. The definition and liberation of Multidisciplinary

The project consists of four defined disciplines, each of which consists of a professor's chair, a doctoral student, and a teaching assistant to form a unified research group. The number of students is 36, and the knowledge background is complex. Half of them are architectural and urban related engineering. The rest are free to accept any subject background, such as: future science, geography, sociology, literature, law, biology and so on. The professional courses are group work, and each group of 9 people constitutes a discussion mechanism with professional balance. The advantages of interdisciplinary analysis are mainly reflected in the expansion of ideas in the previous research and discussion. At the research stage, students of all professional backgrounds greatly enriched the content of the materials. In the research on the same topic, you can quickly penetrate and design multiple aspects. For example, in considering the transformation of science and technology into the future, in addition to space, social organization structure, ethics, law and other aspects have been relatively complete complement, and a more in-depth academic background support. In the process of communication for the same content, the professional advantages bring about a variety of perspectives and critical views, the discussion of the problem is more in-depth, the considerations are relatively complete, and it is easy to form simple systemic logic.

However, during the specific group discussion, many obstacles were encountered due to individual differences. The time cost of the group is huge, and it is difficult to achieve uniformity. It is not applicable to the discussion of too many topics. Before the discussion, under the premise of sufficient preparation of personal materials, each member of the group needs to obtain the original knowledge of 9 times and give suggestions, and then make corrections according to the recommendations. In the case of insufficient material preparation, the original issue needs to be reinterpreted. Therefore, it is recommended to reduce the number of groups in each group to a maximum of 6 people and increase the category 1-2 of the parallel group to improve efficiency.

2.2. The mutual support of the curriculum

There are two main types of tutoring in the basic course. The first is to supplement the design method based on Method and Tool. The course is designed in parallel with the design course and is divided into five sections: Block1. M&T for Spatial Urban Analyses, Block2-M&T for Design & Research, Block3-M&T for Systemic (Integrative) Design and Research, Block4-Sociology & Social Research, Block5- Critical Reflection on Methods and Tools. These parts are associated with the design curriculum as an auxiliary system, and the operational requirements are also interrelated and the objectives are clear. However, in the detailed design, there are often repeated work, and the course rhythm is mixed. Learning for a specific design method is only at the

level of introduction, not enough to guide the work, the methodology is not fully established, the professionalism is insufficient, and then returning to the course design process, usually only stay at the level of understanding, failing to Substantially promote the design process.

The second is a theoretical supplement based on Interdisciplinary and Introduction of Urban Design. This aspect provides a lot of ideas for constructing the theoretical framework of urban design. The main part of urban design lies in the systematic establishment, followed by the technical problems of system implementation. Most of these theoretical courses are questioned based on specific issues that arise in urban renewal, and attempts to answer, such as the changing relationship of urban networks. Therefore, in the face of related design, not only can provide large framework guidance, but also can be used to inspire the whole idea with small dots, and provide support and suggestions for the details. The downside is that these theories tend to have strong special characteristics, and they also face the problem of mutual integration in application. At the same time, they still need to be considered in terms of time dimension. The preachers often choose a single aspect to expand and are easy to form. One-sided thinking is not verified, it requires the listener to have a higher understanding and judgment.

2.3. Simulating reality: sociological charette and fast-work

In urban design, the importance of social science in the practical teaching part is reflected in the sociological charette and fast-work part. In the process of curriculum design, due to the different disciplines and students' backgrounds, the discussion is often similar to the parliament's debate on a certain topic. This situation is actually a sociological simulation of reality. However, the charity varies from a design of a charrette varies, depending on the design problem and the individuals in the group, charrettes often take place in multiple sessions in which the group divides into sub-groups. Such sub-group then presents its work to the full group as material for further dialogue. Such charrettes serve as a way of quickly generating a design solution while integrating the aptitudes and interests of a diverse group of people, the general idea of a charrette is to create an innovative atmosphere in which a diverse group of stakeholders can collaborate to "generate visions for the future". Compare this term with workshop.

On the day of the urban design course, the students went through a total of 3 rounds of charette and quickly designed them based on expert feedback. In this process, the design team quickly scrutinized from the three levels of theme, framework, and space to form a more complete main line and corresponding program. In addition, the participation of charette also includes non-professional personnel, such as Owners, surrounding passers-by, and other people interested in this project, they can make subjective suggestions, these ideas for collage editing, some will be deleted, leaving the most relevant ideas and finishing the law.

2.4. Future Scenarios and Urban Territories

The environment in which the city is designed is always to understand the past and future changes of the city from a spatial perspective. The course theme "The Great Transformation" examines the dramatic changes in the city caused by time accumulation and individual incidents, as well as prejudging changes that may occur in the future. From the current point of view, although the future image of Berlin in 2050 is not long-term, the current rate of change in the urban environment is very fast, and the efficiency of qualitative change is extremely high, which requires the most need for the theme of urban spatial change. Special attention. Therefore, the research team has structured four future themes: Scenario 1. TECHNO/CRAZY or "May the

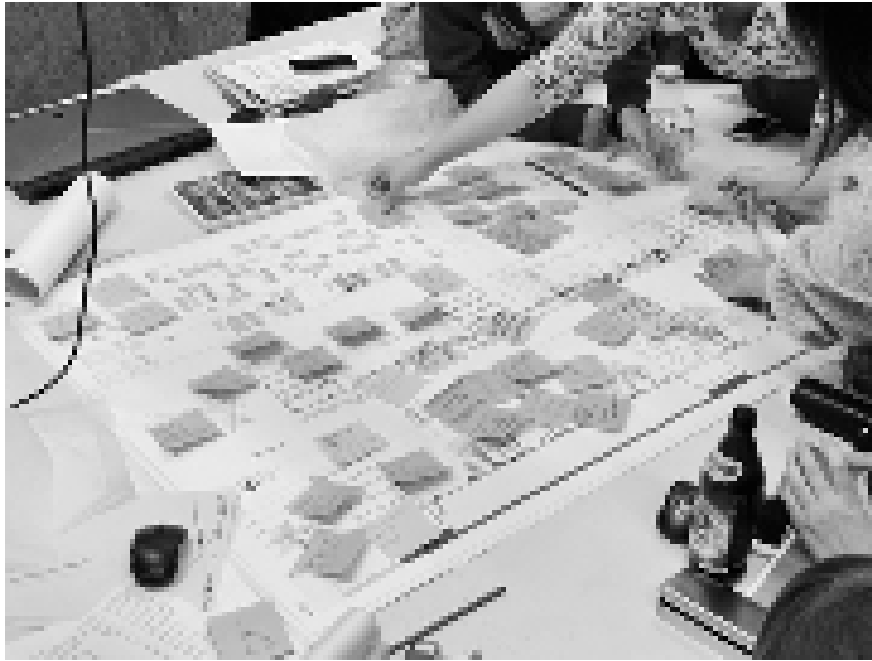


Figure 1. *The charette and fast design.*

Valley safe us all?", Scenario₂. DE-GROWTH or "Less is more (for whom?)", Scenario₃. POST-STATE or "The other global union" and Scenario₄. E-COUNTERCULTURE or "Going back to where we came from/ Brandenburg?". Each subject group then details the incentives that guide these changes. Next, under these themes, what is the most important change, what kind of results will be produced, and they will be described one by one on the spatial scale.

2.5. Actor Network and the "PlanSpiel" Game

The most special design of the entire course is to organize a conference discussion and role-playing game based on the design theme of the course group. The aim builds on three aspects: 1 – Understand how urban development is a negotiation between a broad range of actors and actor-alliances, varying in agency and interests. 2 – Build on the 4 sets of urban development actors in Berlin researched [urban discourse, housing delivery mechanisms, legislation and regulations, urban planning system. 3 – Further develop the Scenarios and transition deeper into the design aspect of the studio

The "PlanSpiel" game based on the "The Great Council" which is called into being at a moment of great crisis in Berlin, when it becomes unarguably accepted that everything has to change, because everything has become a little bit too much. A new forum for meeting to discuss and make decisions is announced. The core of the game is that Prepares 16 Actor Cards for the 16 council members who will respond to the model urban quarter proposal, setting out the intentions, goals, characteristics the particular interests of each actor and perhaps some guidance on playing them. Urban development involves negotiation: the 16 identified actors should have conflicting interests. It also encourages each group to introduce about three unfamiliar/uncommon maybe even non-human actors to the game in order to make other perspectives visible. In the process of carrying out this game, the students have been greatly trained on the system organization in the society. Understand the decision-making process in the city setting, and clarify the complex situations that need to be faced by playing the role expression. Most



Figure 2. *The PlanSpiel.*

urban designs, while the results point to spatial design, are actually more of a balanced relationship between the parties as a means of presentation.

3. Conclusion

Urban design itself is complex and not suitable for premature use in teaching. The urban design teaching of Berlin University of Technology is very rich, and it also has certain system city. The most prominent is the introduction of sociological participation in teaching programs. However, through specific practices, there are still two main problems:

1. The level of assistance for the basic course is not high. Course aids should be carried out in parallel from the other aspects of technology and theory. They should not stay at the level of cognitive understanding and need to focus on analytical research.
2. The design course structure is too complicated. The relevant research at the beginning of the course is not related to the results. The mid-term report organization is complicated. The performance of the result space in the late stage of the course is too weak, and the theoretical system is weak.

The ultimate result is nothing more than abstract extraction and virtual reproduction of the structural relationships in real society. This can only be regarded as a social cognition course for young students who have not yet entered the society. It has not yet made urban design as a discipline to find its own position, nor has it established its own context. These teaching practices can only provide a reference for the theoretical establishment of urban design itself.

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UN STUDIO is cooperation of Habitat-Unit. Prof. Philipp Misselwitz, WM Aine Ryan Chair for Urban Design and Urbanisation. Prof. Jörg Stollmann, WM David Bauer.-Technische Universität Berlin.

Sociospatial Reading of Favela

A Comparative Analysis from Organic Portuguese Cities

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Keywords: favela, urban configuration, sociospatial patterns, space syntax.

Abstract: This research decodifies the favelas spatial system through its configuration in comparison to historical organic structures aiming at searching similar self-organized processes. It is intended to observe in which way the configuration of such areas, read through their spatial patterns, affects their sociospatial dynamics and how it gets closer to common strategies for organizing the urban space: in which way favela reproduces historically consolidated spatial patterns inherent to organic cities? The Theory of The Social Logic of Space (Hillier & Hanson, 1984) is the theoretical, methodological and technical approach for this study, allowing to investigate such phenomena by means of its spatial complexity. The sample consists of 120 settlements around the world, explored according to a set of 26 configurational variables (among qualitative and quantitative, both geometric and topological), compared to a group of 45 Portuguese medieval towns (representative of organic cities). Findings show that the favelas recognized spatial patterns are mostly common to those associated with organic structures. Despite being much denser and apparently labyrinthine shapes, the internal dynamics of the favelas reveal positive global relationships. These settlements behave similarly to consolidated urban systems and share common spatial logics throughout world regions and distinct cultures, feature which allows recognizing the self-organization strategy as essential to their structural and survival process.

1. Introduction

As a complex phenomenon, inside a systemic perspective, favela must be read in its whole system and its relationships among parts in order to capture its organizing structure. The systemic perspective assumes urban space as a spatially continuous whole (Hillier and Hanson, 1984) wherein the meaning of space lies with emphasis on its syntax, that is, the way its elements aggregate and correlate.

The intricate sequence of void spaces in favela often seems disorganized by the existence of spatial rules not based upon simple forms, but in the complex geometry of self-construction and self-organization processes. Favelas present peculiar organizing rules, unclear to the observer, such as fractality which apparently structures its irregular and fragmented form (Sobreira, 2002).

The emergent quality of organic spaces is explored in Christopher Alexander (1977) in his study of patterns (configurations) as in the spatial properties of built environment he presents to be found in nature. Frederico de Holanda (2010) also values informality in contemporary space by recognizing that volumetric and spatial configuration must be varied to achieve exceptional levels of urbanity. The author discusses the interaction between formality and informality in the living spaces, highlighting the relevance of spontaneous human activities in strongly formal areas, associating such presence – of activities and uses – to clear benefits for urban living (Holanda, 2010). In the same way, the author presents configurational peculiarities of favela spaces as promoters of urbanity, structural quality of good urban spaces that catalyse people and diversity, usually guaranteed by spatial characteristics such as clear notions of space, continuity, density and tenuous relations between the public and the private sector (Holanda, 2002, 2010, 2012). Such information reinforces the need to explore spatial reading strategies that allows inferring on spaces performance materialized by spontaneous practices as in favela, specially from the point of view of structuring spatial relations, that is, its configuration.

The research follows Space Syntax theoretical and methodological approach (Hillier and Hanson, 1984) which aims to analyse spatial configuration in terms of sociospatial relations. Therefore, the systemic observation over spatial complexity results in the interpretation of spatial structures into social dynamics.

The paper states favela as something apparently in permanent development, despite the common interpretation of its spontaneity as an undesired transitory process. As the city around it, it might not be a physical and static entity (frequently recognized as a problem) but a dynamical spatial process in constant adaptation. This process allows the existence of adaptative local rules and emerging processes. It is also emphasized the urgency of the re-reading of the city beyond the logic instituted by planning, where the concept of order tends to distance itself from spatial solutions focused on organic complexity (Batty and Longley, 1994). The urban configuration of the favela will be studied from the point of view of its complexity and its spatial patterns, in order to comprehend the emergent processes of city self-organization and its implicit order. For this, the study will follow strategies to evaluate the existing relations in the built space and its social performance.

The aim is the reading of spontaneous production of the city, regarding that official structures have no efficient answers for all demand. The study contemplates an approximation, from the point of view of the configuration, to a world reality whose socioeconomic categorization does not appear to be weighted in the different space-society relations that are identified. Such purpose relies on the hypothesis that the spontaneous or organic city as concept and form includes favelas, and that the spontaneous process of making city are transverse to the urban structures. It presents itself in global urban areas and in the history of settlements. This common process, which one seeks to read in favela, seems to guarantee characteristics of organization that attribute the type of diversity desired to a good development.

The lack of understanding of space in favela is recognized as the major obstacle to its consolidation, since definitions and positions on this object assume that its geometry and configuration are inadequate to today's city and this leads to intervention processes that interrupt their self-healing processes (Salingaros, 2006). It is believed that by ignoring configuration an essential part urban space knowledge is denied, and the scrutiny of the favela spatial configuration is relevant to better clarify this type of urban dynamics and its spatial patterns.

2. Defining favela by understanding organicity in urban structures

Informal settlements do not appear to have a homogeneous behaviour. Leeds and Leeds (1978), Sobreira (2002), Valladares (2005), Davis (2006), Jacques (2006), Pasternak (2008), Cardoso (2016), and so on, make clear the differentiation between favela, often located closer to central areas and the illegal settlement or allotment in periphery (Figure 1).

Valladares (1981) refers to irregular settlements or informal settlements as common processes in Latin America. But despite the frequent categorisation of informality as one thing, the simple fact that there is an associated initial cost, that of buying the lot (Davis, 2006), and the prior and global organization of spaces, makes the process seem quite different from that of favela.

Jacques (2006) argues about the adaptability of housing space to income production in the favela, a dynamic often incompatible with legality within the formal zoning and clearly more advantageous than the tendency towards homogenization of the periphery housing. It is not intended to deny the existence of a similar sense of community, after all both cases are spaces of urban segregation, but it is questioned if the ways of interaction prevail as dynamic as in favela. Jacques also discusses that spaces can formalize in different ways, and one might find the favela placed on the hill (*favela de morro*) and the “favela like” community (*comunidade favelada*) of the periphery (Jacques, 2006). In both cases self-construction is present, but it seems that the processes can be quite different: in one side the continuous process of building private and public space at the same time in favela, in the other the labour exchange for building houses and space improvements present in settlements such as informal allotments (Chinelli, 1981). The first seems to represent self-organization processes, the latter self-construction dynamics in specific – already defined – areas. It is questioned whether favela’s community constitutes such differentiated spatial models that its dynamics of solidarity may also become distinct. Here the discussion seems to approach how spatial configuration correlates to the underlying structures that originate spontaneous urban life in favela, and, in opposition, formally imposed and monofunctional areas without fulgurous public life (Figure 2).

The dynamic life in the favela seem to be close to that of the so-called “traditional” city (both in European and Brazilian colonial terms), whose commerce often occurs on the ground floor and the upper areas are designated to residence. Here only the less busy streets are intended exclusively for housing, as opposed to the modern city, where zoning distances human activities and formalizes them. Medeiros (2013) recalls that throughout the city’s history we have always

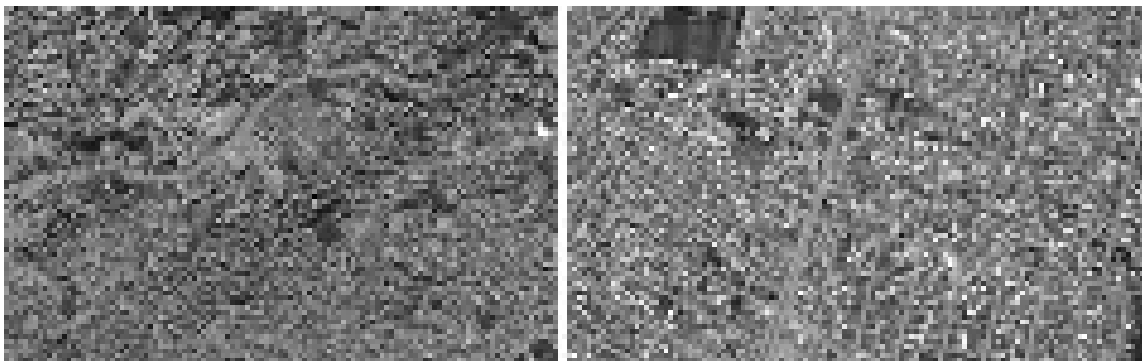


Figure 1. Difference between favela and informal allotment: Rocinha, Rio de Janeiro (left) and Sol Nascente, Brasília (right).



Figure 2. *Spatial contrast between favela (Left: Dona Marta, Rio de Janeiro, Brazil) and social projects in Rio de Janeiro (Right: PAC Social Project, Manguinhos, Rio de Janeiro, Brazil).*

dealt with the two processes in parallel, that of organicity (which permeates the whole history of the “traditional city” and seems to reach the favela today), and that of formalization of space, imposed by prior and regulatory planning.

In this context, it can be said that favela is an informal settlement once it does not follow the urban rules prefigured by the current legislation in terms of land subdivision and street geometry, in the same way that an illegal or irregular allotment follows them, but still recognized as informal for not complying with legal formalities in terms of territory occupation and property. Urban informality implicates, therefore, to assume a relation of absence or inaccuracy, something not happening as would be expected. It is, in any case, a term applied in several contexts – often derogatory, favouring its opposite. Informal settlement, therefore, characterizes the production of space on the margins of urban legality, and despite its strictly spatial focus, this definition seems useful in framing the favela in a larger whole. Since both the favela and the informal community (Jacques, 2006) of a clandestine or irregular allotment (Figure 3) have easily characterized as informal (for example, the spatial arrangement in the slums or informal economy in allotment) the term is assumed to be inclusive. In this, the study object differentiates in its spontaneous and self-organized logic.

The research focuses on space and its ability to organize itself in the most diverse forms, assuming, therefore, that the space of the favela will not be characterized by itself as something good or bad, but something to be observed and understood and which presupposes the existence of a logic, even implicit (Salingaros, 2006).

It starts from the understanding of favela as something in permanent development, breaking with the tradition of perceiving in its informality something undesired, because like the city that embraces it, this is not a fixed state but a space in constant adaptation. This process that materializes over time allows it to adjust according to its own rules and emerging processes that Salingaros (2005) calls self-healing. The author considers that spaces such as favelas should be deeply studied and their spatial logics understood before any intervention, since it already contains useful properties to a proper development as an urban space (2005). Usually understood as spatially segregated fractions of strong organicity, they tend to remain interpreted in their problems and needs, so the inherent potential tends to be neglected or ignored.



Figure 3. *Sol Nascente, Brasília, Brazil.*

3. Theoretical methodological and Technical approach

The theoretical, methodological and technical approach of Space Syntax that structures this research, seeks to re-signify the relationship between space and society, joining both layers in a single system of analysis. By understanding the intricate level of spatial patterns in the city one might find the consequences and antecedents of form and capture the social city in the physical one (Hillier and Vaughan, 2007). In the spatial layout, the theory recognizes two types of determining properties, the intrinsic ones that are related to the elements we see, constructed elements and their appearance (easy to memorize and most striking in our spatial experiences) and the extrinsic ones, whose apprehension is only possible when we move, infer and memorize spatial relations (Hillier, 1999). These extrinsic properties result from the reading of the patterns of organization or configuration and are those that most explain the social dynamics of the place because they allow the understanding of the complex system of potential relations that space represents.

It is intended to identify performance patterns in the interpretation of permeabilities (spaces that can be socially coexisting: public spaces) and barriers (private spaces of restricted use) to the movement, as an element of representation for urban dynamics. According to Medeiros (2013), the analysis regards organization and interparty relationships, as well as reading hierarchies. In a system, such information would be the motor for recognizing most structural and global relations, as well as those more local, presupposing the ability to capture information from the reading of the whole and its parts (Medeiros, 2013). For Batty and Longley (1994), as mentioned above, the understanding of urban patterns involves reading of self-similarities and hierarchies, which are only possible to perceive according to the observation of recurrences or regularities. Space Syntax, throughout its sociospatial information, allows access to recurrences and regularities in urban form, from the perspective of the dynamic information that is potential movement patterns. In terms of procedures, the research developed in three essential moments: 1) literature review and theoretical conceptualization, 2) data collection for the analytical base and production of the cartographic bases, and finally 3) the interpretation of the results and their confrontation with the purposes of the research.

Following the definition of the research object – favela as a spontaneous and self-organized settlement –, a framework of urban informality was defined and in it the type of settlements desired. A list of cities was obtained from the intersection of more populous and most unequal cities (Gini index), and this would be the framework for the desired context for settlements. In

the sequence, for the identification of study cases some visual parameters were important, such as free access satellite images with enough quality to observe the network of pathways.

Once the sample was defined, the analyses were developed based on axial and segmental maps, from which 26 variables were verified between qualitative and quantitative categories for 120 case studies. The analysis of spatial configuration of favela was complemented in two phases of comparison; first with the consolidated data for a) Brazilian cities (Medeiros, 2013) and second, with b) Portuguese organic cities, from a sample of 45 cities (Medeiros, 2016). Once the axial and segment maps were explored, the databases were scrutinized according to the same set of variables, and cut into three distinct categories: complete system, old core (for Portuguese cities) and integration core (main central lines of the system). Regarding the configuration analysis itself, according to Space Syntax, it is necessary to fulfil a set of methodological steps that were structured in the research tools: (1) elaboration of an adequate and consistent cartographic base that allows (2) the modelling of representations, (3) their analytical processing, and (4) the establishment of the correlations and interpretations necessary to reach the research results.

The axial map results from the linear representation of pathways drawn from the fewest and largest straight lines (Hillier and Hanson, 1984) considering all access network through urban system (Medeiros, 2013) – once read in terms of integration it illustrates the potential flows and most central areas. The segment map is obtained from the axial map. However, in this case, the axes are fractioned whenever there is an intersection, becoming an independent unit. This is a refinement of the axial map pondering minimal angular variations in order to interpret them as a continuation of the same path (not a change of direction as in the axial map). The resulted measurements can be illustrated chromatically, resulting in the classic view of an axial map in which the warmest colours correspond to the most accessible spaces and the colder colours the least accessible. For the analysis, 26 variables were analysed, divided into geometrical and topological (figure 4). The research is based on a sample that is structured in two moments of comparison: one contemporary and the other diachronic. The first consists of reading the contemporary favela, based on a set of exploratory clipping for the interpretation of the favela's spatial patterns. The favela was framed in the organic production of the city with the intention of developing the exploration of its current dynamics in a diachronic perspective, deconstructing the idea of phenomenon simply product of contemporary reality. To this end, Portuguese cities were used in the comparative process, whose organic traces of their old nuclei allow the relation between the layout of the favela and that which is a clear example of the organic pattern for cities throughout history.

4. The organic pattern of informality as part of the organic structuring of spaces

Jacques (2006) argues about the space of favela as a benefiting space for the city as a whole, both for its resilience associated with urbanism and for the recognition of its importance in Brazilian urban identity. The capacity and possibility of adapting the housing space to the production of income is incompatible with the legality of the formal city (Jacques, 2006) and clearly more advantageous than the tendency to homogenization of the housing periphery.

The dynamics above are very reminiscent of the so-called traditional city (in European or even colonial terms), whose trade often takes place on the ground floor and housing on the upper, and only the less busy streets are intended for housing only. Medeiros (2013) recalls that throughout history we have always dealt with the two processes in parallel, the one we recognize here as organicity and spontaneous self-organization (which permeates the whole history of the

Table 1. Measures used in research (Loureiro, 2017; Loureiro, Medeiros and Guerreiro, 2017).

	NAME	DEFINITION	SIGNIFICANCE FOR ANALYSIS
IDENTIFICATION	Name	–	–
	Country	–	Location
	Geographic Region (UNESCO)	–	Location
QUALITATIVE	Topography	Flat slope, moderate slope or steep slope	Context
	Size	Large, medium or small (according to kohlsdorf's procedure, 1996)	Dimension
	Position in urban context	Inserted in continuous fabric, Peripheral, or Peripheral on hill	Context
	Position of Integration Core	Most integrated or topologically most accessible ones tend to be internal, Peripheral or Mixed	Centrality
	Form of Integration Core	Linear, Deformed Wheel (Hilier & Hanson, 1984) or Mixed	Centrality
QUANTITATIVE-PHYSICAL	N° of Lines	Total of axial lines in each favela	Dimension
	Area	Favela's area in km ²	Dimension
	Total Line Length	Sum of all lines length in km	Dimension
	Compactness A	Reason between number of lines and area, in lines/km ²	Density
	Compactness B	Reason between number of lines and area, in km/km ²	Density
	Line Length	Mean length of axes in linear representation	Mean length in the street system
	N° of Segments	Total amount of segments in each favela	Dimension
	Total Segment Length (km)	Sum of all segments in the favela, in km	Dimension
	Segment Compactness A	Reason between number of segments and the area of the settlement, in segments/km ²	Density
	Segment Compactness B	Reason between total segment length and the area, in km/km ²	Density
	Segment Length (m)	Mean length of segments in the segment map	Mean block's size
	N° of Segment/N° of Axial Lines	Reason between the number of segments and number of axial lines in each favela	Level of orthogonality: an higher number reveals orthogonal tendency (much more segments than axes) a smaller number reveals a non orthogonal, or more organic structure
QUANTITATIVE-CONFIGURATIONAL	Connectivity	Average of connections per line	Related to an higher or lower quantity of routes and paths
	Integration HH Rn	Mean value of global integration (calculated according to Hillier & Hanson, 1984) representing mean global topological accessibility	It addresses the ability to move easily through space according to configuration, also influencing on land use and main centrality formation
	Integration HH Rn Base 100	Mean value of global integration (Hillier & Hanson, 1984) weighted according to Medeiros, 2013, representing the degree of mean global topological accessibility of studied settlements in a scale from 0 to 100	Addresses movement, land use and main centrality for settlement comparison
	Local Integration HH R3	Mean value of local integration calculated according to Hillier & Hanson, 1984 representing the degree of mean local topological accessibility	Observation of local movement, activities and centralities in favelas
	Synergy	Correlation coefficient between global integration and local integration	Synchrony among local and global parts of the system, affecting on spatial perception
	Intelligibility	Correlation coefficient between global integration and connectivity	Expectation of highly connected lines to be also the highly integrated, affecting spatial perception of place
	NAIN	Normalized angular integration, normalization for the measure of integration in segment maps	Mean values for topological accessibility, enabling settlement comparison without scale distortions
	NACH	Normalized angular choice, normalization for the measure of choice in segment maps	Analyses the through movement of hierarchy of path in the settlement, enabling comparative analysis without scale or size distortions

traditional city and seems to reach the favela today), and that of the formalization of space, imposed by a prior and regulatory planning. The forms of urban illegality here referred to as diverse are the parallel contemporaneity of this reality and seem to be related to the paradigm of formality / urbanity, discussed by Holanda (2002). The work will not focus specifically on the paradigm, but it is hoped to mark the urbanity potential of the favela from the identification of spatial patterns recognized as catalysers of urban life and recognized in the organic city.

With this analysis for the sample of 45 Portuguese cities, observing their old core and integration core, and having confronted all the information with those referring to what Space Syntax has pointed out as structural patterns for favela, it was possible to expose a set of ideas that argue these urban phenomena as similar or distant.

4.1. *Physical structure*

Old centres showed similar areas to favelas on average (0.21 and 0.14 km², respectively, as opposed to the whole city of 5.34 km²), as well as similar maximum and minimum. Favela seems to have approximate dimensions to what would be the oldest core of the Portuguese organic city. However, favelas are substantially denser than these cores (6539.5 to 776.4 lines / km²). The compactness values for favelas are much higher, revealing denser spaces despite the same occupation areas, which may be related to the absence – in the most compact cases – of the block's conformation or with its extreme diversity of sizes. The degree of compactness of the favela, compared to that of the organic city is also related to the type of location most common for the settlements: plan sites inside continuous fabric. Unlike the other analysed systems, favela materializes a space of opportunity in the large contemporary city, a place of access to opportunities that do not exist in the surrounding official peripheries, so the density tends to be very much associated with that intensity of occupation. Favela seems to be able to optimize its spatial relations intensively, transforming what would be the average space for block into only enough distance for one or two buildings. This organicity is expressed in the internal occupancy patterns by means of average segment and axial lines length, revealing reduced dimensions (14.6 m for axes and 9.3 m for segments) and extreme internal variation.

Favela, despite having a fewer proportion of segments per axial lines in comparison to Brazilian city (with 3.21 and favela 2.98), reinforcing the lack of a structure with connections that cross the system frequently, reveals higher ratio than the Portuguese city or its old cores (2.22 and 2.45 segments per axis, respectively), indicating a greater continuity of the traces, than would be expected. Despite the irregularity, the favela studied here is not characterized by the presence of alleys or dead ends. Two items stand out from this finding: on the one hand the topography as an essential role in Portuguese city and its tradition of adaptation to the territory, on the other the density of the streets network stands from the rest, guaranteeing a set of connections inexistent in more consolidated and historical structures. Although exploratory in the selection of cases and in the mode of representation, the sample shows that the favela is characterized much more by the organicity and sinuosity of its structures than by the existence of alleys or dead ends, a situation that contradicts the common imaginary. The favela intensifies the organic pattern in its spatial relationships (as being denser), but it seems to be unrelated to the sinuosity of the structure, once that, in the analysed sample, most favelas are in flat areas. Other important fact is that by searching for optimization of space, the formation of alleys or large blocks are not as favourable as a network of paths that, although precarious, extends to the whole system.

4.2. The topology of favelas and Portuguese historical cities

For connectivity and angular connectivity, favela reveals higher mean values (3.68 and 2.67) than the values for Portuguese cities (2.95 and 2.33), but very similar to old cores (3.64 and 2.58), revealing proximity in the kind of regularity patterns for both structures. Observing the data according to the area of the system, larger Portuguese cores tend to present higher mean connectivity (4.26 for the set of cores categorized as larger), as larger favelas tend to slightly decrease the mean values (3.84 for the set of small slums and 3.10 for the very large slums). This situation might indicate that consolidation processes over time tend to improve connections relation in a way that connectivity naturally develops. Otherwise in the favelas one can point out two particular situations that might correlate to presented values. First, very small systems whose spatiality seems to be distinct from that of larger systems (for instance, in the absence of blocks as discussed). Second, the process of consolidation in emergency situations, frequently in short periods of time, results in less connected systems due to their endogenous character and their diversity of internal scenarios – some highly connected spaces and many less connected, resulting in polarized systems, characteristic of its complexity.

Regarding measures of potential centrality (HH Rn), Portuguese cities (0.71) and their cores (0.79) reveal smaller values, as well as Brazilian cities (0.76), than favelas (1.06). The measure points out that favelas effectively tend to have stronger structuring axes linking the system as a whole, despite the apparent density and profusion of its system. The aspect seems to be related to the size of the systems on one hand and the polarization of values, on the other. Observing normalized values for the same measure (HH Rn Base 100 and NAIN), different nuances are observed that are worthy of attention: (1) the global integration for base 100 (Medeiros, 2013) reveals that favela has the most polarized structure, followed by historical cores (41.19 to favela, 46.25 to Portuguese cities and 44.46 historical cores), so with greater distance between its ends, revealing higher internal levels of segregation possibly by concentrating the integration on a smaller set of rows. (2) When looking at the normalized values by angular weighting and scale, NAIN, a measure that presupposes comparison with less distortions of scale, there is a prevalence of higher values in the favelas systems (0.94), followed by old cores in relation to Portuguese cities (0.90 and 0.83 respectively). This shows that somehow the structuring relations of centrality are stronger in the favela and historical cores, and one might assume that perhaps it retains in its emergent character a clear global organization, possibly due to the development processes, where few axes may be responsible for capturing the full integration of the system. Ultimately, the present stage of favelas seems to give signals that space is structured and follows clear organization patterns, producing stronger polarized centralities.

Observing angular normalized measures for Choice (NACH), which allows observing potential patterns of hierarchy, there is a main or global organizational structure (Hillier, 2016; Hillier et al, 2012) that permeates favela, such as the city. The measure represents the continuity of paths in order to identify the potentially easier movement path, the most chosen pathways by being the smaller topological routes. The result reveals that although apparently profuse, favela seems well organized and distributed in terms choice, there is a balance between local and more structural routes in favela street network. It is of high importance to demonstrate how a rule applied to well consolidated urban spaces (good through and to movement relations) is clearly expressed and structured in favela (figure 4). This reveals how self-organization informality can generate similar patterns to urban spaces, and how organic structures, even informal ones, can retain better organizing rules than other systems.



Figure 4. *Normalized choice patterns in two favelas (up left: Tiradentes, Belo Horizonte, Brazil; down left: Douala El Koudia, Marraquesh, Marroco) and two historical cores (up right: Covilhã, Portugal; down left: Beja, Portugal)*

4.3. Reading topography and centralities in the Portuguese city

Throughout the research, ponderations over topography are crucial and revealing of its importance in the dynamics of self-organized cities and how it implies different performances. Integration cores of Portuguese cities are mainly structured in the shape of a deformed wheel and reproduce categories of centrality associated with the good urban structure (Hillier, 1984, Holanda, 2002, Medeiros, 2013), much different from the inward-facing structures in favelas central lines, which tend to be composed of fewer and less structural/global lines. Topography seems to play a preponderant role in issues such as the size of the old core, however in all topographic categories different integration core models are possible, confirming that organic city does not declines with topography, instead seems to use it in its self-organizing and consolidation processes. At the same time, in favela it was possible to perceive slight declines in the topological performance of the system as the topography is accentuated, associating the higher fragmentation of the system to its impossibility of shaping the network of paths freely in the territory. Nevertheless, it is essential to state that topography accentuation slightly decreases mean values of accessibility in favelas but do not dramatically change the pattern recognition – organicity stills present and similar in all stated measures. Self-organization seems to structure space independently of its topography.

The absence of a peripheral integration core in the Portuguese city is symptomatic of the developing stage of the favela and, mainly, of its natural condition as part of the city and not an independent system. This indicates that in spite of the ghetto feeling and the ghettoization of



Figure 5. – *Example of different integration cores of favelas – Segment maps, Variable NAIN. Up left: Tingo, Arequipa, Peru; Up right: PNR Nagar, Bangalore, India; Down left: Musseque 1, Luanda, Angola; Down right: Thideer Nagar, Chennai, India*

which it tends to be targeted, its structure seeks in its processes of self-organization some form of connection with the city (figure 5), establishing interdependencies at the same time as it is organized internally by the frequent generation of mixed cores.

Finally, favela presents characteristics of spatial perception similar to those of the old cores. For synergy levels, favela presents similar values to historical cores (55% for favelas, 53% for historical cores, and 49% for whole Portuguese cities), which indicates the similarity in organizing processes and approximate hierarchy levels from the point of view of user. Levels of intelligibility are, however, somewhat smaller, reinforcing the intense organicity of the systems (25% for favelas, 28% for historical cores and 23% for Portuguese cities as whole). This reinforces once again the interpretation of favela as constituted of similar patterns of self-organization in organic systems, seen here according to the Portuguese city. It seems important to reinforce that such comparison has resulted in common patterns between favela and historical cores and not with whole Portuguese city. One finds that such similarity is not present in Portuguese complete urban systems due to the contemporary planning processes that had originated different urban patterns and scales.

5. Conclusion

The presented discussion allowed us to verify what apparently constitutes a morphological explanation for the favela phenomenon in itself, by bringing it closer to the historically constituted

organic cities. Similar processes of self-organization are identified in both types of settlements, which allows us to demonstrate how space organizes itself and its effects on spatial patterns.

Findings lead to two main reflections: favela (1) is a segregated urban space, which spatiality reveals a pattern of occupation less connected and less immediately apprehensible, despite its developing phase (more or less consolidated), and (2) at the same time reproduces almost all the urban attributes necessary for the conformation of good urban spaces and found in cities of organic genesis: strong centrality, good hierarchy potential, structured spatial relations both internal and locally (generation of community) or externally (strong relations to its surroundings), and above all, it assumes a structure that allows a continuous flow within its parts, despite the depth and profusion of its local geometry. Favela structures itself as cities do too, making it possible to infer general lessons about how self-organizing processes are consolidated over time and develop clearer patterns of organization than might be expected.

It is believed that in such type of informality – self-organized one – one can assume to recognize potential levels of urbanity, related to an implicit order that allows space to be configured in order to respond well to the needs of its users. It was necessary, however, to break down built-up assumptions and symbolic values recognized in informality in order to analytically comprehend the properties of these spaces, that increasingly constitute contemporary cities all over global south. Interpreting city dynamics analytically lead to observe spatial forms without prejudice, resulting in important lessons such as self-organizing informality as not an exclusive contemporary phenomenon, but seemingly part of organic cities intrinsic processes. This might surely be important in terms of urgent spatial interventions for sanitary and humanitarian matters, once some structural properties can be recognized and kept due to its proven spatial qualities.

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Methods: Embedding Different Approaches into
the Study of Urban Morphology

A Cultural Perspective on the Typo-Morphological Approach

A Planning Proposal for Hehua Tang, China

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Keywords: Urban heritage, Typo-morphology, Chinese context, Street, Fringe belt

Abstract: Hehua Tang once was a lively historical dwelling settlement in the inner fringe belt area of Nanjing. For decades, it was ‘forgotten’ during the rapid urbanization of the city. Nowadays, streets in Hehua Tang, which act as the main collective space for residents, are facing the enormous threat of losing their precious vitality due to controversial conservation and restoration schemes driven by local government.

This paper uses typo-morphology analysis to extract the characteristics of Hehua Tang. It also categorically defines the streets in this area in terms of a setting of street culture, with traditional customs, historical inheritance. The study also covers the multifaceted reactions of urban planning policies, and awareness and requests of residents. The analysis details the current situation of street system and form at two urban scales: the neighborhood and block scale; building scale, including building types, facade continuity, height-width proportion, plan rhythm, distribution of living units, and density.

This study not only provides a detailed graphical analysis, but also demonstrates a cultural perspective for reading and understanding the Chinese street. In particular, it is of use in seeking possible strategies to balance the preservation of Hehua Tang’s street vitality and improvements of living-environment quality.

1. Introduction

Many historical cities are currently suffering from a morphological and typological crisis, due to mass production and the internationalization of design. Beyond the conflicts between old urban patterns and new ones, universal architectural solutions have strengthened the debate against the idea of the ‘modern tradition’ architectural style since the 1960s (Dellapiana, 2018). This study focuses on Hehua Tang, located in the old southern town of Nanjing, which has been neglected during its explosive urbanization; it is an ideal candidate for understanding the inner-city traditional settlement as a physical and cultural object.

Following a series of UNESCO, ICOMOS, ICCROM conferences, the definition of the heritage issue has been progressively broadened (Blake, 2000). The Historic Urban Landscape approach has been adopted as a holistic urban heritage with more inclusive consideration about socio-cultural context, economic and financial development, environmental impact, as well as

urban transformation (Bandarin and Oers, 2012). Meanwhile, the concept 'Living Heritage' has been recurring over the last 20 years with increasing attention to the continuity of community connections and cultural expressions in the heritage sites (Poulios, 2014). Some scholars believe that the re-use of abandoned historical buildings is crucial for revitalizing communities and improving habitability conditions (Coscia et al., 2018). The typo-morphological approach, introduced as a reaction to Modernism, provides a prescriptive strategy of identity restoration in historical districts, which are progressively de-contextualized by market-driven urban development (Oliveira, 2016). It can nowadays be reinterpreted in the Chinese context, to provide a technical and operational guidance/methodology.

In this paper, we apply the typo-morphological approach, which originated in the Italian School in the 1950s, as a main method in the context of HehuaTang historical neighborhood. Despite being one of the last neighborhoods to have thrived for a thousand years, the Hehua Tang area has depreciated into a place of physical and moral decay for decades. However, despite the overcrowding and haphazard (chaotic) setting resulting from incoherent additions, Hehua Tang could be an emblematic example to study the identity of the traditional urban dwelling area owing to its abundant scope to reveal "a slow and organic piece-by-piece development process" (Kupka, 2012).

Following the introduction, the work is organized in three sections. The following section discusses culture integrated urban conservation approaches which emerged from Modernism and describes the possibility of reading the typo- morphology approach with a cultural perspective. In the third section, the paper illustrates a brief overview of the socio-economic evolution in Hehua Tang and analyzes the current built environment with corresponding cultural explanations. Besides, there is an analysis on the street system, that in the context is carried forth in two scales: neighbourhood/block scale, building scale. The last section is an overall discussion of urban transformation in Hehua Tang and concludes with design suggestions for future urban planning.

2. Methodology

This study adopts a multi-disciplinary methodology combining the typo-morphological analysis with the cultural demonstration, to investigate the impact of the changes of residential environments on the identity of the city and on the resident's perception. The spatial analysis identifies the characteristics of physical environment in terms of building types, spatial sequence, density and configuration. In addition, the spatial and cultural continuity in the transformation process of urban form can help sustain the local identity, thus benefiting resident's living quality. This study adopts a dual methodology by combining the typo-morphological analysis and the illustrations from a cultural perspective: sense of place. In addition to exploring the impact of typo-morphological changes of the built environment, the paper also defines a framework of guidelines for the future urban design.

The attention to existing cultural contexts has been at the core of emerging urban conservation approaches in the twentieth century. Among architects, planners, and social thinkers, the Italian architect Gustavo Giovannoni stood out as the first person who coined and defined the term 'urban heritage' (Choay, 2001; Zucconi, 2014) as an amalgamation of the cultural function and the built environment (Bandarin and Oers, 2012). Inspired by Giovannoni, Italian scholars Muratori and Caniggia developed a new method since the 1950s, the typo-morphology approach, to understand the transition process of urban structure; it is inclusive of both the phys-

ical and socio-cultural elements (Caniggia and Maffei, 2001) and is deemed as one of the most significant milestone in the field of urban heritage conservation (Bandarin and Oers, 2012).

Despite the long history of theoretical and practical studies in western countries, academic interest in the Chinese urban fabric is a recent issue. Since the beginning of the twenty-first century, the Conzenian methodology, known as urban morphology (Conzen, 2004), has been more prevalent with the extensive contribution of scholars, such as the British geographer J.W.R. Whitehand and the New Zealander planner Kai Gu (Whitehand et al., 2011, 2014). On the other hand, the recent works of the young Chinese researchers like Fei Chen and Shuyi Xie introduces typo-morphology approach into Chinese context. They believe that this approach can help to “interpret the built landscape in relation to location, time and scale in order to understand the production and transformation process of urban form and guide quality design practice” (Chen and Thwaites, 2018). However, there is still a lack of practical exploration of the Italian school approach to the Chinese context (Xie, 2019).

The transformation of city must be understood as an integration of various urban components. In urban design, the street has constituted a planning element of value equal to the building or the building block. Despite numerous transformations, the streets, being the strongest urban morphological sign, influence the shape of the city for a prolonged period of time (Conzen, 2004; Xie, 2019). Following this, the examination of the case study is carried out through an in-depth analysis from the morphological to the typological scale. To this end, Hehua Tang area is defined into two different scales: Urban neighbourhoods scale and building scale. The neighbourhoods, which are defined by Conzen as the area which is “bounded wholly or partly by street-lines” (Chen and Thwaites, 2018; Whitehand et al., 2014), has a slow but strong influence on the urban form, as well as the urban landscape (Oliveira, 2016); Building, especially the ordinary houses, is the real cultural carrier (Caniggia and Maffei, 2001), since they play an intimate role in the daily life. The typological processes of houses, on the other hand, are more ductile and flexible to the cultural and social evolutions. The street in this case is considered as the extension of the house, providing not only the access to houses, but also the social and multifaceted public space.

It is important to highlight that the Chinese historical cities have an ontological different cultural context from those faced by Muratori and Caniggia. Initially, the definition of the city has been cosmological in nature rather than morphological, which translates into a practical scarcity of graphic data. In fact, “ground floor plans of cities in historical periods have been largely absent,” which makes the analysis of Chinese urban form transformation extremely difficult (Chen and Thwaites, 2018). Moreover, the shape of the urban city is designed to heed the affinities of state power, such as the city central axis of Nanjing. Thus, typo-morphology as a research approach based on western city study needs to be addressed into the specific cultural contexts in Chinese historic urban landscape.

“The continuity of a culture is closely associated with the continuity of housing” (Gokce and Chen, 2018). Among the wide variety of identified cultural landscape elements, the sense of place has particular relevance for urban form. Sense of place is the contemporary equivalent of the ‘genius loci’ of ancient times, which was the guardian divinity of a place, its ‘genius’ or protective spirit (Bandarin and Oers, 2012). The argument about continuity, as a way to mitigate the trend of place-lessness in the transformation process of the historic urban settlement, is particularly relevant to the embedding of residents’ collective memory (Bideau and Yan, 2018; Gokce and Chen, 2018).

Sense of place can be mainly projected into three dimensions: visual, psychology and spiritual aspects. Carmona and their fellow researchers declare that the visual experience of localities, such as the height of building, the scale of the street, etc. has strong connection to

human activities, as well as their behavior (Cullen, 1995). Meanwhile, the psychological aspect can be demonstrated predominately as “hierarchy of identity and place-lessness” (Tuan, 2001). Regarding the spiritual aspect, the sense of place mainly refers physical elements which can represent beliefs and memories of local community (Tuan, 2001). Literature review and online survey are the main tools of this research to gather information from Chinese literatures, local newspapers, digital archives, as well as reports about residents’ interviews. Further research may involve other research approaches, such as ethnography, to achieve a better understanding by “thick descriptions” on local societies and cultures (Geertz, 1973).

3. Analysis/Results

Nanjing has a rich history dating back to thousands of years, however, in the recent past, it has experienced several dramatic changes, from the demolition of the inner-city walls to geometrical restructuring through ‘Great Capital Plan’ and the contemporary boom of new commercial skyscrapers. Hehua Tang is located in the inner-fringe belt area of Nanjing, as part of the “Nanjing’s Precious Historical City Conservation Zone”. It is an outstanding historical district which still retains the features of Chinese traditional residential settlements mainly formed in Ming and Qing Dynasty.

3.1. *The Streets (figure 1)*

The streets in Chinese historical urban district are usually as narrow as 2 to 3m, while the ones in the modern settlements could reach over 40m in width. Despite the size difference, the main transformation concerns the relation between blocks, buildings, and streets. The boundary between public and private areas are not clearly defined in the traditional street system, while in later cases, it is distinguished and accentuated by large semi-private or semi-public spaces.

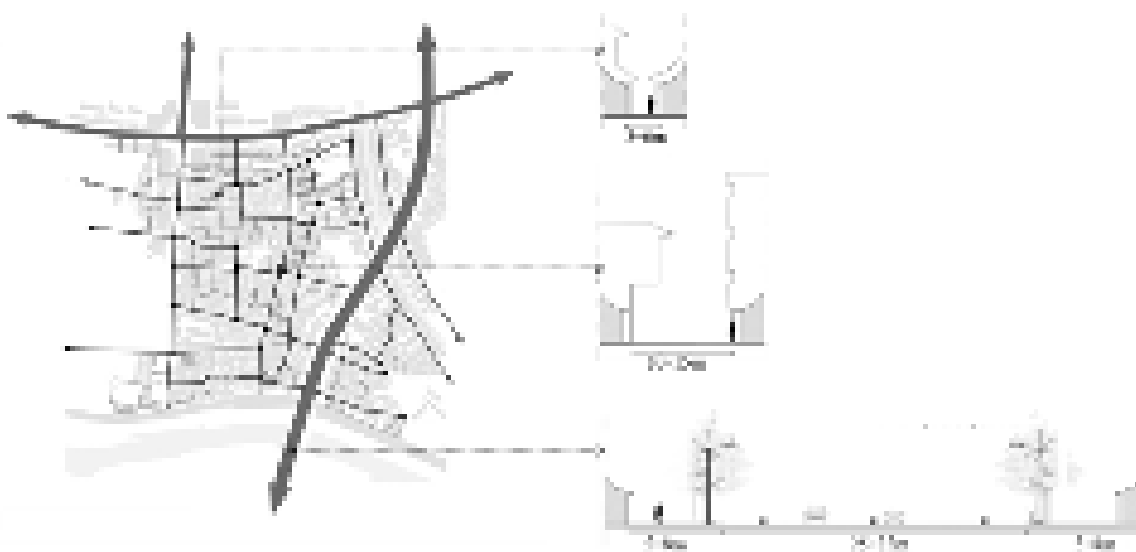


Figure 1. *Street system structure. Source: made by the author.*

Essentially, three types of streets can be identified according to the urban structure in Hehua Tang: the modern boulevard, the traditional lane, and the capillary alleys. The first type originates from the contemporary top-down planning, which literally overlaps the traditional street pattern. For Hehua Tang, the Zhongshan road is undoubtedly the strongest mark, that divides the old south town of Nanjing into two administrative districts. It creates a contrast with the traditional pre-existing urban fabric and street system. On the other side, the traditional lane, which is shaped by courtyard houses as surroundings, has been designed to provide a social space to merge the communities instead of dividing different blocks. Besides playing the role of social catalyst, it traditionally and presently provides access to the houses. Moreover, we can identify a recently emerged network of capillary alleys which are developed inside the private buildings. They represent a spontaneous reaction to the informal transformation and fragmentation of the traditional courtyard houses.

Since street is inserted in the urban context as a morphological structure, the street will be discussed again together in two scales of built environment: the neighbourhood and blocks scale as a space continuity, and the buildings scale as a social catalyst.

3.2. Neighbourhood, Blocks and the streets (figure 2)

Tracing back to Song dynasty (960-1279), an important urban system has heavily influenced the current urban fabric in Nanjing: the Lifang unit system. Lifang is an urban layout for Chinese capital cities regulated by central government from Tang dynasty (618-906). Some researchers believe that a unit of Lifang is theoretically identical to the concept of an urban block



Figure 2. Neighbourhood, blocks and the streets. Source: made by the author.

(Schinz, 1996). Despite the symbolic central axis of the city, the constitution and urban planning regulation of Song dynasty states that the urban area should be divided into a number of rectangular or square shaped districts. In addition, the city walls should be built with four main gates around those districts. This Chinese 'utopia block' still retains a significant impact on the historic urban neighbourhoods and districts. Nowadays, in Hehua Tang area, as well as most of the dwellings along Qinhuai River, some remnants from Lifang unit system can still be recognized from the organization of the residential blocks. Generally, most of the plots in Hehua tang follow the arrangement of a row with the short side facing the streets providing the access. Maintaining the system orthogonal, the warping of the urban fabric can vary from a north-south orientation to a less common east-west one according to the shape of the block. A typical plot is about 8 to 15 m wide and flexible in length in order to accommodate a traditional courtyard house.

The main current morphological characteristics of the Hehua Tang historical area are homogeneity and high density. On one hand, the carpet-like tissue that characterizes Hehua Tang is composed mostly of one or two stories of courtyard houses. On the other hand, the density of house units of the previous urban fabric is noticeably higher than the contemporary one resulting in lower land coverage. Despite its formal homogeneity, the Hehua Tang urban tissue is the result of several informal stratifications. The morphological evolution of Hehua Tang can be divided into three stages: the traditional city (1929), the industrial city (1977) and the speculative city (2019).

As shown in the graphic, in the 1920s, the West side of Chunhua gate was completely covered by traditional settlements composed by low-rise courtyard houses, which created the typical carpet like tissue. There were still some areas left as arable land or open land inside the city wall, mostly near to the south-west corner. In the second half of the twentieth century, the previous empty spaces as arable lands were progressively filled up by big industrial factories until saturation. Consequently, the street patterns resulted in an expansion without essentially changing. The third stage corresponds to the large-scale replacement of the 'decayed' traditional built-up area in the 90s. In this stage, the existing traditional fabric was progressively replaced by a punctual and serial arrival of high rises, and multi-story commercial districts.

The street patterns in 1920 shaped the urban blocks and still reflect the traces of the feudal period. Essentially, the streets followed a regular 'T' junction patterns that are organically developed according to the topography, mainly in the areas along the river. However, since 1977, the Zhongshan road defines the current Hehua Tang East border with west wing of the Chunhua gate. This street, as the main transportation path, is incoherent to the traditional patterns by changing the hierarchies. Meanwhile, other historical streets in this area have been renewed to accommodate an increasing number of cars (this is the case of the other two streets which define the North and the West border of Hehua Tang). Buildings alongside the two types of streets in the last three decades have been largely replaced by the aforementioned high-rises. The buildings height varies from two stories to ten so that the width-height ratios differ significantly, creating a chaotic visual effect. Although it was strongly lacerated, the traditional road system is still evident nowadays.

3.3. Buildings and the Streets (figure 3)

The Hehua Tang courtyard house represents the traditional vernacular typology in this region. It is widespread in Nanjing and other surroundings such as the Anhui province (another Chinese province along Yangtze River). As shown in the graphic, Hehua Tang courtyard is usually

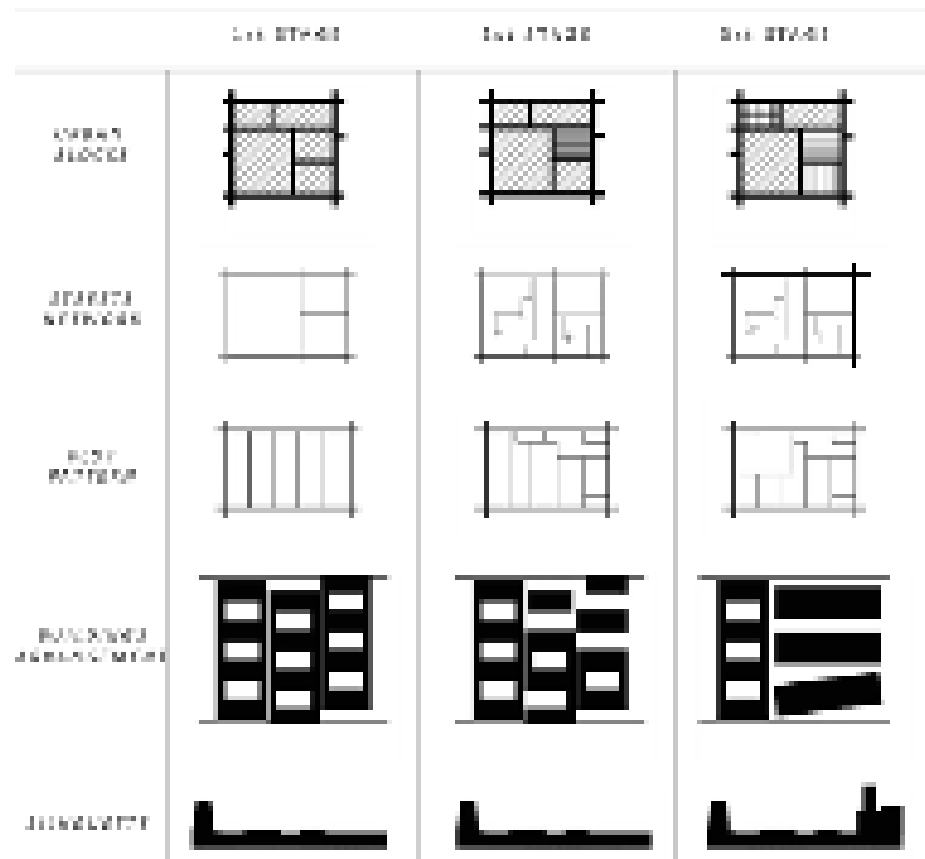


Figure 3. Buildings and the streets. Source: made by the author.

composed by a sequence of buildings and is developed inside a long and narrow plot. In order to assemble an urban block, the houses were placed beside each other. The buildings can be detached by a street: attached or partly attached to each other (fig.4). The number of courtyards could vary from one to five, according to the social status of the owner beyond the financial conditions. As the other typologies of the courtyard houses, the house has flexible plans ensured by simple and punctual structural elements. The individual buildings, as the components of the house, are usually narrow and developed in length. The courtyards were designed essentially to improve the ventilation inside the residential buildings. They are usually surrounded by two-story buildings or corridors, in order to reduce the onslaught of direct sun rays.

Originally, the orientation of these buildings follows an orthogonal orientation, prevalent along north-south axis. The distribution arrangement of this typology respected a specific functional and social order. Starting from the South, the first building was meant for the workshop; the following building was for the family activities or the accommodation of young generations; the biggest one was for the older generation of the family and, in the richest houses, the last building to the north was for the servants. However, it is hard to find an aboriginal typology in the current built environment of Hehua Tang owing to several significant socio-cultural revolutions: from the progressive vibrant state to the current ownership ambiguity. Thus, in order to host new social groups, the traditional houses have been transformed by the residents with minimal distributive interventions. After the Liberation, in a context of strong urbanization, the traditional house complex is too big to be affordable for a single family. For these reasons, this typology was progressively fragmented to adapt to new spatial and economical needs.

Thus, the need to reach the remote buildings of the complex necessitated a new different distributive street system. The series of surveys detected four main strategies of transformation

in Hehua tang: internal corridor, lateral corridor, access from the street and hybrid detached houses. In the first two cases, a new corridor is obtained inside the courtyards to access each building, as a living unit for single family. In the third case, the secondary street provides additional accesses to the courtyards. In the last case, new modern detached houses reshape the facade, the section proportion and the plan rhythm of the original street. These new additions create new hybrid solutions which witnesses the resilience of this historical residential area over years.

3.4. Sense of place at Hehua Tang: Illustration from Cultural Perspective

“Psychologically, traditional urban forms are imprinted into the collective memory and become symbols of a culture” (Chen and Romice, 2009). In Hehua Tang, the high density of low vernacular houses facilitates a high frequency of social interaction between dwellers.

The proportion of the height and width of streets creates a sense of belonging and safety for the community. Thus, the function of the streets in Hehua Tang is more similar to an open living space for residents, in which people can share news, eat together, play games, as well as dry their clothes. Some living rooms of the living unit are completely open to the streets, creating an ambiguous extension of the houses. In addition, the size of blocks and distance between street corners are friendly for open-air marketing. Hence, another impressive characteristic of the street is continuous appropriation with spontaneous and improvised commercial activities, such as selling vegetables in the early morning or street foods at the late night.

The courtyard, on the other hand, is another communal place for family dining, doing housework, and gathering. The plants and gardens are the most common elements for a courtyard, which helps people to distinguish the slight difference between the open-access place and family only space. Moreover, this intimate feeling is enhanced by the enclosing arrangement of the surrounded houses, as well as the almost blind facade towards the street.

4. Discussion/Conclusion

This study makes a typo-morphological analysis in the Chinese cultural context. It examines the applicability of western spatial study approaches in Chinese urban heritage conservation. In addition, it explores a practical way to maintain a continuity of community in the historical

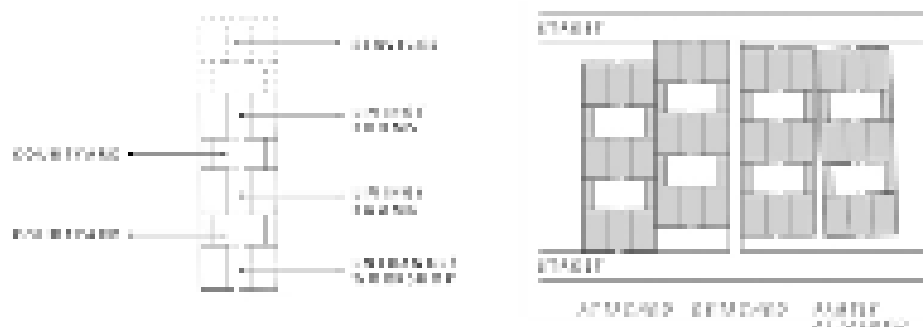


Figure 4. The typology of traditional courtyards. Source: made by the author

districts which are losing their livability and identity. The physical and social nature of heritage conservation in such areas are usually interrelated without definitive, or objective solutions.

The study offers design suggestions in response to the current built environment and vernacular culture. The urban morphology evolution of Hehua Tang area shows unique traces from the Chinese feudal period. Moreover, the sense of place, especially the spiritual aspect, has a strong connection with the local spatial characteristics. To sustain preservation of the local community, the courtyards should be maintained, as well as the traditional street structure. New design proposals should reproduce the high density of the current built environment, aiming to revive the local lifestyle. Meanwhile, the appearance of blocks must be compact, with the main accesses in the perimeter road. Porous solutions, such as *ilot ouvert*, should be avoided as much as possible regarding the arrangement of residential blocks. On the other hand, the plot should be respected, mainly in terms of proportions. It is not a fundamental element to be preserved in the original imprint, due to the vulnerability to rapid socio-economic changes. In addition, the open spaces should be redefined spatially and functionally with precise restriction. The social and cultural function of open spaces along the streets should be highlighted instead of the symbolic meaning of the state power. Furthermore, restored traditional courtyard houses should be adapted to the different needs which are required at present.

Since the population of the city has increased rapidly, it is hard to find a housing complex which is owned entirely by only one family. As the structure and space utilization are separated in the traditional house complex, every plot can be subdivided into different living units for different families. Even though this kind of typological process has already happened spontaneously and informally in Hehua Tang, a more planned intervention could produce fruitful effects in terms of living quality.

The research offers a multi-layered and multi-scale demonstration about the Chinese urban landscape which is facing heterogeneous and complicated circumstances, and seeks for a balance between urban heritage conservation and local community development. However, further study on typo-morphology is needed to fully examine its feasibility in the Chinese urban heritage context. Improvement could be achieved by introducing a more detailed consideration both of economical phenomena, such as market-driven tourism and ownership ambiguity, and socio-cultural impacts.

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Analyzing Recent Morphological Evolution in Central Beijing during Relocating Non-Capital Functions Based on POI Data and Digital Maps

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Keywords: Morphological evolution, Point of interest (POI), Hybridity, Beijing

Abstract: After China's reform and opening up, Chinese cities have undergone large-scale spatial restructuring, which is reflected in urban renewal and urban expansion. Our study focuses on recent morphological evolution in central Beijing during relocating non-capital functions, when Beijing began to adjust the economic structure and spatial structure according to the "Beijing-Tianjin-Hebei Collaborative Planning Outline" since 2014. Based on point of interest (POI) data and digital maps, a series of indicators on urban morphology are specified to classify urban blocks, from the perspectives of the built environment as well as land use. And hybridity, a key morphological characteristic in traditional cities, is measured quantitatively based on these indicators. Through the observation of the trend, extent and intensity of these changing indicators, the evolution of urban form is revealed.

Results suggest that central Beijing can be classified into three different regions: the old city, the newly-built area and the fringe belt. Three regions vary in characteristics of the built environment and land use. The two aspects of urban form are correlated, and certain types of land use tend to locate in blocks with certain built environment characteristics. The changes in land use clearly reveal the effect of relocating non-capital function during this period. However, this compulsory function relocation has led to homogenization in the old city of Beijing, leading to a possible reduction in urban vitality and convenience.

1. Introduction

During 40 years of reform and opening up (1978-2018) in China, the number of residents in Beijing has increased from 4.92 million to 21.7 million, and the urban built-up area has grown from 346 square kilometers to 1,603 square kilometers. A large amount of labor was concentrated in the city when the urban area keeps expanding and merging the nearby villages. Meanwhile, in the old city of Beijing, a proportion of traditional buildings were redeveloped and substituted by buildings of larger scales. The whole city gradually takes on a hybrid and fragmented appearance (Chen, Y.S. & Qi, X. 2018). As China's urbanization is shifting from medium quality to high quality, its driving force also is switching from capital-intensive to innovation-intensive (Fang, C.L. 2019). According to the "Beijing-Tianjin-Hebei Collaborative Planning Outline", the designated function of the city has changed. Beijing began to adjust the economic struc-

ture and spatial structure by means of “relocating non-capital functions” after 2014. In this research, we are trying to explore the morphological hybridity of Beijing in this period and the influence this policy shift has caused on the urban form until now.

With the development of information and communications technology (ICT), urban data are accumulating at an unprecedented speed. The explosion of data makes it difficult to understand in traditional ways (Pan, Y. H. 2018), and a number of new analysis methods are put forward in the era of big data, opening up new possibilities for urban research. Through the analysis of multi-source and fast-updated urban data, the evolution in urban form can be quantified more comprehensively and accurately, revealing the relationship between the built environment and urban function in depth.

This study aims to inspect urban form quantitatively based on point of interest (POI) data and digital maps. From two perspectives of the built environment and the land use, several block-level indicators on urban morphology are specified, and hybridity is then calculated. Finally, through comparison of these changing indicators, the evolution of urban form is revealed.

A number of scholars have worked on quantifying urban form since M.P.G.Conzen (1968) and his followers established the connection of urban form with town-plan, building types and land use. From the perspective of the built environment, the Spacematrix method uses multiple parameters of floor space index (FSI), ground space index (GSI), height and open space ratio (OSR) to distinguish between different forms of urban blocks (Berghauser Pont, M. & Haupt, P. 2007). From the perspective of land use, the mixed-use index (MXI) tool quantifies the degree of mixing in land use by calculating the ratio between housing, working and amenities in the area (Van den Hoek, J. W. 2008). With the help of big data, studies with new data source and new methods have emerged. For example, Dutch scholars studied the multi-dimensional character of neighborhoods by clustering algorithms (Gil, J. et al 2009). Long Ying's team used algorithms to construct the relevance between POI and block (Liu, X. & Long, Y. 2016). Yu Ye (2014) combined Space Syntax, Spacematrix and MXI in urban morphological analysis. At the same time, some Chinese researchers began to use big data to analyze the spatial distribution of functions in cities (Wang, F. et al 2015; Chen, W.S. et al 2016; Yang, T. 2018).

2. Methodology

2.1. Data sources and preprocessing

The data used in our study include a) data of urban buildings and urban blocks (parcels), which are generated from digital maps in 2015 and kindly made public by Beijing City Lab (<https://www.beijingcitylab.com/>), a virtual research community dedicated to studying China's capital Beijing quantitatively; and b) POI data from 2014 to 2018, which comes from Nav-Info, a leading digital map and navigation service provider in China. POI data consist of points representing geographic entities, including latitude and longitude coordinates, address, name, and category, etc. Such data may provide wide coverage and fast update of land use information with relatively high accuracy. After purging invalid records, all the data are transformed into the same type of coordinates and cropped by the 5th ring road, which basically represents the central urban built-up area in Beijing.

Note that we have not obtained data of the built environment through different years. Nevertheless, as the built environment changes rather slowly compared with urban functions

and POI during 2014–2018 (Wegener, M. et al 1986), the influence of this lack of data is limited and reasonable conclusions can still be achieved.

2.2. Research framework

Conzen's method combines town plan, patterns of building form, and patterns of land use to inspect urban form (Conzen, M. R. G. 1968). As the data of land lots are hard to obtain in China, we mainly focus on two perspectives of urban morphology, the built environment and the land use. The built environment is analyzed via clustering the four Spacematrix indicators generated from digital maps, while the land use is represented by the POI data, and summarized by the Latent Dirichlet Allocation (LDA) algorithm. Next, the relationship between the built environment and land use is inspected and then hybridity of different blocks is generated. At last, the morphological evolution during relocating non-capital function is revealed through comparison of indicators in different years, and several conclusions are drawn.

In all the above analysis, we take urban blocks surrounded and separated by motorways as the spatial unit of analysis, because an urban block is a relatively coherent entity in urban morphological evolution and data of smaller units (i.e. land lots), are not available.

2.3. The analysis of built environment based on digital maps

Spacematrix (Berghauser Pont, M. & Haupt, P. 2007) is an efficient way of quantitative description of built environment, simultaneously representing the building density and various building types. Spacematrix takes into account four correlated indicators of block-level built environment: a) floor space index (FSI) is the sum of area of every floor in buildings in a block divided by the area of this block, which is a common indicator in Chinese urban planning; b) ground space index (GSI) is the total area of buildings footprints in a block divided by the area of this block; c) layers (L), the average story of the buildings in a block, numerically equals FSI divided by GSI; d) open space ratio (OSR) is the total area of open space, i.e. vacant space within blocks, divided by the total built area of buildings in this block. These four variables express the intensity (FSI), the compactness (FSI), the building height (L) and the pressure on non-built space (OSR) in a block respectively. The Spacematrix diagram inspects the four indicators simultaneously. The FSI on the y-axis indicates the intensity in an area and the GSI on the x-axis reflects its compactness. The OSR and L are gradients that fan out across the diagram. Thus, every block is represented by a point in the Spacematrix, and different region in the Spacematrix reflects different patterns in the built environment.

Unlike previous studies, where Spacematrix is classified subjectively into separate regions representing different building types, we utilize classic *k*-means method to cluster points in Spacematrix into different categories of building form. Clustering allows the classification of instances in multi-dimensional space where there are no classes defined beforehand. As a classic and basic clustering method, the *k*-means algorithm iteratively partitions the whole data set into a *k* number of clusters and adjust the locations of *k* cluster centers, seeking to minimize the sum of variance in each cluster (Witten & Frank 2005). In this way, Spacematrix is partitioned into separate regions less subjectively on the basis of the distribution of data, and all the blocks in our study area are classified into a certain cluster of built environment.

2.4. *The analysis of land use based on POI data*

Land use information directly acquired from planning maps usually assigns a single land use in one location. However, in a real urban environment, mixing of different land use is the usual case. Van den Hoek (2009) utilized the mixed-use index (MXI) to quantify the degree of land use mixture, based on the percentages of the gross floor area of dwellings, working places, and commercial amenities among all the floors of buildings in a block.

With the help of POI data, the information on mixing land use can be characterized more accurately with higher spatial resolution and quicker update. The POI data are provided with 47 detailed categorical identifiers, such as personal services, companies, public security agencies, medical institutions, retail, education, etc. Numbers of different types of POI points are summed into corresponding blocks and then normalized according to the area of blocks. The density of different types of POI is representative of diverse land use, revealing the distribution and agglomeration of different urban functions as well as hybridity and correlation between different land use.

However, a drawback in approximating land use with numbers of POI points lies in the varying quality and importance of POI points of different categories. Typically, information about human activities or data on the scale of POI points is needed to deal with this problem. As these data are not available, we utilized the TF-IDF (term frequency–inverse document frequency) transformation, based upon the assumption that rare types of POI are of more importance. TF-IDF is a numerical statistic in information retrieval, which is intended to reflect how important a word is to a document in a collection or corpus (Wu, H. C. et al 2008). The TF-IDF value increases proportionally to the number of times a word appears in the document and is offset by the number of documents in the corpus that contain the word, giving rare words relatively more importance. Here we made an analogy between information retrieval and urban function quantification, with different kinds of POI points corresponding to different words, blocks corresponding to documents, and the entire central Beijing taken as the corpus. The transformed spatial distribution of different types of POI is then used to represent relevant urban functions.

The distribution of different kinds of POI is inter-correlated. Through pairwise correlation between different types of POI, it can be found that some POIs are closely related to each other, while some others are relatively independent. Some POI combinations represent basically the same kind of land use, such as residential area and personal service, car sales and car service. For better comprehension of land use, the original detailed categories in POI data are summarized into fewer latent types. Several methods exist to extract latent factors from observed data, such as principal component analysis (PCA) and factor analysis. In accordance with the aforementioned analogy with information retrieval, Latent Dirichlet Allocation (LDA) is utilized to discover latent topics of land use. LDA is a generative probabilistic model of a corpus (a collection of observed data) (Blei, D. M. et al 2003). The basic idea is that documents are represented as random mixtures over latent topics, where each topic is characterized by a distribution over words. In our land use setting, LDA tries to model an urban block with different categories of POI as mixtures over a small number of latent topics of land use, where each topic of land use is characterized by a distribution over categories of POI. The mixture of land use topics is a better representation of the real mixing urban functions, balancing between comprehensibility and detailed precision, and changes in land use topics may reveal the evolution in urban functions.

In practice, the number of topics is an important hyper-parameter affecting the performance of LDA. And we choose the appropriate number of topics where there is a sharp drop in model perplexity or topic similarity.

2.5. The analysis of hybridity

Hybridity, the interweaving state of various buildings, people, and urban functions, is a result of conflicts and contradictions in the process of modernization and urban expansion in traditional cities, reflecting urban vitality. In our study, the hybridity of urban blocks is characterized by two aspects, i.e. the built environment and the land use.

From the perspective of built environment, hybridity can be quantified by the degree of mixture between different form types of individual buildings. Types of building forms are determined by the height and shape of buildings. After inspecting the overall distribution of building heights, heights of buildings are classified as “low-rise” (one or two floors), “mid-rise” (three to six floors) or “high-rise” (above six floors). Building shape is measured by area-perimeter ratio, and classified as “strip”, “block” or “point” with increasing area-perimeter ratio values. Hence all the buildings are divided into nine form types and an urban block can be characterized by the volume of buildings in each of these nine form types that belong to this block. Then we measure the hybridity of built environment with Shannon entropy, a mathematical measure of the degree of randomness in a set of data in information theory and a popular diversity index in the ecological literature (Jost, L., 2006).

From the perspective of land use, the hybridity of a certain urban block can be estimated from the degree of mixing in its associated land use topics. Similarly, Shannon entropy of the topic distribution in a block is calculated as an indicator for hybridity.

3. Analysis of Results

3.1. The analysis of built environment

The block-level Spacematrix indicators are clustered into 9 types (Figure 1 B), with the cluster center values in Table 1. According to the spatial distribution of clusters (Figure 1 A), three different regions are revealed: old city area, newly-built area, fringe belt. The old city is the historical region surrounded by the ancient walls of the Ming and Qing Dynasties. The newly-built area is the region of urban expansion since the founding of the People's Republic of China. The fringe belt is the interweaving urban and rural areas, where the urban characteristics are gradually reduced away from the city center.

It can be found that the FSI of the building in Beijing is low in the center, high in the newly built area, and the fringe belts are lower again, forming a ring pattern. As shown in Figure 1 A, the scale of the urban blocks gradually increases from the old city to the fringe belt. This indicates that the closer the location is to the city center; the finer division of the land plot is, and vice versa (Table 3).

Due to the hybrid types of building in the block of Beijing, the value of each cluster corresponds to several building types (Figure 1 C). However, Chinese urban land is state-owned, and urban buildings tend to show different characteristics at different times. The form of buildings can be judged roughly by the different built times in the three regions. In the old city, the historical area is of carpet shape, that is, a kind of high-density courtyard building, while some redevelopment areas are high-rise blocks or strips. The newly built area mainly exhibits a high degree of homogeneity with medium density, which is characterized by mid-rise strip buildings. There are still some blocks with low-density forms such as parks and urban villages, and

Table 1. *The index of 9 block clusters.*

Cluster	0	1	2	3	4	5	6	7	8
FSI	0.048700	0.382171	0.918825	1.128469	1.264736	2.037636	2.601148	4.534147	7.295834
GSI	0.032020	0.153036	0.467038	0.299068	0.641320	0.247713	0.415441	0.290448	0.621224
L	1.660942	2.671250	1.987091	3.825410	1.979606	8.369767	6.301446	15.966836	12.137201
OSR	30.898885	2.521109	0.621259	0.667635	0.321749	0.383549	0.231832	0.163752	0.050629

Table 2. *Relationship between region and building type.*

	0	1	2	3	4	5	6	7	8
Old city	Park	Low-rise strip	Less Car-pet+ strip	More Car-pet-strip	Strip+ high-rise point	Mid-rise block	High-rise strip ₁	High-rise strip ₂	High-rise block
Newly built area	Low-rise point	Low-rise strip	Mid-rise point	Carpet+ strip	Strip+ high-point	Mid-rise strip+ high-rise point	High-rise point	High-rise block	X-High-rise block
Fringe belt	Low-Rise point	Low-rise strip	Less Car-pet+ strip	More Car-pet-strip	Mid-rise block+ mid-rise				

Table 3. *Relationship between region and cluster*

	Main cluster	Minor cluster	Block size
Old city	2\3	0\1\4\5\6\7\8	Small
Newly built area	4\5	0\1\2\3\6\7\8	Medium
Fringe belt	1\2	0\3\4	Large

higher-density forms such as business centers. The form of the fringe belt is the result of the interlaced development of villages, farmland and mid-density residential areas. (Table 2).

3.2. *The analysis of land use*

In Figure 2, urban blocks are colored according to the density of POI of a certain type. The spatial distribution of POI is related to its characteristics. Some public welfare and historical functions are only distributed in specific areas. For example, most of the scenic spots are distributed in the old city, international organizations only appear in the embassy district, and public security organizations are evenly distributed in cities.

The aggregation of POI in some categories has a clear tendency, which reflects the layout of urban planning. For example, culture, social groups, education, and scientific research are concentrated in the northwestern built-up area because the university town is in this area.

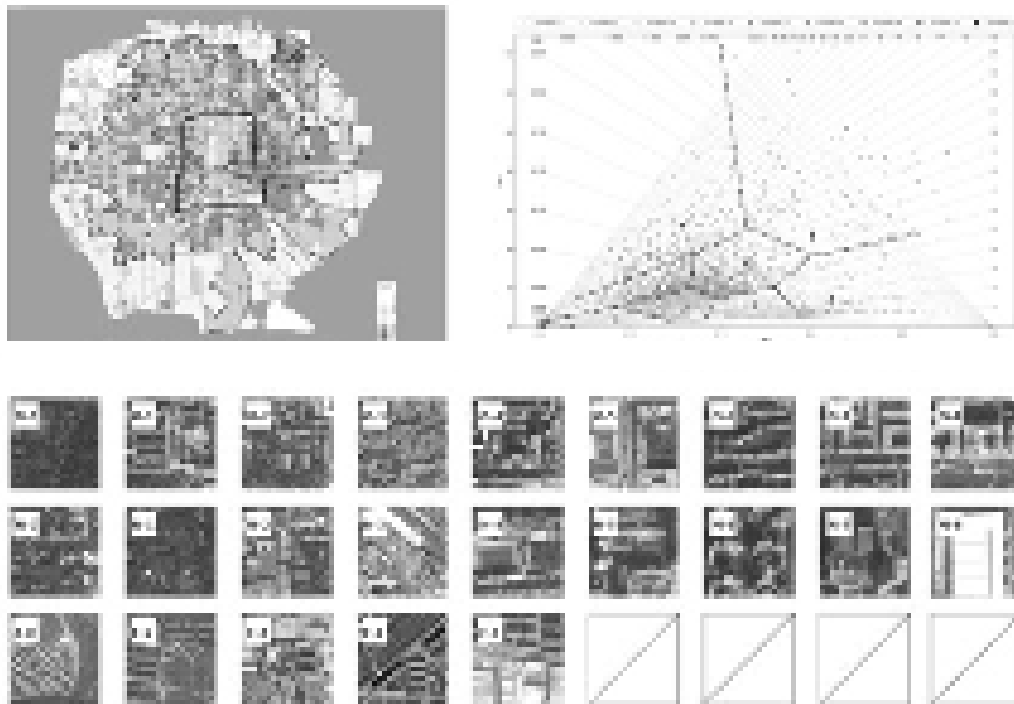


Figure 1. The spacematrix index, the distribution of the block cluster and remote sense image (a. The distribution of the block clusters; b. The Spacematrix index of the 9 clusters; c. The Remote image of the 9 clusters).

Commercial facilities are concentrated in Wangfujing-CBD, Xidan-Finance Street, Zhongguancun, and car services are gathered at the edge of the southern city. And profitable POI has a tendency to gather in the center, such as commercial accommodation, children's retail, restaurants, cultural retail.

With the aforementioned method, nine topics of land use are derived from LDA (Table 4). Through the distribution of each topic over different types of POI, the semantic meaning of each topic can be determined. Figure 2 F shows urban blocks with their most prominent land use topic. Different topics exhibit varying spatial preferences. Topic 8, related to “corporate companies” is prone to locate in the east and north directions between the 2nd Ring Road and 3rd Ring Road, and Topic 3 (commercial services) are widely distributed in the west and south. The old city is dominated by Topic 1 (government affairs), Topic 3 (commercial services) and Topic 5 (leisure).

3.3. The correlation of built environment and land use

Base on the clusters of built environment and topics of land use, the relationship between the built environment and land use can be explored (Table 5). It can be found that Topic 4 (international organizations and parks) prefers cluster 0, which is characterized by blocks with low density. Topic 7 (automobile logistics) prefers cluster 1, and the large car shops and warehouses make the building level not too high. Topic 3 (commercial and residential) prefers clusters 2 to 6, Topic 6 (residential services) prefers clusters 5 and 7, and Topic 8 (business) prefers clusters 6\7\8, which themselves must maintain a certain density. In particular, “business” is more inclined to a high-density environment.

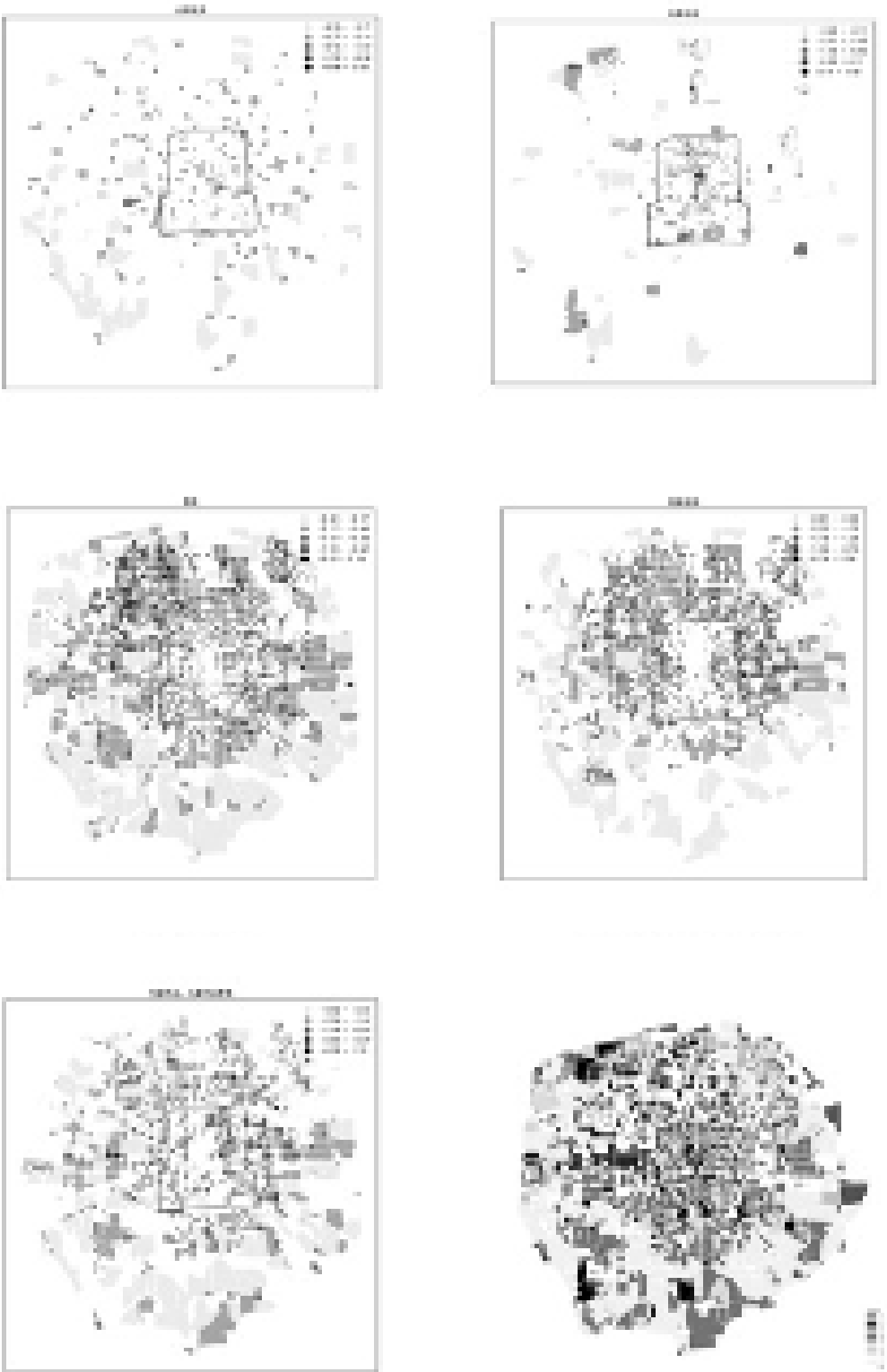


Figure 2. POI distribution and main function distribution (a. public security organs; b. scenic spots; c. education; d. commercial facility; e. maternal and child products retail; f. the topic of land use).

Table 4. Relevance of POI and Topic.

	Topic	Rank1	Rank2	Rank3	Rank4	Rank5
0	POI type	Scenic spots	Medical institutions	Culture, media	Personal service	Public security organs
	Intensity	0.210335	0.110839	0.0909369	0.0526513	0.0439428
1	POI type	Government and regulatory agencies	Other units	Social groups, associations	Research institutions	Personal service
	Intensity	0.112281	0.0775246	0.0635607	0.058314	0.045888
2	POI type	Road auxiliary facilities	Personal service	Integrated retail	Fast food	Retail of beverages and tobacco and alcohol products
	Intensity	0.656289	0.0378517	0.0278673	0.0264926	0.025771
3	POI type	Personal service	Restaurant	Maternal and child products retail	Retail of beverages and tobacco and alcohol products	Fast food
	Intensity	0.147875	0.0908856	0.0898191	0.0764612	0.0724976
4	POI type	Leisure vacation	International organizations	Rental service	Scenic spots	Road auxiliary facilities
	Intensity	0.267939	0.0969138	0.0689593	0.0598811	0.0351575
5	POI type	Retail of culture, sporting goods and equipment	Casual dining	Restaurant	Leisure and entertainment	Sports venue
	Intensity	0.118951	0.110061	0.0755494	0.0753661	0.0726666
6	POI type	Residential accommodation	Education	Personal service	Road auxiliary facilities	Financial Services
	Intensity	0.205713	0.13855	0.061418	0.0563674	0.0497855
7	POI type	Passenger and cargo transportation	Car sales and service	Retail of automobiles and related products	Retail of hardware, furniture and interior decoration materials	the company
	Intensity	0.0867158	0.0850847	0.0810609	0.0690214	0.0569026
8	POI type	The company	Financial Services	Commercial facility	Restaurant	Road auxiliary facilities
	Intensity	0.209603	0.0853332	0.0792545	0.0418569	0.0389604

3.4. The analysis of hybridity

From the perspective of built environment and land use, the degree of hybrid can be measured. On the function side, the hybridity represents functional diversity. The higher the degree of hybridity, the more diverse the function representing the street block. From Figure 3 A/B, it can be seen that the old town and the urban fringe are more hybrid than the newly built area. The hybridity of the old city is reflected in the high degree of integration of urban functions after a long time, while the hybridity of the urban fringe belt is reflected in the intertwining agricultural and urban functions. In contrast, the newly built-up area showed homogeneity, which is probably affected by the zoning in modern urban planning.

On the built environment side, hybridity implies the mixing of different building types (Figure 3 C/D). High value of hybridity means that different types are located in the same street block. In the old city, hybridity has relatively low value, indicating the townscape more

Table 5. Relevance of built environment cluster and land use Topic.

Topic \ Cluster	0	1	2	3	4	5	6	7	8
0	0.132030	0.068915	0.116309	0.139191	0.179405	0.097928	0.065056	0.146132	0.055034
1	0.107460	0.099910	0.071193	0.115681	0.109350	0.096168	0.092850	0.214517	0.092870
2	0.120778	0.119233	0.044792	0.304577	0.043504	0.125617	0.066901	0.098440	0.076159
3	0.089390	0.153290	0.042706	0.213713	0.043823	0.069446	0.139506	0.122322	0.125803
4	0.095402	0.114566	0.043379	0.345664	0.044404	0.141347	0.058959	0.086864	0.069414
5	0.044617	0.113048	0.034312	0.226000	0.040896	0.067602	0.213924	0.064808	0.194794
6	0.071567	0.160073	0.037311	0.213812	0.036363	0.104025	0.107195	0.058322	0.211331
7	0.047277	0.063575	0.045426	0.186670	0.046475	0.059846	0.217816	0.040032	0.292883
8	0.055979	0.079463	0.041632	0.213389	0.042810	0.126115	0.074951	0.043839	0.321821

Note: the number in grey cells is the most two dominating topic in each cluster of built environment.

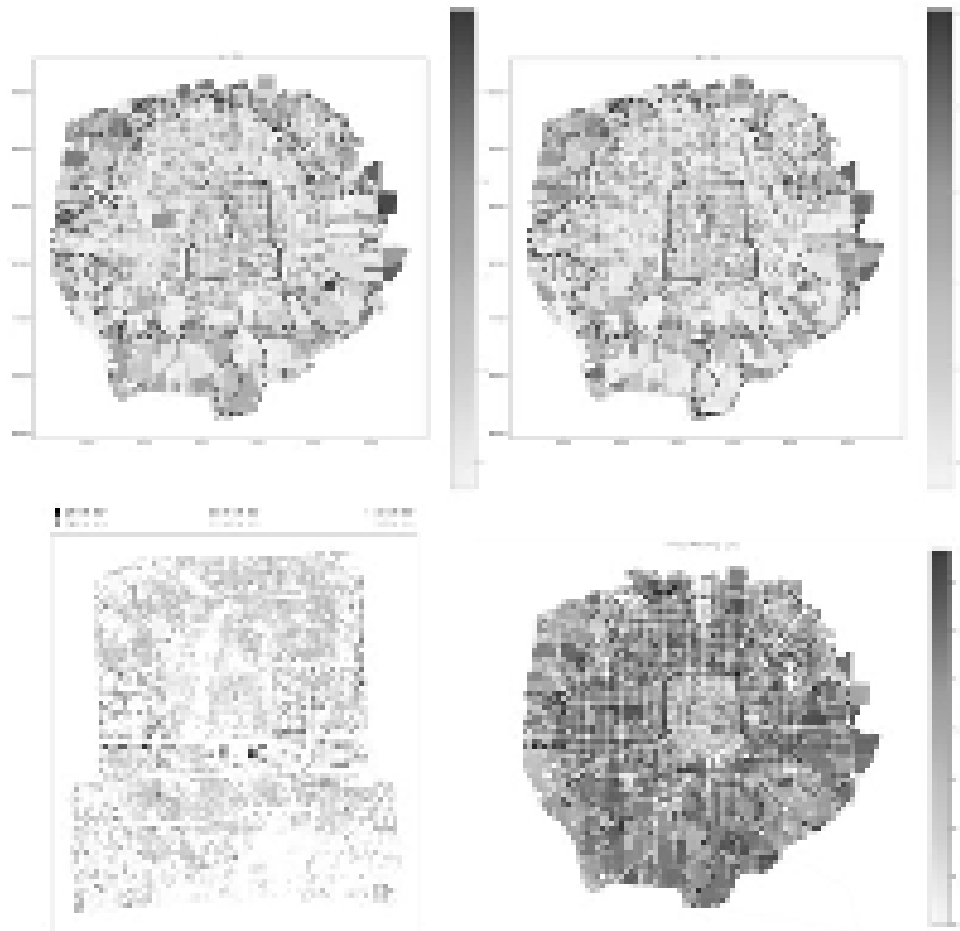


Figure 3. POI distribution and main function distribution (a. Hybridity of POI in 2014; b. Hybridity of POI in 2018; c. The type of building; d. Hybridity of building types).

uniform. As the block size becomes larger from the newly built area to the fringe belt, more categories of buildings are included in the same block. By contrast, the blocks in the newly built area are most hybrid, containing high-rise buildings, mid-rise strips, as well as low-rise buildings. These particular hybrid blocks may reflect the DANWEI unit, which is a special Chinese working and living form.

3.5. The morphological evolution

Under the guidance of the Beijing-Tianjin-Hebei Collaborative Development Plan, Beijing carried out actions such as “relocating non-capital functions” and “Developing Tongzhou Sub-center”. By comparing the topics of land use between 2014 and 2018 (Figure 4), the influence of such policies may be revealed. Topic 1 (government function) has decreased in the old city and increased in the newly built area, which reflects a shift in the government function from municipal to state government. Topic 3 of “commercial and residential services” has been reduced greatly in a large part in the old center in comparison with the newly-built area, reflecting the impact of the relocating action. Topic 6, related to “residential services”, have been strengthened in newly built areas, a sign of improvement of living conditions. Topic 7 of “automobile logistics” was gradually substituted, impacted by the relocation policy in Beijing.

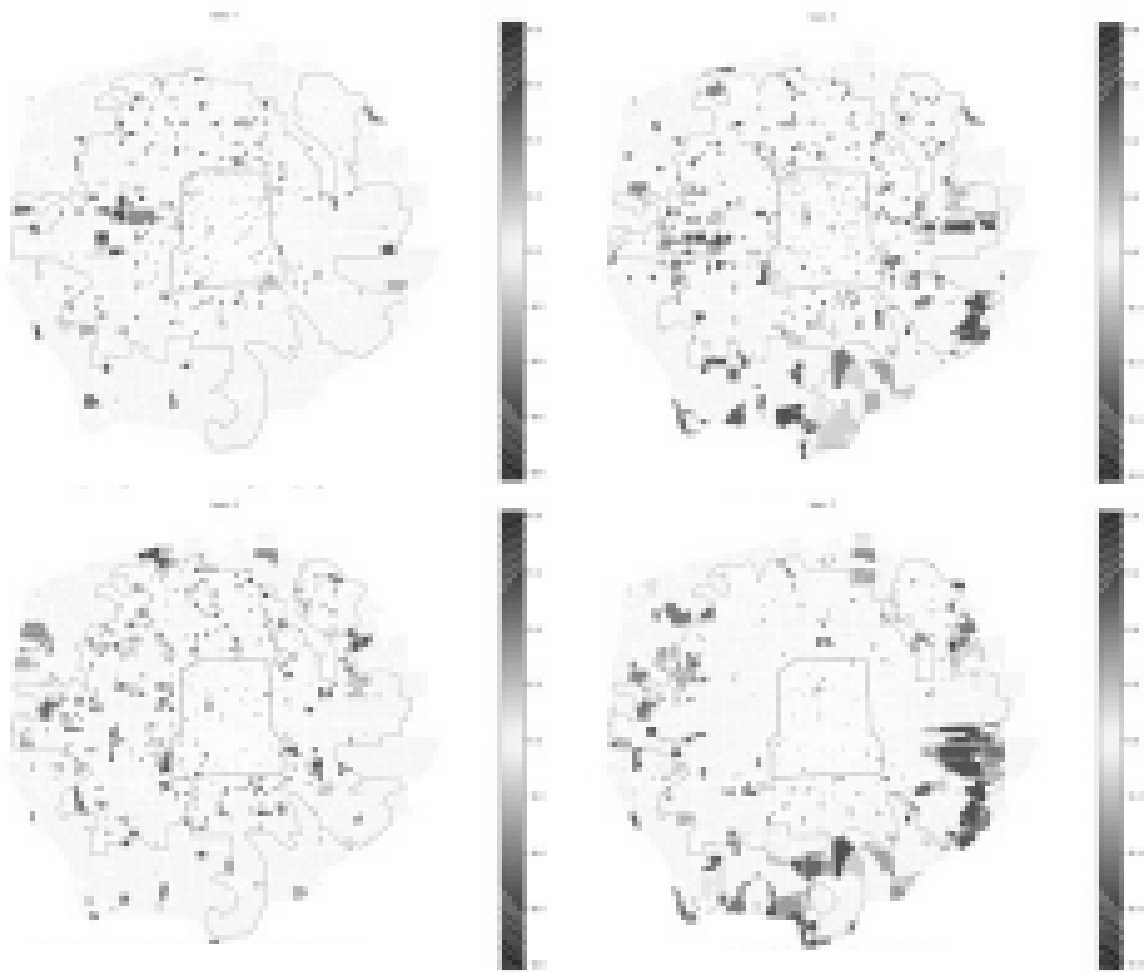


Figure 4. The change of functions from 2014 to 2018 (a. Topic 1: government and regulatory agencies and etc.; b. Topic 3: personal service and etc.; c. Topic 6: residential accommodation and etc.; d. Topic 7: car service and etc.).

4. Discussion and Conclusion

This study aims to quantify the morphological evolution in the two aspects of built environment and land use based on POI data and digital maps. Our study provides a possibility of combining the traditional Conzenian methods of morphological analysis with new data sources in the era of big urban data, as well as algorithms from the fields of data science, such as k -means, TF-IDF transformation, LDA and Shannon entropy.

However, there are still some aspects to be improved:

1. The data used have some errors. When studying the city as a whole, the increase in the amount of data can make up for the low precision. Analysis based on big data can be more objective in reflecting the characteristics of the city.
2. Spacematrix has shortcomings. Spacematrix is not effective with regard to mixing built types in one same block due to the hybridity of different indicators; the whole distribution of Spacematrix indicators is generally continuous, which requires subjective discrimination to classify into different clusters.
3. LDA algorithm is not stable. The result could vary according to different initial parameters. But through cross-validation and multiple tests, a relatively reasonable result can be achieved.
4. The balance between clarity of meaning and the abstraction. When iteratively processed, the information contained in the data is gradually integrated and abstracted. The key to its intelligibility is whether the comprehensive criteria are classified by human experience or by algorithms.

In conclusion, central Beijing can be classified into three different regions: old city, newly-built area and fringe belt. Three regions vary in characteristics of built environment and hybridity. The distribution of FSI basically forms a ring structure, low in the old city, high in the newly built area, and low in the fringe belt. Profitable land uses tend to agglomerate into centers, while public and welfare urban functions tend to disperse uniformly across the entire city. Some specific types of land use are limited to particular regions out of natural or historical. The built environment and land use are correlated, and certain types of land use tend to locate in blocks with certain built environment characteristics. As for hybridity, the old city region shows a high degree of mixing function and occupies convenient locations, while the newly built area is relatively homogeneous. The degree of hybridity in the fringe belt is higher because of the rural-related POI.

The changes in land use reveal the effect of the government adjusting the distribution of urban function through administrative methods from 2014 to 2018. Some related functions are relocating such as government affairs, residential services, and automobile services. The action optimizes the distribution of industrial and enhances innovation. However, this compulsory function relocation has led to homogenization in the old city of Beijing, leading to a possible reduction in urban vitality and convenience.

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Study on Vitality of Small Open Space based on Behavior Observation Techniques

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Keywords: Open space, Behavior mapping, Usage Frequency.

Abstract: In the trend of high-density urban development, small open space has gradually become a popular subject of both designing and research. A small open space with high quality can encourage walking behavior and outdoor activities, promote social communication and improve urban vitality, as well as other comprehensive benefits. This research has improved the traditional method of behavior mapping by two means: first, to conducted random sampling by repeated time periods to get rid of the question of subjectivity; second, to pre-designate symbols for different behavior information and arrange a technique to use the CAD software, therefore solve the problem of conduct quantitative analysis to abundant behavior information. In case study, this analysis method which integrated statistic analysis and data visualization, allow the researchers not only to intuitively judge the efficiency of space use, but also further explore two important spatial vitality indicators, the ratio of lingering and passing behaviors and the mixing degree of population composition. This can give a full picture of space usage and then thoroughly conduct interpretation in combination with physical spatial attributes. In short, this empirical study proves that behavior mapping is a promising research tool. By the collection of integrated information of both spatial location and behavior, it can help the researchers to answer the fundamental question in the field of environment and behavior studies – how and to what extend does the physical and spatial factors of built environment influence people's conception and behavior.

1. Research Background

In the trend of high-density urban development, small open space has gradually become a popular subject of both designing and research. A small open space with high quality can encourage walking behavior and outdoor activities, promote social communication and improve urban vitality, as well as other comprehensive benefits. However, due to the restrictions on minimum size of urban green area by China's Urban Planning Documents, these small green spaces are not included in the calculation of overall area index, so little attention is paid by researchers and corresponding findings are relatively scarce.

From actual effects, the usage frequencies, also called as space vitality of enormous small open spaces in urban areas are in relatively big difference. Only part of public open space wins the flavor form citizens, and others are deserted. So, what are the reasons that encourage or

discourage people to visit these open space? To unravel the mystery, two small open spaces of similar size have been selected at Hangzhou City Center Zone where detailed, accurate and systematic investigation and analysis has been conducted to spot new discovery.

2. Case study and the research questions

2.1. *The selection of two cases*

Two selected small open spaces of similar conditions at Hangzhou City Center Zone are Xiaoying Park and the green space in the front of Zhejiang Provincial Library which are respectively abbreviated as Site A and Site B. The two sizes are similar in size, and one is 2,640 square meters, the other 3,222 square meters. 670 meter distance between Site A and Site B can ensure that the surrounding population composition is similar, reducing the impact on usage frequency. In addition, in order to preclude the repulsive effects of West Lake, a large open space on small open space, the minimal linear distance between the two sites and West Lake is about 1.3 km, namely 20-minutes paces off.

The two sites are of similar size but of different spatial characteristics. As for Xiaoying Park, it has wide east-west path, narrow north-south path and high southeast topography without walls all around; in terms of the green space in front of Zhejiang Provincial Library, it has narrow east-west path, wide north-south path, and broad stairs in the south of the main entry to the library with fences and flat terrain. When it comes to the landscape, Xiaoying Park is of traditional garden style, with a large grassland surrounded by shrubs and at the southeast corner is a rockery and pavilion; the green space in front of Zhejiang Provincial Library is much more natural, and at the large admissible grass scattered around are low trees and at the northwest corner stand tall cedars. The two sites are equipped with medical facilities in the surroundings, such as the Second Hospital of Zhejiang Province in the vicinity of Xiaoying Park and Tai Rentang Clinic of Traditional Chinese Medicine in the front of the library, and the former is much larger. In addition, in the surroundings of Xiaoying Park, a large number of cultural and historical buildings exist, such as Former Site of Ting Palace the Taiping Heavenly Kingdom, Memorial Hall for Chairman Mao's Visit at Xiaoying, and so on; the green space in front of Zhejiang is surrounded by dwelling buildings, and such large public service buildings as Zhejiang Library and Youth Holiday Activity Center.

2.2. *Research questions*

Next, we will give a systematic and detailed account of the material space characteristics and behaviors with regard to the two cases to make a comparative analysis. As an explorative study on vitality of small open space based on behavior observation techniques, the specific issues under the focus include the following two aspects.

The first one is about importance of methodology. Although we can easily distinguish vitality degrees on the basis of subjective experience, but in terms of scientific research, we should collect behavioral data by objective and quantitative methods to illustrate the differences in viability. In this study, we will try to collect behavioral information by the method of behavioral mapping rather than common questionnaire method in the traditional research. Secondly, we should be committed to mining the knowledge that can facilitate designing. For example, which material space characteristics have concerns with usage frequency and how designers

manage sites to create a small open space popular with citizen. From the text below, it is obvious that complex information acquired by the method of behavioral mapping can facilitate our discussions on the connection between usage frequency and material space characteristics.

3. Methodology

3.1. Collection of behavioral data

During the case study on open space, the main method for scholars to collect information is questionnaire method. The data obtained by observation method is considered as subjective and difficult to carry out statistical analysis, so it is auxiliary. the main method to collect information in this study is behavior mapping, in combination of a series of sophisticated technical auxiliary methods can clean up two problems above, and the most important is the method can simultaneously record specific behaviors and their spatial location of high precision (Dai Xiaoling, 2013). The spatial information of high-degree precision can be elusive on the basis of written questionnaires.

In this study, we use two types of behavioral mapping to describe the behaviors in selected sites. Snapshot, the primary one designed to describe users lingering in the sites is a variant of behavioral mapping and widely used by researchers on the Theory of Space Syntax. Just as the name suggests, the step is to observe users' behaviors at certain moment, snap pictures in surveyors' minds, and immediately indicate the symbols of these instant messages on the prepared map. We have referred to the practices of Golick and others (2010) and determined a set of symbols (Figure 1) in advance. This approach allows investigators to quickly collect rich information about behaviors and conduct systematic analysis and map expression later. In light of researchers' better familiarity with CAD software, we have made improvements different from the practices of Golick and others where they input information into GIS platform. As shown in Figure 1, the designed symbols can simultaneously record four types of user information. [Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Drawing Tools tab to change the formatting of the pull quote text box]: spatial position, gender, age and postures (sitting, standing and movement). In more detail, symbolic forms are used to distinguish postures, colors are for different ages, and solid or hollow expression for genders. This symbolic system can easily

age\gender	age	<7		7<Age≤18		18<Age≤40		>40	
	gender	neutral	male	female	male	female	male	female	
behavior									
sit									
stand									
walk									

Figure 1. Behavioral Symbols Determined in Advance (Source: Self-drawn).

collect complex information, and in the following analysis, will play a key role in the interpretation of behavioral patterns.

In order to conduct random sampling, the recording on space users is conducted on the mornings, at noon and at night of both weekdays and weekends. Since the survey data of two sites are collected at the same period, the usage frequency for the two sites is valid and not subject to changes in whether.

The second structural observation method as an auxiliary is called as gate count used to describe the users across the site. This approach means that a number of important footpaths in the survey area are aimed and a street section (gate) is selected to record the number of pedestrians and bicycles on the chosen footpaths. The counting section includes all the paths to the site and main sidewalks of surrounding roads. There are twelve observation points selected in Site A, and six in Site B. Similarly, the counting is conducted on the mornings, at noon and at night of both weekdays and weekends with 2 statistics during each period of 5 minutes, so that the time is random. The collection of this information can help quickly form an objective understanding of the internal and external flow of people in the sites, and it is conducive to the interpretation of behavioral patterns.

3.2. Analysis of behavioral data

Then we will express and analyze the behavior data. At first, the simple statistics of overall behavior data is conducted. Electrolyze the two types of field records and respectively input them into excel and CAD software. Snapshot data should be input in CAD, through make block and layer management, integration of multiple information and mathematical statistics can be realized at the same time. Secondly, we will make visual mapping of usage frequency on the map, and finally compare usage frequency with material spatial characteristics to discuss the link between the two.

4. Simple statistical analysis of behavioral data

4.1. General demographic property of observation samples

Against gate count, a total of 1,303 people at internal paths and surrounding streets were recorded (848 at Site A and 455 at Site B). As for snapshot method, the recorded number of people staying or lingering at the site is 517 (272 at Site A and 245 at Site B). The proportion of users collected by two different methods is basically consistent, and young users at Site B are slightly more than Site A for Site B is located at the square in front of the library.

4.2. Information management under Gate Count

The average flow rate is converted into hourly flow, and then its distribution is analyzed.

Main findings include (1) the paths in the two open spaces are relatively quiet compared with the external streets with high stream of people. (2) The flow of people at various entrances of open spaces is of great difference.

4.3. Information management under snapshot

By inputting snapshot data into excel, we get a trend chart where overall behavior changes with time (Figure 2). Since we simultaneously collected the number of users who pass through and lingering, separate display is conducive to discussions on the relationship between static and dynamic activities. Two conclusions can be drawn from Figure 2. First of all, with the change of time, there is a big fluctuation in the general behaviors of on the two sites. Secondly, there is no correlation between the static and dynamic activities of the same site at the same time, and in some cases, the opposite trend is presented. As at noon on the weekends, the reduction of pedestrians passing Site A and the increase of lingering people coexist; then, at a noon on weekdays, the increase of pedestrians passing Site B and the reduction of lingering people coexist.

Though the layer control tools CAD software, we can easily get Behavior Distribution Graph and Behavior Overlap Graph at a single observation period. From Overlap Graph, it is found that usage situations of the whole site are of strong inhomogeneity. Therefore, it is necessary to divide the site into three main aspects, including overused, being used and abandoned (Marcus, 1998).

5. Detailed analysis of behavior distribution

Next, we will describe and discuss the behaviors at the two types of open spaces, including 8 sections in more detail (Figure 3). Jan Gehl has pointed that static activity is the best indicator of the quality of public spaces: large flow of people walking in the city do not necessarily translate into excellent spatial quality, however, if there are a lot of people in the outdoor space of urban cities killing time, it shows excellent public space quality (Gehl-Architects, 2004). Therefore, in order to explore the source of vitality of small open space, the following content will focus on a detailed analysis of what spatial characteristics can influence the frequency of static activities on the sites.

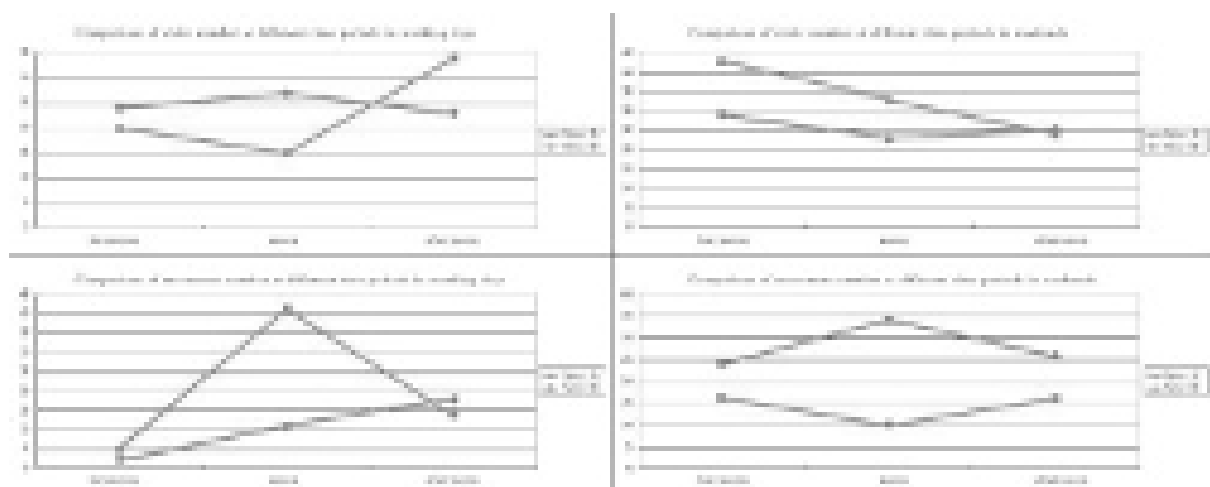


Figure 2. Comparison Diagram of Static/Dynamic Headcount at Two Sites during Different Period (Source: Self-drawn).

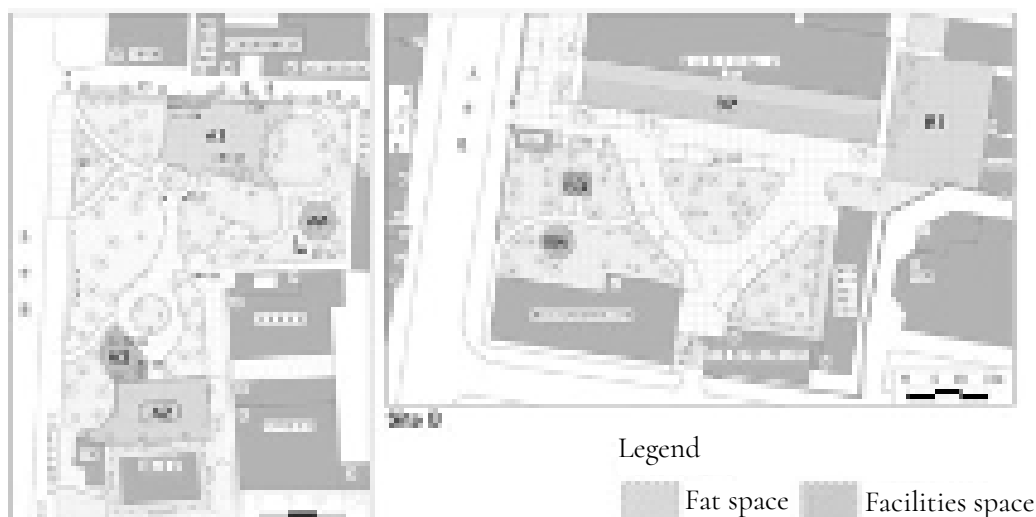


Figure 3. *Index Plan of Detailed Analysis* (Source: Self-drawn).

5.1. Usage and interpretation of block space

On the basis that spatial shape and size can pose limitations on its activities, physical activity space can be divided into two categories, linear space and block space. We first focus on the usage of block space (or centralized site) which is defined as a small square of less-than-6 meter side and not-less-than-100m² size where a variety of activities can be conducted. Under this definition, two pairs of sub regions can be identified as A₁/A₂ and B₁/B₂. From the behavior data, only Site B₁ does not hold lingering people and the other three sites are much more popular.

Main Entrance of Xiaoying Park (Site A1)

From the behavioral data, Site A₁ is relatively crowded at the three periods of a whole day. The users are highly mixed in terms of gender, age and body postures. Group activity occurs in the middle of the field both in the afternoon and at noon when individual activity is more common.

Site A₁ mainly include favorable factors. First of all, on the three sides of the site are luxuriant greenbelts with sufficient sunshine, suitable for group activities such as group dancing, playing with children. Secondly, the terrain at southeast corner is naturally elevated, and multiple seats are lined along the uplifted area from which a panoramic view of the whole site is possible. In this region, relatively frequent communications activities occur (Figure 4-A).

Site A2 in Front of Yulu Xiaoying

From the Behavior Overlap Graph under snapshot method (the left one of Figure 4-B), it is found users at Site A₂ are highly mixed in terms of gender, age and body postures and the usage frequency at the site is relatively high. There are three main advantages for this site. In the first place, tree shade and seats lined on both sides of the square contribute a heaven for rest and recreation. In addition, on the south side is a small community office building of attractive veranda style. Finally, due to the west bus station, the site has become a shortcut for passengers.

Site B1 on the East of Zhejiang Library

After the comparison of Behavioral Overlap Graphs at six periods (the right one of Figure 4-B), it is found that, the usage frequency of Site B1 is the lowest among there four centralized sites. Most people at this site just walk through without stay. On the basis of data under gate count, the northern side of the site leads to a secondary entrance, but the front-porch square has a high popularity. Why is the utilization rate of this regular space so low? We speculate that there are two main disadvantages. First of all, in the south stands a three-story building with terrible green landscape and poor lighting. Secondly, the public toilet in the east side is quite crowded, which discourage other potential users. Of particular note is a public toilet on the west of Site A2 which is against regular space, so no negative impacts occur.

Stairs in Front of Zhejiang Library (Site B2)

On the basis of Behavioral Overlap Graphs under snapshot method, it is found users at Site B2 are highly mixed in terms of gender, age and body postures and the usage frequency at the site is highest. There are three main advantages for this site. In the first place, the uplifted front porch of the library translates into good visual landscape, and the elegant forms of historical architectures also make this site enjoy aesthetic and exceptional advantages. Secondly, the spatial width can accommodate several static activities; the porch facing the south provides suitable micro climates. Finally, the library itself has a great effect to centralize flow of people. We note that, at the moment of library opening and library closing, the dynamic activities at the stairs are especially frequent. On the afternoon when primary students are dismissed from school, parents will play with their children here and the static activities at front steps (playing badminton, playing games, reading, playing the ball) have increased (Figure 4-C). Of course, compared with the other three sites, the average age of users is much younger.

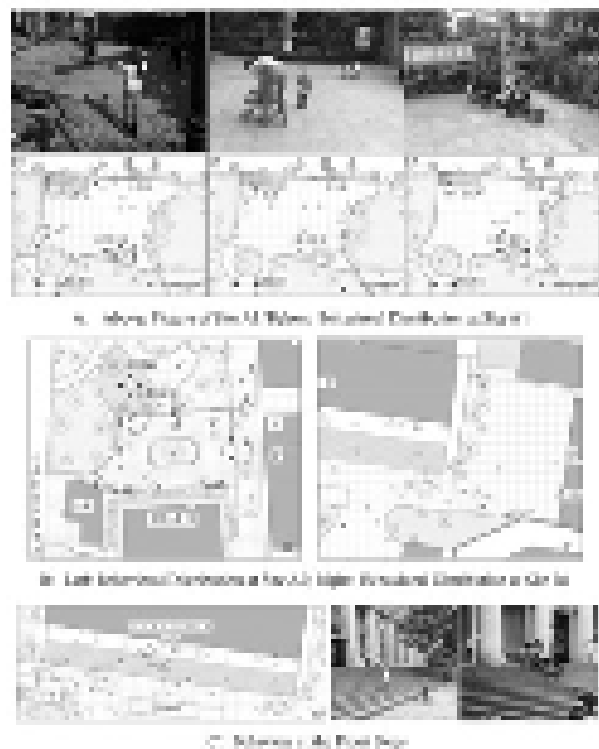


Figure 4. Behavior Mapping.

To sum up, we find centralized hard-ground squares popular with users are characterized by the following features. First, an available hard-ground site should meet the requirements of minimum width. Among the three sites with high usage frequency, only the center of Site A2 is occupied by rectangular flower beds, but its remaining ground meet the requirement more than 6 meters. Secondly, the site with high lingering rate is close to main traffic lines which do not go through the site. With the sense of enclosure, it is can also be relatively accessible. Site B1 does not satisfy this requirement, people coming into and out of public toilets can discourage visits by others. Thirdly, a certain amount of formal and informal seats should be equipped. We have found that in the three sites of high usage, the mixing rate of sitting, standing and passing arrives at a proper extent. An informal seat can be a step, the edge of a flower bed and a big rock. Finally, a perfect landscape and view can be appealing.

6. Conclusions

Based on empirical research, this study has discussed the most important physical and spatial factors which would influence the usage frequency and vitality of small open spaces. The main methods to collect data are snapshot and gate count. The snapshot method is an updating version of behavior mapping. It improved the old tool by two means: first, to conducted random sampling by repeated time periods to get rid of the question of subjectivity; second, to pre-designate symbols for different behavior information and arrange a technique to use the CAD software, therefore solve the problem of conduct quantitative analysis to abundant behavior information and also collected behavior data with higher resolution of spatial location which could not be abstained by questionnaire.

This new method can integrated statistic analysis and data visualization, allow the researchers not only to intuitively judge the efficiency of space use, but also further explore two important spatial vitality indicators, the ratio of lingering and passing behaviors and the mixing degree of population composition. This can give a full picture of space usage and then thoroughly conduct interpretation in combination with physical spatial attributes. Therefore, this new type of behavior mapping method described in this paper is a promising data collecting and analysis tool which have great potential and should be promoted in the field of environment and behavior studies.

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Territories and Frontiers in Inconclusive Concepts within the Schools of Urban Morphology

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Keywords: Landscape Units; Territorial Type; Schools of Urban Morphology; Academic Studies.

Abstract: The results of a research project entitled Territories and frontiers in inconclusive concepts within the schools of Urban Morphology are the principal object of this paper, due to the fact that they have remained poorly developed and neglected in the field. As such, the approaches of the English School, with regards to morphogenetic regions and their scales of action will come under particular examination. In addition, concepts generated by the Italian School such as type and the territorial type also form part of this research. The central aim is, therefore, to understand the lacunae and the causes of this conceptual fragility so as we may consolidate and better employ such concepts in our research projects. A complimentary comparison of the similarity or incongruity of landscape units, examined together with morphogenetic regions and territorial type, should establish a basic concept that can be applied productively to all elements. Finally, a further investigation of the Brazilian reality may offer the opportunity to decode and transmit the findings, which could be used in research developed by interdisciplinary teams participating on Master's and Doctoral programmes.

1. Introduction

The motive that prompted this research was the difficulty in utilising some concepts of the traditional schools of urban morphology, due to lacunas found during application in either teaching or practice. Concepts generated by the Italian School such as type and territorial type, allow different interpretations as a result of the difficulties in establishing a common and concrete idea. In addition, morphogenetic regions and their scales of action are central to this particular examination due to the difficulty in establishing the boundaries between them.

Moreover, a current tendency for students, on postgraduate courses, is to extend morphological approaches into broader territories. Thus, there is a contemporary need to incorporate the concepts of landscape units, disseminated in the field of ecology, in a morphological investigation of the Brazilian scenario. The findings from such a merger between morphological and ecological concepts may then be usefully incorporated in research developed by interdisciplinary teams participating on Master's and Doctoral programmes.

The surveys manifesting this merger are consequently related to the dual themes of urban planning and the sustainability of landscapes, both in their theoretical and practical aspects

and, as such, should be of central consideration in public policy formation. It is important to note that these themes are being developed in the context of the Multidisciplinary Postgraduate Program on the Built Environment and Sustainable Heritage (PACPS) offered by the School of Architecture at the Federal University of Minas Gerais.

The observation that the approaches of the English School of Urban Morphology, concerning morphogenetic region and scale, has given rise to the tendency for studies, discussions and practical applications that address the obvious lacunae within the concepts. Moreover, aspects referring to types and the territorial type, all integral to the approaches of the Italian School of Urban Morphology and its founders, have been the object of differentiated interpretation in Brazilian studies. For a research laboratory team that has, as one of its main objects, the study of Urban Morphology and its application in the Brazilian context, this discussion and deepening of the theme is considered crucial.

Concepts referred to as "unfinished business" raise the question of whether ideas have been fully explored and developed by researchers. Such possible lacunae can be explained, either by the decease of one of the founders, Muratori, or the fact that the other, Conzen has only more recently been rediscovered. Taking these key points into consideration, the next step was to acquire solid notions in order to understand the hidden ideas and possible approaches to be used in case studies and other possible applications. The most feasible action was to try to understand such ideas through examples presented in previous studies which were the main object of our chosen methodology. The final objective is to disseminate the results on postgraduate courses and thus contribute to the enhancement of planning policy in Brazilian cities.

2. The adopted methodology

The methodology primarily utilised secondary sources all related to the literature associated with and developed by, the founders and their followers. This included a survey of various bibliographic sources which enabled a better understanding of the concepts. This first phase was followed by a practical exercise, which aimed to apply the concepts and ideas to real contexts, such as, the colonial town of Tiradentes, located in the state of Minas Gerais, Brazil. This allowed us to test, compare and analyse the precepts in relation to the surveyed aspects of an urban site.

3. Methodological Tools

In order to avoid individual interpretation of concepts and cause misunderstanding, the Landscape Laboratory put forward some strategies to develop the research. A 45-hour weekly course, designated for teachers, under and post-graduate students, was set up to acquire the relevant literature on the subject. Texts would be sent in advance to the participants for everyone to read, so as air any doubts and discuss differing interpretations in the class. This strategy has been used in the Laboratory as a way of consolidating ideas and approaches over a number of years. Firstly, there is a reading session regarding a course subject, followed by a discussion which attempts to condense the concepts into a tool named CMAP. This is formed by diagrams which exemplify the synthesis of the researched object. In addition to this, doctoral students need to find a territorial type that can bring together all features to be used in the model for analysing contemporary landscapes on the city borders.

Some texts on urban morphology that contemplate the whole methodology were the first to be used to make under-graduate students, who have never been acquainted with the subject, familiar with the concepts. Bearing those aspects in mind the followings texts were chosen to broaden the concept of type and territorial type.

In terms of Italian Urban Morphology, the first text analysed was by Saverio Muratori and the School of Planning Typology (Cataldi *et al.*, 2002) as it gives a general conception of the founder's practice and teaching. A discussion on type, and the difficulty of using the term with the correct application was consequently covered in the texts (Pereira, 2012; Panerai, 1988; and Scheer 2015). Having achieved an understanding of the complexity of defining types the next subject was related to territorial types.

The territorial organism as individuation of typical connections, between routes, productive settlement and urban organism (Caniggia et Maffei, 2001) had already been the object of studies in the Laboratory with various interpretations appearing in a number of Master's dissertations.

The next step in the course was designed to cover recent studies and books by Italian teachers and students that have addressed unfinished concepts in geography. In particular, the theme has been the object of Marzot's analysis, (2015) in which he cites the works of Giannini, 1984. Cataldi, 2013 and Lombardini 2017. According to these authors, such studies note the observations made by Muratori in 1967 and which, are further embodied in a number of drawings and sketches, all of which encapsulate aspects related to features of the landscape. Giannini, his pupil, used these drawings to present an initial theory related to such features and applied them to studies done in Africa, China and Italy, (1984).

Finally, a PhD thesis, developed by Tagliazuchi in 2013, was the last work on territorial types examined in class. As such, Cataldi and Giannini's studies were used to develop her own interpretation regarding territorial types. However, what such studies clearly demonstrate is that a personal interpretation of a drawing executed almost fifty years ago fails to be compelling proof of what Muratori really had in mind. Essentially, this leaves Urban Morphologists free to speculate on concepts. Moreover, as these references were written in Italian it was not always easy to fully understand the concept and to consider if it could be applied in a doctoral thesis as a method which incorporates use of the territorial type.

Contrastingly, with reference to the unfinished concepts in the English School of Urban Morphology, the founder left space for many possible ambiguities when referring to the morphological or the morphogenetic regions. Whitehand (2015) when referring to these in an interview with Oliveira, commented that Conzen had explored them in studies on several scales. The most relevant studies included those on Ludlow, Alnwick and Newcastle Upon Tyne. As such, these formed the basis of class discussion together with Gu (2019) Whitehand (2009) and Oliveira (2015).

This first phase was followed by a practical exercise during classes, which aimed to apply the concepts and ideas to real contexts, such as, the colonial town of Tiradentes located in the state of Minas Gerais, Brazil. This allowed us to test, compare and analyse the precepts in relation to the surveyed aspects of an urban site. The final step will be to test the concepts on the above-mentioned town.

4. A discussion of the unfinished concepts of the Italian School of Urban Morphology

Studies carried out by the Italian school demonstrate a concept of urban to territorial type in which the scale is extended and thus considered unfinished. This incompleteness, as result of

his death, refers to the scale of the territorial type proclaimed by Muratori – a point also noted by the specialists of the Italian school (Cataldi, 2002).

In the book, *Architectural composition and building typology: Interpreting Basic Building*, Caniggia and Maffei (2001) explain the basic territorial type considering it to be a portion of territory occupied and used for some kind of activity. It therefore represents the conquest of the settlement and the establishment of productive activity such as a farm or pasture. According to these authors, the basic territorial type is not, however, confined to its mere productive area, but is related to the total structure, equipped with access roads and related dwellings, both physically associated with the principal farm buildings.

The glossary defines the territorial type as a hypothetical, territorial and cultural project shared by its inhabitants, manifesting clearly established definitions of space and time. It encompasses a specific way of traversing, harvesting, cultivating, as well as organizing it into a hierarchical system of poles located around the markets in which the products are sold.

As may be observed, these are incipient concepts that can generate differentiated interpretations, due to the restricted development of the theme. For Gauthier (2005) this is a consequence of the typological paradigm, which in itself leads to ambiguities. He cites, in particular, the broad definition proposed by the Italian school: the type. For this author the concept represents the cognitive instance that makes the relational interpretation between the subject and the object in the formation of the built environment. He believes that, although the type may be viewed as an object that condenses the rules that established it, it also manifests the culture and social group that maintains and transforms it. Significantly, this characteristic factor can explain the various ambiguous interpretations that have subsequently followed Gauthier's analysis.

This discussion on types is of particular importance for their use in ongoing research, which discusses basic types located in a sub-district destroyed after the burst of a tailings dam in the state of Minas Gerais, Brazil. These studies are intended to contribute to the Public Ministry of the Environment's recommendation's that models for a new sub-district, should be as similar as possible to the one decimated. The recommendation included the choice of a new location to be discussed and agreed with the former residents. Other important factors to be considered were that the newly-constructed neighbouring houses should replicate the previous arrangements and socio-cultural relations. (Teixeira *et al.*, 2018).

In fact, during the development of this research project it became apparent that a single house would not represent the social and territorial needs of the former residents as the type could not be contained within four limited walls, being that, the plot should include areas to raise animals and cultivate crops. The hypothesis was made that the axis chosen by the residents to go fishing could also be viewed as constituent of a basic housing type. As such, it was impossible to propose a new environment when traditional features were not taken into consideration and alien semi-detached houses were bizarrely included in the first proposal.

In relation to anthropic action, the territorial type encompasses the place in which human beings spontaneously recognize themselves, in terms of living, circulating, inhabiting, producing, socializing and conducting business. The hypothetical design of a territory conventionally shared by its inhabitants, has definitions of space and time clearly established. This project integrates a specific way of traversing, occupying and cultivating the territory and finally of organizing it as a hierarchical system of poles around the markets in which the products are marketed (Pereira Costa *et al.*, 2017).

From the environmental point of view, the geographic position defines the territory on a global scale, by its climatic zones and characteristics of geological formation. However, it is on a local scale that one can observe the specificities of the territories. In this sense, geomorpholo-

gy assumes a fundamental role, since it focuses on the forms resulting from the relief, that is, on the spatial expression of the surface and its visible appearance. The geomorphological aspects define the topography, the drainage systems, water basins, the location of the watercourses and types of soils that characterize a certain landscape (Pereira Costa *et al.*, 2017).

In addition, human beings using their spontaneous consciousness are able to recognize the favourable dimensions that allow them to define an ideal unit for the establishment of their activities. This unit is structured by adaptations that, over time, allow inhabitants to experience and recognize themselves as part of this territory (Pereira Costa *et al.*, 2017).

5. A discussion of the unfinished concepts of the English School of Urban Morphology

Reading the work carried out by Conzen on the three towns, what is striking are the meticulous descriptions and analyses of a mosaic revealing a landscape made up of numerous streets and buildings settled around a ground floor arranged to perform a certain function according to a previous plan. His identification and analyses are rich in details and, although the author does not exactly explain how to select and classify into planning units and geographic orders, he presents examples and by following and examining those selected it is possible to interpret and use these as concepts.

However, regarding morphogenetic regions, planned units and geographical order, the author uses examples rather than offering explanations. It is very different to the presentation of the tripartite concepts, the burgrave plots or fringe belts that allow for a common concept. In this case, it raises the possibility of individual interpretation which may induce incorrect statements and conclusions.

Whitehand, Slater and Gu all refer to this situation, in which, a series of terms can demonstrate the weakness of the concepts (in the case of the English school) or the difficulty in understanding approaches (in the Italian school's case)

One of the weaknesses is related to the fact that the concepts, until relatively recently, have not yet been condensed into one single term. As Gu (2019) observes, these concepts are complex and clarification has not been helped due to the variety of morphological terminology. He identifies the mixed use of several terms such as urban morphological regions which can be also referred to as 'townscape regions', 'urban landscape regions', 'urban landscape units', 'townscape units', 'morphological units' and 'character areas', concluding that the problem deserves more systematic attention.

Whitehand also recognised the lack of coordination between disciplines and reports that both research and practice have tended to be slow in benefiting from the integration of the different disciplinary strands from analysis of urban morphological ideas of plan units and regions, to the architectural typological concept of fabric. He considered that plan units and morphological regions are primarily explanatory, and only secondarily a planning tool. A tissue has a notion to be applicable in architectural practice, involving an evolutionary process of the building types.

For Baker and Slater (1992) the term morphogenetic regions have their origin in Conzen's 1962 study of Newcastle upon Tyne. This work, cites the author, contains extremely detailed maps, but focuses on the morphological evolution of local urban plans taking into account the pre-modernist, industrial, and twentieth-century periods. He further comments that the maps do not present an explanation for identifying a morphogenetic region, nor do they contemplate

the medieval periods. This fact can still be observed in the technical glossary at the end of the book that does not mention the term, its principles and characteristics. However, as Slater notes, the term appears on a map of Newcastle, without further explanation.

6. Final considerations

The objective of these studies has been to enhance and improve knowledge regarding the unfinished concepts in Urban Morphology and to apply them to Brazilian contexts. A secondary intention has been to assist students in their theses and dissertations when identifying the most feasible notions to be utilised and developed in their studies. There was also a need to develop and supervise research, which enabled teachers to disseminate the results and to apply them in further studies. Members of the Landscape Laboratory have a belief that knowledge is better acquired when shared within the components. Strategy seminars and practices have thus been conducted to achieve these goals. At the beginning of these studies there was a general feeling that the group had not grasped an understanding of the unfinished concepts.

However, with time it became clearer that the authors and their disciples were also not so definitive or sure of these ideas being that they were themselves occupying an evolving environment. Moreover, to analyse transformations and facts one has to examine and use the contextual background, which inevitably incorporates interpretations and personal views. As such, the places that a researcher analyses in Brazil will manifest different characteristics to those in Italy or England, not only because of the environmental context but also because of the intervening cultural assumptions.

In relation to the study of territorial types, the place's occupation history should be established and the landscape constraints drawn and indicated on a map. Identification of geographical features, river basins, ridges, routes, built areas, poles and nodes further allow the understanding of the land occupation and its basic types. Another important realization is that to define planning units or geographical orders, it is imperative to develop a thorough morphological analysis of the surveyed towns. Without a solid knowledge of the evolution of such towns, it becomes an impossible task to delimit the morphological periods and consequently identify the planning units and their respective geographical orders. In conclusion, such considerations may ensure better project execution and may be of fruitful use when applied to the Brazilian context.

7. Acknowledgments

The authors acknowledged the support received from the Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG), from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) to develop this research and to present this paper.

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Applicability of Morphological Tessellation and its Topological Derivatives in the Quantitative Analysis of Urban Form

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Keywords: morphological tessellation, plot, Voronoi diagram, contiguity, topology.

Abstract: Urban morphology is experiencing growth in quantitative analysis but faces a twofold problem concerning data used to represent urban form – their availability in the first place, and reliability in the second. Both problems concern several urban features, but are especially true in regard to the plot, whose GIS representation capturing a precise morphological meaning is scarcely available. This problem has challenged the authors of this paper to develop a different approach to spatial division. Using the morphological tessellation method, which entails partitioning of space starting from building footprints, utilising the principles of Voronoi tessellation, we explore the possibilities of such method in the definition of analytical units and test their reliability on the case study of Prague, Czechia.

Morphological tessellation and spatial units derived from this analysis are consistent in capturing built-up space uniformly, with no discontinuity. This allows us to follow the topology of morphological structure and determine analytical units based on their contiguity, capturing topological neighbours of variable distance. One of the side benefits of this approach is that block-like units, defined using morphological tessellation are also less dependent on the quality of street network data, whilst at the same time retain the information of variable street width. Empirical tests are presented to assess the reliability of the approach in identifying recurring patterns within urban form. Morphological tessellation partially substitutes the need to derive intricate plot forms from a combination of sources; the research shows furthermore a new approach to capturing spatial structure with reduced data demands.

1. Introduction

Quantitative urban morphology, or Urban Morphometrics studies urban form through the quantification of its spatial elements. Recently, it has entered the era of big data and powerful computing alongside other scientific fields. However, even though there is currently a variety of sources of data available for analytical purpose, this data does not always meet the standards urban morphologists would need. This is true of several urban form features, but plots are a particularly difficult case: essential to describe urban form, but very hard to be captured and represented rigorously and comprehensively.

To support quantitative analysis, urban morphometrics needs partitioning the built-up area consistently at both small and large scale. Historically, the most widely used spatial unit in urban morphology analysis is the plot, which however raises multiple concerns. First of all, there is no univocal definition of the term, which has been referred to land use (Conzen, 1960), accessibility (Porta and Romice, 2014), or ownership (Moudon, 1986). From an urban morphology perspective, even the purely physical definition proposed by Porta and Romice (2014)¹ shows problems, starting from the simple availability of the necessary information for the identification of the plots as GIS data. Most of the data portals and other GIS sources do not offer any plot layer, and if they do plots are derived from land ownership rather than legible spatial accessibility, while these two concepts often do not match on the ground (Kropf, 2018). Moreover, in sparse modernist urban tissues the reliability of existing plot information in GIS, no matter the definition, is questionable (Levy, 1999).

In urban spatial analysis, “partitioning space” means parcelling space into consistently defined measurable (spatial) units. A method that allows the consistent partition of space is a *morphological tessellation*. This method, which entails partitioning from building footprints, utilises the principles of Voronoi tessellation (Fleischmann *et al.*, 2020). Morphological tessellation objectively defines spatial units named “morphological cells” through the influence that each building has on the space surrounding it (Hamaina *et al.*, 2012). Thus, a morphological tessellation capturing the spatial configuration of urban form derived from building footprints is algorithmic, hence rigorous and objectively replicable. Moreover, it is fully comprehensive, in that it operates consistently across different types of urban form and its source information (building footprint) is widely available (Figure 1). Previous research demonstrates that the informational value of morphological tessellation is in fact similar to that of the plot, which makes the former a reliable alternative to the latter in urban morphometric analysis (Fleischmann *et al.*, 2020).

Since urban morphology analysis aims to capture patterns of urban form, it must describe single elements (buildings, plots, morphological cells) as well as their spatial configurations and relationships. To do so, larger analytical units must be identified. Generally, we can distinguish two approaches to do so: area-based and location-based (Berghauser Pont and Marcus, 2014). Area-based approaches divide space into preselected units, i.e. administrative boundaries (Gielen *et al.*, 2017), abstract projected boundaries (typically grid) (Galster *et al.*, 2001), or larger morphological structures such as a block or a Sanctuary Area (Dibble *et al.*, 2017). However, such methods face two connected issues, together named “Modifiable Areal Unit Problem” (MAUP) (Openshaw, 1984): *scale issue* (how big the area of aggregation should be) and *aggregation issue* (where should we draw its boundaries). Area-based approaches are prone to both of them, particularly the latter: a change of the boundary, for example the voting district, might affect the analysis’ results.

Location-based approaches generate analytical units independently for each source-element as a unique aggregation *around* it, typically at walking or driving distance, where distance is measured either along the street network (network distance) or an approximation of it (for example: as a crow flies). Therefore, the aggregated values are uniquely and consistently generated for each source-element (e.g. building), and the effect of arbitrary data aggregation is minimised, resolving MAUP’s aggregation issue. For this reason, literature, including the research presented in this paper, prefers location-based analytical units, as their nature partially resolves MAUP. The scale problem part of MAUP is present also in location-based methods, and it is up to the methodology adopted on a case-by-case base to limit its effect to a minimum.

Currently, morphological literature relies on a few methods to define an aggregation of units in a location-based manner. The most straightforward is based on simple Euclidean (as-crow-

1. “A fenced portion of land that is entirely accessible from the public space” (Porta and Romice, 2014, p. 90).

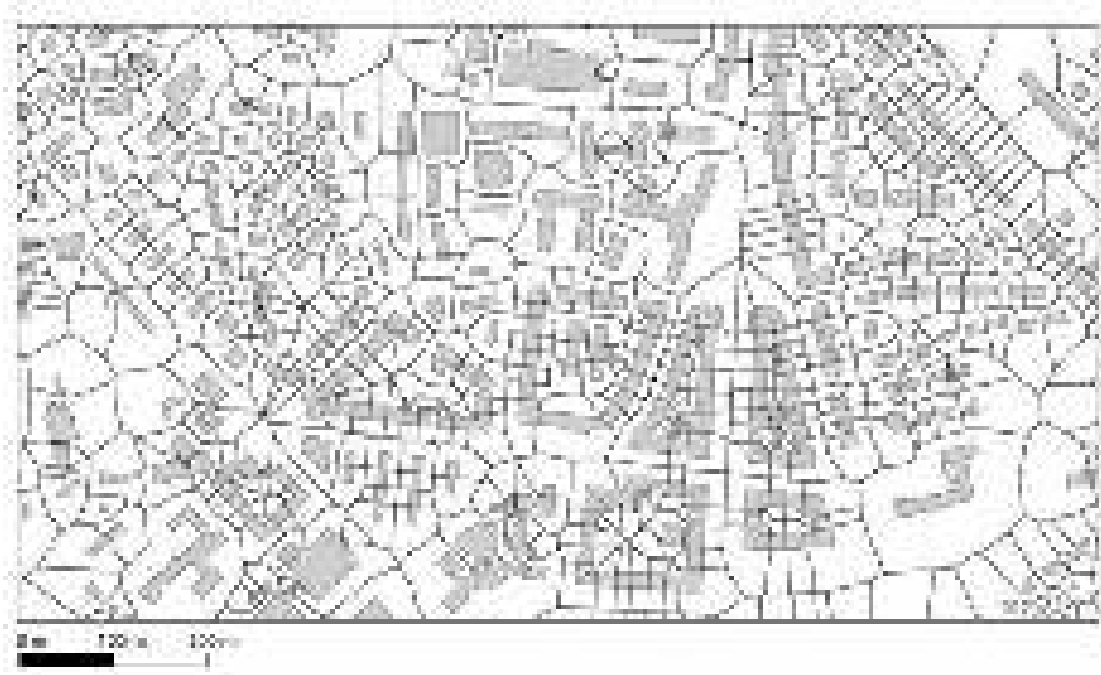


Figure 1. Morphological tessellation of Podbaba neighbourhood in Prague, illustrating the behaviour of tessellation on various types of urban form. The structure of the tessellation mesh directly represents the spatial configuration of buildings in the area.

flies) distance from the elements of analysis (typically radius of 400 metres around a building) (Schirmer and Axhausen, 2015). However, such an approach does not reflect the actual morphological situation on the ground. In some instances, such as in traditional compact urban tissues, it can capture hundreds of buildings within 400 metres, but only a few in sparse modernist urban tissues, leading to fundamental differences in the amount of information captured, causing issues of comparability of such information.

Excluding effect of certain morphologies from the definition of aggregations overcomes method based on metric reach. Following street network or axial map of urban form (Berghauser Pont and Marcus, 2014; Marcus *et al.*, 2017), it captures the area which is possible to reach within a set distance (mostly metric). As a location-based method, reach is useful because it reacts to unequal morphologies, but only through constrains that limit accessibility to space, rather than through a detection of a difference in urban form itself. The logic is based on the cognitive experience of cities but limited to accessible open spaces, excluding the intra-block relationships. It can generate situations of two buildings facing each other *across* the block (hence directly influencing each other) not being aggregated together, ignoring their relationship.

Both Euclidean distance and metric reach methods cannot capture the change in the granularity of urban tissues, hence effectively measuring different *information* in granular than sparse tissues. In the case of reach, the distance could be defined topologically as a number of steps on the network (represented by the graph) (Berghauser Pont and Marcus, 2014), allowing to recognize the change in the pattern of aggregations, but it still does not eliminate the issue of intra-block relationships. On top of that, network-based methods faces issues in data availability – street networks usually need significant adaptations before they can be used, as they are typically drawn for traffic purposes, not morphological ones; axial maps are scarcely available, and their generation needs a very specialised type of morphological knowledge limiting the applicability of such method.

The third method present in literature is K-nearest neighbour (KNN) analysis, which is also based on Euclidean distance but using it differently. It defines aggregation as a set number of nearest neighbours, defined via as-crow-flies distance. Whilst only scarcely used in urban morphology (Liqang et al, 2013), it has potential as such an approach might reflect changes in the granularity of urban tissues. However, due to the Euclidean definition of nearest neighbours, it cannot react to the detail of some spatial configurations (e.g., be able to detect linear patterns with natural boundaries between as features across the boundary might be closer than those within the pattern). Theoretically, KNN could be used together with reach analysis, joining both the ability to capture morphology represented by networks and scalability of KNN, but we are not aware of any research using this concept so far. However, it would still not resolve the issue of intra-block relationship.

To sum up, literature currently offers two general approaches to aggregation – area-based and location-based. The first one is prone to both parts of MAUP, for which reason it is preferred to use location-based methods. Three location-based methods used in literature are Euclidean distance, metric reach and KNN. However, to date none of these methods is able to capture the structure of urban form which, for its complexity and variance, requires both morphological detailed definition and sensitivity to intra-block relationships.

Thus, we present here a morphological tessellation, which is able to cover the built-up area as a continuum, thus allowing to identify all topological relations between morphological cells, including intra-block relationships, enabling to identify location-based aggregation sensitive to urban patterns.

Topology captures the information on adjacency of neighbouring elements (cells) – two cells are neighbouring if they share at least one point (so-called Queen contiguity) or one segment (so-called Rook contiguity). It defines the proximity of elements in terms of the number of steps needed to get from each element A to each element B. Topological relationships can be of two types – unconstrained, if not limited by any other element than tessellation itself, and constrained, if the step between two neighbours is impeded by constraint (a block is the maximum number of topological steps from element without the need to cross the street network, while the street network is the constraint in this case). Thus, we can define an aggregation around each element based on a number of topological steps (topological reach) on the morphological tessellation, where aggregation defined by n steps includes all morphological cells which we can reach within $x \leq n$ steps.

The definition of aggregated analytical units via the topology of morphological tessellation can overcome issues of the three methods described above and provide a more consistent way to understand the relationship between adjacent elements of urban form (in the case of buildings or morphological cells). This paper is testing this hypothesis in the case of Prague, Czechia.

2. Methodology

The methodology of this research follows a twofold approach, analysing both small scale case studies and urban scale statistical data. Small scale case studies examine the difference between three methods extracted from literature (Euclidean distance, metric reach, K-nearest neighbour) and unconstrained topology of morphological tessellation in different types of urban form; large scale statistical analysis examines the parameters of these methods of aggregation across the whole of Prague.

Prague was selected as a case for its morphological richness of multiple historical layers still intact. The study area is limited by the administrative boundary of the city, but still extends the

built-up area of the city by a large margin. The data used within this study were provided by Prague's Institute for Planning and Development (www.geoportalpraha.cz).

We compare how each of the tested methods aggregate tessellation cells (being smallest spatial unit) within two scales: one achieved by nine topological steps, the equivalent of approximately 400 metres used in morphological analysis to represent walking distance of 5 minutes; and one achieved by 4 topological steps, representing roughly 200 metres. The number of neighbours for KNN is then derived from mean number of neighbours captured by each of the topological distance, to keep the dimension comparable (Table 1).

The aim of small-scale analysis is to understand how each of the four methods identifies and represent the same information across 5 types of urban form – medieval organically grown, 19th century compact perimeter blocks, 20th century mixed single and multi-family villas, 20th century modernist housing, and 20-21th century industrial estates. It should allow to ascertain how consistently each method distinguishes variations in form and morphological behaviours.

At the urban scale we conduct statistical analysis to compare the distribution of values derived from the whole of Prague (its administrative boundary). Statistical distribution of data across whole urban area describes the spread and variance of values, which can be used to assess the ability of each method to capture the intended information across types of urban tissue. To understand the different performance of each method, we compare distributions of two descriptive variables as a proxy for the performance assessment – number of neighbours and covered area.

The first variable is the number of neighbours captured. Neighbours represented by buildings and related tessellation cells capture most of the morphological information. For that reason, it is desirable to use method which will identify somewhat similar number of neighbours no matter the urban tissue to keep the similar essence and amount of information to maximise comparability of values, meaning that the distribution of such values should have relatively small standard deviation and be close to symmetrical distribution to have the similar positive and negative deviations from the mean.

The second variable should represent the concept of geographical extent of aggregation, as it bears the information of the scale of each type of urban tissue and therefore could describe the ability of each method to adapt to the scale. Amongst the possible measurable variables are mean distance to neighbours, maximum distance to neighbours and area covered by aggregation. Because they all represent scale and extent of aggregation of elements (buildings, tessellation cells), we use only area covered to represent them all as it is the most straightforward one and easy to understand. The statistical distribution of covered area should represent the adaptability of aggregation method. For that reason, ideal outcome should have high standard deviation and high range of values, meaning that many different options (levels of granularity of urban form) are all captured.

Table 1. *Default topological distances and their equivalents. Values are derived from the summative analysis of topology-based aggregations defined around each morphological cell on Prague.*

Topology of MT	Euclidean	Metric reach	KNN
4 steps	200 metres	200 metres	70 neighbours
9 steps	400 metres	400 metres	320 neighbours

3. Results

At the small scale, we studied how five urban types in Prague are represented by the four methods of aggregation. The Old Town, a tissue of a medieval origin which has grown organically, shows few differences between the four methods, with slightly larger footprints of aggregations defined by Euclidean distance and a morphological tessellation topology at both 200 (Figure 2a) and 400 (Figure 3a) metres distances. Numerically, the difference is clear, but for pattern-detection this difference is not substantial, suggesting that all methods are relatively equal in this tissue for both 200 and 400 metres (and equivalents). Differences might be explained by the high granularity of the tissue, with many elements on a relatively small area (the reason for KNN being the smallest) and complex configuration amongst them (buildings have many neighbours, expressed by more extensive topological-based aggregation).

In the second case, the urban tissue of 19th century of compact perimeter blocks in the Vinohrady neighbourhood, results almost matches the previous case. Due to the high granularity of this urban tissue, purely Euclidean distance-based area is the largest, while K-nearest neighbour the smallest (Figure 2b, Figure 3b).

Overall, in these two historic tissues, the difference is not significant to conclude that one method is better than the other – simple visual comparison shows that boundaries almost overlaps for both tested distances.

The first crucial differences are noticeable in Hanspaulka, an area of 20th century mixed single and multi-family villas, where the street network is becoming less dense and less connected than in the city centre, leading to the difference between the area captured by metric



Figure 2. Comparison of boundaries of aggregations defined by each of the tested method for 4 topological steps and equivalents (200 metres, 70 neighbours). a) Old Town, b) Vinohrady, c) Hanspaulka, d) Jižní Město, e) Malešice © IPR Praha, CC BY-SA 4.0.

reach (smaller) and the other three methods, which almost overlap without any substantial distinction (Figure 2c, Figure 3c). This indicates that the street network plays a crucial role in the applicability of reach-based methods.

The twentieth-century modernist housing of Jižní Město is the first example of a post-WW2 urban tissue. The planning ideology behind it comes with the radical change of scale and a distinctive approach to streets and their connectivity. This change is reflected in how each of our tested methods captures the space: while the area defined by Euclidean distance remains mostly the same as in pre-WW2 tissues, the area captured by metric reach shrinks due to the convoluted street network. In theory, both topological and KNN definitions of aggregation should be able to capture the difference in scale and up to a certain level they do. However, KNN, even though being larger than metric-based methods, lacks the ability to deal with large pavilion-like buildings with many direct neighbours, unlike the topological definition which correctly reacts to the abrupt change of scale of the granularity of urban tissue and captures the relationship between high-rise buildings and their low-rise pavilion counterparts by acknowledging that they are neighbouring (Figure 2d, Figure 3d).

Whilst industrial type tissues are generally not the concern of urban morphology, as classified as specialist and treated differently than more ordinary fabric, they are nonetheless large, therefore important parts of our cities and as such deserve to be studied using the same approach as the more conventional ones. Their scale is radically different. Buildings are of the size of the traditional block or larger, the plot structure is mostly unorganised, and the street network is utilitarian only, following different principles than in residential or mixed-use parts of the city. These differences are captured through the application of our four methods. The network-based method is unreliable on this tissue, capturing the only a minor area around the

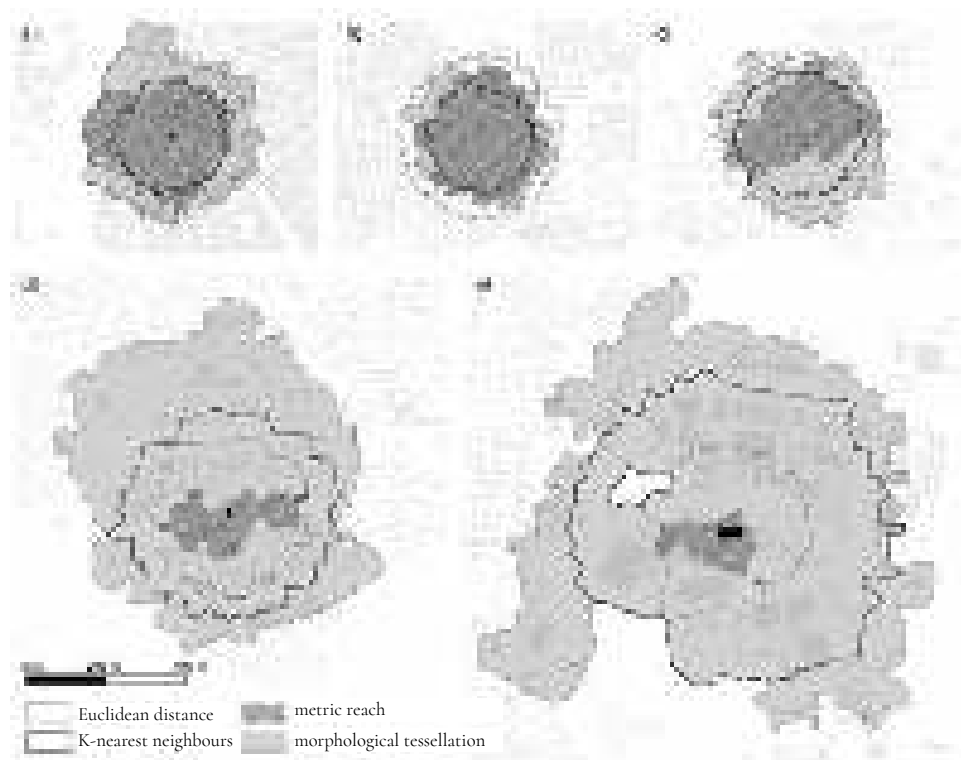


Figure 3. Comparison of boundaries of aggregations defined by each of the tested method for 9 topological steps and equivalents (400 metres, 320 neighbours). a) Old Town, b) Vinohrady, c) Hanspaulka, d) Jižní Město, e) Malesice © IPR Praha, CC BY-SA 4.0.

building due to the major drop in a granularity and connectivity. The Euclidean distance of 200 or 400 metres, which seems to capture enough information in more granular urban tissues lacks the same capacity in this case. K-nearest neighbour analysis struggles to capture the peculiarities of this particular urban tissue, which is characterized by a large amount of additional built-up structures to main buildings, leading to the identification of smaller area that make a comparison with the other cases confused. The topological definition achieved by the morphological tessellation seems to tackle all issues of the other methods, whilst capturing a similar amount of information as it did in previous cases (Figure 2e, Figure 3e).

Overall, the differences between methods in defining aggregation are heavily dependent on the type of urban tissue analysed. More traditional (from a European perspective) urban tissues like medieval (Old Town) or perimeter blocks (Vinohrady) indicate that in these contexts the choice of the method is purely the matter of opinion and that the resulting value offered by the four methods is mostly similar. However, once we start focusing on post-WW2 development, we often observe a change of scale of urban patterns, which makes distance-based methods (Euclidean, metric reach) unable to react to such change. The information captured is consequently different in pre- and post-WW2 urban tissues, complicating the further comparability, whilst we seek similar and consistent data. If the urban patterns change their scale, the method of capturing such extent needs to be able to adapt to it. Our results of the small-scale analysis indicate that topology of morphological tessellation is the method able to fulfil this condition adequately.

Whilst small scale analysis illustrated the capacity of the four selected methods to provide stable information, it is only at an urban scale, through statistical analysis, that we can show a full overview of how the four methods perform.

As mentioned, neighbouring elements are bearing the primary information about urban patterns. For this reason, researchers aim to use methods capturing an equal number of neighbours across contexts. Such a method might be K-nearest neighbour, but due to the variety of urban configurations, a method needs a certain level of adaptability (which KNN with fixed number cannot provide). As Figure 4(a, b) shows, the statistical distribution of the number of neighbours captured is the most stable for topology of morphological tessellation, being almost perfect Gaussian distribution (the deviation in the number of neighbours is the same in both directions from the mean), with the smallest standard deviation (s). The metric reach method provides right-skewed distribution and Euclidean distance high deviation, which are both undesirable features in terms of stability of information.

Then, comparison of distributions of covered area aims to test the adaptability of each method. As mentioned, the changing scale of urban patterns means that the same level of information is spread to larger areas. Therefore, an ideal method should show high flexibility (the distribution of values should have large range and high standard deviation) in the area captured to fit all patterns possible. The results as shown in Figure 4(c, d) indicate that topology of morphological tessellation offers by a large margin the highest standard deviation out of tested methods, indicating that the change of the scale is captured successfully. Metric methods (Euclidean distance, metric reach) are the least flexible in this sense, while K-nearest neighbour might offer desired value alongside with morphological tessellation topology.

Even though there are differences between smaller and larger distances (4 steps / 9 steps and its equivalents), topologically defined aggregation seems to reflect desired outcomes (i.e. stability in number of elements captured and flexibility in metric values) in both statistical comparisons better than other tested methods. This finding is in line with the one we drew from small-scale case studies, indicating that topology of morphological tessellation is a valuable approach to be employed in morphological analysis.

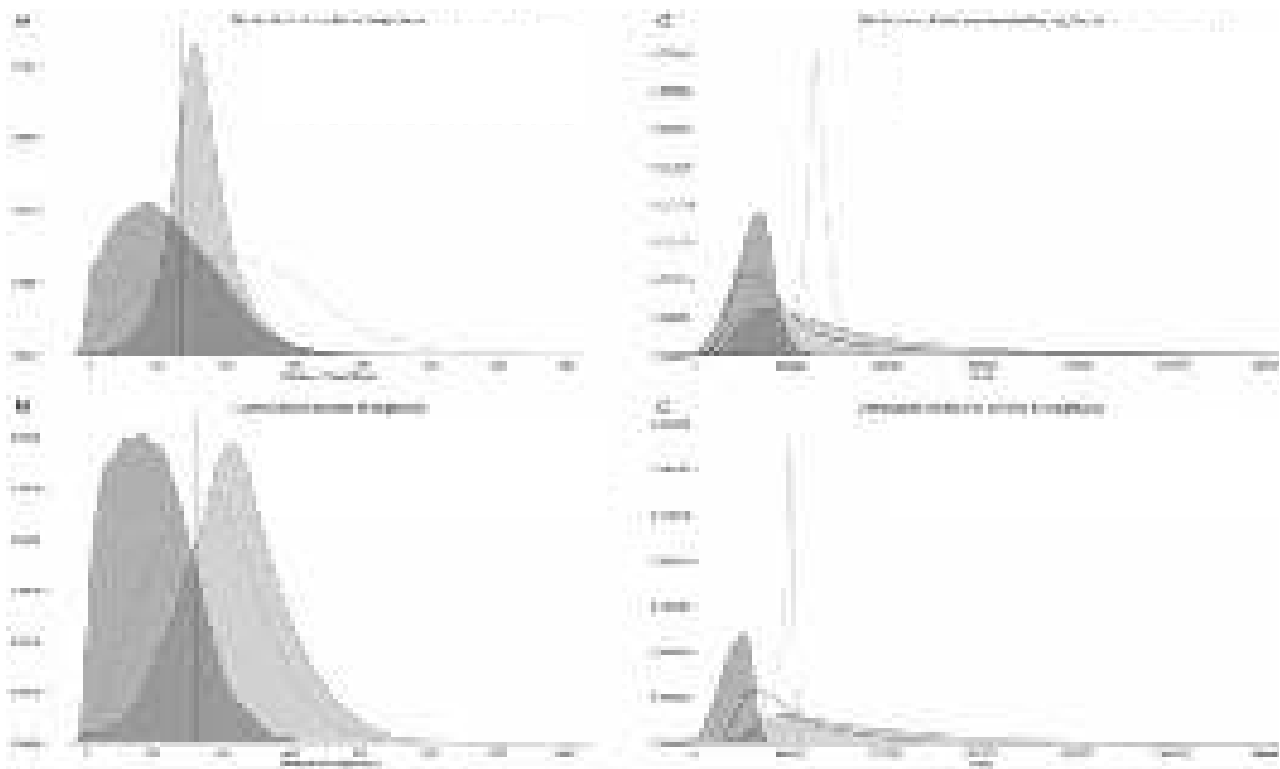


Figure 4. Statistical distributions of number of neighbours a) 4 steps and equivalents, b) 9 steps; and total covered area c) 4 steps and equivalents, d) 9 steps.

4. Discussion

Existing location-based methods of aggregation of elements into larger analytical units all face some issues limiting their applicability and reliability. The alternative method presented is based on the topology of space as captured by the morphological tessellation. Such a method of partitioning space reflects the influence of each building on the space around it with the aim to overcome existing challenges and provide a context-sensitive method. Initial results of the twofold analysis of the topological ability of the morphological tessellation indicate that the type of urban tissue influences the outcome of morphological analysis, and that in the case of pre-WW2 traditional European-like urban tissues, all currently available methods of definition of aggregation are relevant and almost interchangeable. However, this is not the case with post-WW2 urban developments, as in them there has been a significant change in the scale of form's granularity. In these cases, urban morphology needs to employ methods which are sensitive to the scale and configuration of urban form and at the same time can detect its granularity. The morphological tessellation and the topology derived from the analysis of its structure seem to be the most successful, sensitive method, suitable for general analysis.

All of the methods that have been tested partially solve one of the key issues identified in spatial analysis (MAUP), as data are aggregated independently for each element and there are no preselected boundaries in play.

No matter the results of presented analysis, methods extracted from literature have their role in morphological analysis. However, Euclidean definition and metric reach should be used in specific situations only, due to their abovementioned limitations. It is either in stable envi-

ronments without abrupt changes of granularity or in a definition of larger-scale aggregations, where multiple urban tissues are included. In that case, the main benefits of the morphological tessellation — following the spatial configuration of urban patterns — is not so crucial and from certain scale does not even provide added value.

For the analysis done on the small scale (scale of urban tissue and smaller), Euclidean definition and metric reach do not provide a stable information, unlike KNN (which always captures the same number of elements of similar informational value, but not the same relationship) and the topology of morphological tessellation. Moreover, aggregation defined via the topology of morphological tessellation may be used even on the smallest scales of one or two steps as it will always capture intended comparable information based on the relationship of elements.

Currently, tools to generate a morphological tessellation and work with its topological relations are available under a MIT license as a part of open source Python package named “momepy – Urban Morphology Measuring Toolkit” (Fleischmann, 2019), which, together with its source code, is publicly available and is under active development.

Further research should focus on the question of the exact meaning and variation of topological distance and its definition for specific purposes. To date, the question of how many topological steps should be used for the analysis of urban form remains open. It is expected that it will vary depending on the scope of the research.

The morphological tessellation is a step towards achieving consistency in urban morphology in both definitions of the smallest spatial unit (Fleischmann *et al.*, 2020) and analytical aggregation. The advantage of morphological tessellation is that it limits the data dependency as it is based on building footprints only and allows the elimination of subjectivity in the partitioning of space. Most importantly, it is context sensitive allowing the researcher to use the same method across different types of urban tissues whilst still get comparable information, much needed for reliable results of any statistical analysis.

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Intensity Mapping: a Non-Essentialist Approach to Methods in Urban Morphology

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Keywords: intensity, mapping, assemblage theory, methods.

Abstract: In assemblage theory, all entities have extensive and intensive properties and intensity is one of the core concepts that explains the processes of morphogenesis. Extensive qualities are related to the material features and define boundaries, whereas intensive properties are linked with becoming and dynamic processes that are forming the identity of an entity. Both aspects are interdependent. In urban morphology the analysis has often focused on the extensive properties and their permanence. There is a limited exploration of the dynamic aspects of the extensive qualities or intensive properties that guide change. Thus, this paper asks, how can we apply the intensive and extensive properties in studies of the built environment? How can the concept of intensity be explored in the analysis of urban morphology?

The paper begins with defining the concept of intensity in assemblage theory based on the difference and uses a case study approach to apply and test various intensity mappings. The aim is to discuss the potential contribution to the analysis focusing intensive mappings. Intensive maps are visualising dynamic phenomena and the paper is comparing intensive with extensive results. The maps are using ArcGIS and standard deviation to generate intensity data and compare the spatial characteristics of various intensities. The results contrast a range of interpretations of the intensity and their visualisation.

1. Introduction

Assemblage theory could be considered as useful framework to advance existing theories as it focuses on the aspects often overlooked in those theories, such as dynamics, changes, relationships and complexity. It is often used as a “conceptual toolkit” that opens a different way of thinking and analysing the world (Massumi, 1987: XII). Therefore, when mobilized with other theories, application of the concept of assemblage does not replace but adds new ideas (McFarlane, 2011: 208). There are three main ways how assemblage theory has been applied to other theories: empirical (explaining actual assemblages), methodological (creating new and advancing exiting methods) and ontological sphere (Brenner, Madden, & Wachsmuth, 2011: 230). It has been applied to global anthropology e.g. Ong and Collier (2004); Collier (2006); actor-network theory e.g. Law and Hassard (1999); Castree (2002), Latour (2005); place theory Dovey K. (2010); critical urban theory e.g. McFarlane (2011); Brenner *et al.* (2011) and human ge-

ography e.g. Anderson, Kearnes, and McFarlane (2012). Despite the wide potential, there is not much experimentation with its applications, particularly in the fields of urban morphology (K. Dovey, Rao, & Pafka, 2018, p. 265).

However, because of these diverse applications there are problematic aspects of assemblage theory in relation to its consistency and clarity. Namely, there is hardly any coherence in what is called “assemblage theory”. In addition, the concepts are fully explained and explored only once they are contextualized in various disciplines (McFarlane, 2011, p. 207) which further contributes to this seeming inconsistency. Furthermore, Delanda (2016, p. 138) argues that the relationship between concept of assemblage and the real actual assemblages should be established one case at the time, having different application depending on individual context, thus resulting in dynamic and incoherent state of the assemblage discourse rather than a theory. However, there are also attempts to structuralize it into a coherent theory (Anderson *et al.*, 2012), which might be argued to oversimplify the existing discourse and the core intention by Deleuze.

Another critique often presented towards assemblage theory is related to the clarity of discourse and definitions in assemblage theory. It could be argued that concepts such as emergence, heterogeneity, ephemeral etc. are fashionable and thus gaining popularity, whereas in reality, they generate “...enduring puzzles about ‘process’ and ‘relationship’” without creating their definitions (Markus & Saka, 2006, p. 102). However, all those aspects are popular because they are offering something new that is usually omitted from the mainstream theories, especially because it is a slippery field, difficult to grasp. Thus, it could also be argued that this is a new area of research that has the potential to advance existing theories, and that because of this it also needs to develop a new discourse (K. Dovey *et al.*, 2018, p. 266). Furthermore, the intention of Deleuze’s philosophy, might be argued, is in dynamic, incoherent and open-ended qualities of a discourse and not in the clear structured definitions.

In this paper, when referring to assemblage theory it is dominantly the work of Deleuze and Delanda that are considered for the contributions to this opus. Deleuze’s opus attempts to build a new materialism, that which is different from the dialectical materialism and positions it between materialism and phenomenology (Deleuze, 1994, p. 222). At the broadest sense, this approach corresponds well with morphology as it focuses on the material aspects of the built environment. Furthermore, in assemblage theory the focus is on the dynamic processes produced within the material world, its aim is to explain the processes of change and transformation by the intrinsic characteristics of the material. Therefore, assemblage theory has the potential to intersect and contribute to the studies in morphology.

The studies of urban form are naturally dealing with various forms of change, often the change is described with the intention to understand its origin or cultural meaning and implications, however there is no focus on the “abstract model of change” (Kropf, 2001, p. 29). There are various types of change that are covered by various authors and their different approaches in the analysis. For example, Conzen identifies street, plot and building systems in their planar representation and studies the change through burgrave cycle and fringe-belt formation. Muratori and Caniggia identify building types bounded by territories and regions. Both approaches are dealing with different type of change and degree of change as they are also demonstrating different levels of complexity. Fringe-belt formation represents an example of complex single object and transformation of types referrers to class or population of buildings. In defining the change in urban morphology most of the concepts are deriving from the natural history, one referring to ontogenesis (the origin and development of the individual, also called development) and phylogenesis (the history and evolution of the type, evolution) (Kropf, 2001, p. 32).

Ontogenesis can be differentiated into two types depending on their complexity, single object (like a house for example) and aggregate object (a settlement).

Assemblage theory offers a different approach to understanding of change that opposes essentialist approach (exemplified within typological approach in morphology) and focuses on the dynamics and aims to explain the processes of transformation and individualisation through the multiplicities. Multiplicity is thus the concept that replaces the essence (M. Delanda, 2002, p. 9). Essence is usually referred to as the characteristic of certain entity that defines its identity. If an entity loses its essence it will become something else. Essences are thus important elements that define types. However, in Deleuze's ontology, identity is not framed through existence of essences but through dynamic morphogenetic processes, "...multiplicities specify the structure of space of possibilities, space which in turn, explain regularities exhibited by morphogenetic processes" (M. Delanda, 2002, pp. 9-10). This difference in approach has the implication that identity is not observed as something static and eternal but a dynamic and developed progressively.

Even though assemblage theory is not using the classification based on the essences, it does not mean that all transformations are observed at individual level. The main difference is in classification, which is relative in assemblage theory and depends on the process of transformation in question. One of the examples offered in this sense is deriving from geometry. Instead of classifying the geometrical shapes by using their characteristics common to all cubes, spheres, or circles just to name few, they are classified based on how they "...are affected (or not affected) by active transformations, that is figures are classified by their response to events that occur to them" (M. Delanda, 2002, p. 18). The classification process that describes transformation might not be changing the ideas in morphology, as it seems quite similar, however, what is different is the focus on the process that determines such transformations.

This paper is focusing on the change of the individual object, defined as ontogenesis or development. The ontogenesis or transformations in assemblage theory are explored through processes guided with the intensive qualities. This is where the division on the intensive and extensive qualities becomes useful for building a new approach to understand transformation in built environment. Thus, this paper aims to explore how can intensive and extensive properties be applied to analysis in built environment? And more broadly, how can the concept of intensity be explored in the analysis of urban morphology?

The paper is divided in three parts. Firstly, definitions of intensive and extensive properties in assemblage theory are presented. Secondly the definitions from philosophy are applied in methodology and methods to the urban morphology analysis. And thirdly the analysis is tested at the concrete case studies.

2. Intensive and extensive properties

In assemblage theory all entities can be defined through intensive and extensive properties (M. Delanda, 2005, p. 80). The division derives from thermodynamics, however Deleuze has used that definition to broaden it into a philosophical approach that can be then applied to various fields.

In thermodynamics the division to intensive and extensive properties is defined based on divisibility. Extensive properties are related to the physical aspects of the space and are divisible and intensive properties are indivisible (M. Delanda, 2002, p. 45). To explain this in simple terms we can use the example of room. The volume, length, width and area would represent extensive properties of the room that are changed if the room is divided for example in two

rooms, thus those are divisible properties in this case. However, the properties such as temperature of the air or pressure would not change upon the division of the room thus those belong to indivisible properties. Intensive properties include all those challenging to measure qualities, such as joy, love, hate, grief, beliefs, desires etc. Importantly, difference in intensity can produce change, as a spontaneous flow that tends to cancel the difference in intensities and restore the equilibrium (M. Delanda, 2005, p. 81). Therefore, differences in intensities are important guide to the processes of change in space. Furthermore, intensive factors or differences in intensities are main forces that define the process of individualisation, forming the character of any entity.

This could be applied to the space and changes in built environment. Process of gentrification is one of the most common drivers of change in cities. With the sudden attraction of certain location, the creative class starts to move in, creating intensity through a difference in the population that drives the change in built environment. Once fully gentrified the built environment is also fully transformed changing its identity. After reaching the equilibrium a new tendency will emerge, and change will take place again. However, the question remains if there might be some intensity found within the extensive characteristics of the built environment that can generate the difference and transformations, which are going to be explored through the examples in this paper. Furthermore, the question is shifted towards the material aspects, and asks if there are some qualities in the built environment itself that can produce intensities and thus generate processes of change.

3. Actual/virtual and real

Another important aspect of the division between the extensive and intensive properties is the tendency towards the singular state that any assemblage is striving towards. All assemblages are having a tendency towards the absolute state of equilibrium. For Delanda this is a “final state” which acts as “attractor” or singularity (M. Delanda, 2002). Those attractors, “...even while not being fully actual, since they guide real processes towards a definite outcome.”..., they are objective and real (M. Delanda, 2005, p. 83). They act as the “space of possibilities” (ibid). Furthermore, there is no singular equilibrium state but multiple states that define importance of history and avoid the existence of essences. In other theories we would assume the ultimate singularity that is absolute and not changeable, an essence, while here the singularity has the potential to change depending on the circumstances that entity is going through. Applied to the analysis in the morphology, this implies that there is no singular archetype that everything else is evolving around, actually there are numerous singularities that buildings are striving to.

To define those tendencies and singularities (M. Delanda, 2005, p. 86) uses terms of actual and virtual spaces. Both actual and virtual spaces are real. Virtual tendencies are guiding the processes of change, which are caused through intensive properties. On the other hand, virtual should not be confused with the possible. “Possible is opposed to the real; the process undergone by the possible is therefore a ‘realisation’. By contrast the virtual is not opposed to the real; it possesses a full reality by itself. The process it undergoes is that of actualisation”. (Deleuze, 1994, p. 211) The virtual is thus not a simple possibility that might be happening sometime in the future, it is actual element of the reality in any particular moment.

Interestingly, the interpretation of virtual might be considered very similar to the phenomenon. Once we see a building or a place the phenomenon emerges which is the intersection between our memory, emotions, knowledge, mood etc and the actual world. Thus, there are

virtual elements associated with the actual reality that we experience. Delanda does not fully exclude the existence of phenomenon but something in between that is defined as noumenon.

4. Methodology

Focusing on the intensity is shifting the analysis from static states to dynamic processes, remaining however within the material world. To analyse intensity in this paper, firstly the concept of the intensity in the built environment needs to be developed. One way of capturing intensity that is most applicable to urban analysis is using the intensity maps and diagrams (M. Delanda, 2016, p. 110). These maps are different from the usual extensive maps that are capturing the actual physical characteristics of the built environment. Intensive map captures the differences in intensities and dynamic phenomena focusing on the thresholds that mark the changes. Thus, intensive maps are representing the relationships between the elements instead of elements themselves. Delanda often mentions as an example of intensive map the weather maps that we see on television everyday with high- and low-pressure systems. But the question what these maps are in the built environment still needs further explorations.

Intensive maps do not resemble the extensive qualities of the space. They have certain level of abstraction and thus could be considered diagrams rather than maps. Intensive maps are capturing the changes that occur within the entity according to external parameters that are also called phase diagrams (M. Delanda, 2016, p. 117). In assemblage theory diagrams, “multiplicities”, “structure of space of possibilities” and intensive maps are used with the same meaning, whereas in urban analysis those are different analytical tools. On the one hand map represents the extensive qualities of built environment with a particular focus on certain aspect of that extensity. Diagrams on the other hand are abstract representations of certain systems that usually have no reference to the actual extensive qualities. In previous studies (Muminovic, 2019) it was found that the balanced approach between abstract and actual map is the most useful in understanding the space. Thus, for the purpose of this paper the intensity map used is a kind of the diagram, focusing on the one aspect of the assemblage, with the clear reference to the extensive qualities of the space. Therefore, the intensive map has clear reference to the actual space.

The diagrams in general and their levels of abstraction are defined through two main aspects, number and type of transformations and invariants (M. Delanda, 2016, p. 113). Every diagram could be defined through elements that are not changing (invariants) and those that are transformable. Invariants are not absolute constants; they are relative to the context and type of transformation that one assemblage is undergoing. Thus, defining the invariants and transformations is important first step in the analysis. In this particular paper the invariant element of the built environment will be the actual geographical position of the qualities, the extensive property of smallness will become the transformable characteristic.

Furthermore, depending on the number of factors diagram could consist of various number of dimensions in maps, it could be one-dimensional as the line or two-dimensional as surface etc. The more dimensions diagram is using in analysis, the more detailed understanding of the assemblage (M. Delanda, 2016).

To define intensity the paper uses the concept of difference that is calculated through standard deviation. Standard deviation can be defined as statistical tool that shows how much variation there is from the average (the mean) of all. If the standard deviation is low, then this means that the element in question is close to the mean (or the average of the whole). If the standard deviation is high, then that means that the element in question is far from the average of the

whole, generating larger difference, thus intensity. In this analysis standard deviation is used to define the classification based on the size, thus all of the classes are generated based on the proportional distance of standard deviation from the mean. This defines the level of difference that each element of the assemblage is bringing, thus, the intensity. The classes (groups) are calculated based on the characteristics of the assemblage that they belong to. Thus, the classification process is relative and depends on individual assemblages; which is in accordance to the non-essentialist approach discussed in previous section.

To further spatialise the relationships between various classes the clustering method was used. Clusters are aggregations of elements of assemblage with similar characteristics (in this case of the same class) in actual space. For this purpose, Ord G* statistical analysis defining to which degree high or low values cluster together. This demonstrates the highest difference within the assemblage and thus the highest level of the intensity.

Spatial statistical tools are used in Arc GIS, hot spot analysis which identifies statistically significant spatial clusters with the highest and lowest values based on selected weighted values (in this case length). The tool calculates both p-value and z-score and identifies the significant spatial clustering. Low p-value and high z-score are showed at the hot spots and they demonstrate that there is less likely that the pattern observed is random (low p-value) and that it is the most different from the average (high z-score) intensive zones. In relationship with the intensity and its link to the difference this tool identifies the most different elements clustered in space, thus the highest and lowest intensities.

5. Analysis and results: case study: intensity of smallness

For the purpose of testing the intensity maps and statistical methods we will use the case study from Tokyo, Yanesen. This area has been chosen as a case study because its urban character, grounded within the smallness and the relationship between public and private spaces (Muminovic *et al.*, 2014). The link between the extensive qualities and identity or the character of the place is important for testing the intensity mapping. Namely, this sets direct link between the extensive qualities that are generating the intensity in creation of the urban character.

Yanesen is located in central area in Tokyo and belongs to one of the 23 central wards. It consists of three neighbourhoods, Yanaka, Nezu and Sendagi. To test the link between the urban characteristic of smallness and intensity maps firstly we have applied the analysis of the sizes of elements of built environment: building footprint, height of the building, streets and blocks. The classification is based on the standard deviation classification method that uses size of the elements.

5.1. Streets

There are total of 189 streets in Yanesen. The calculation of sizes has been based on the area due to the similarity of the calculations for other elements in built environment. Furthermore, this element calculates both length and width, that are both important in the perception of the smallness.

5.2. Blocks

There are total of 212 blocks in Yanesen that were considered for this analysis. The number of classes are showing less diversity compared with the streets, there were no elements that belong to the extra small nor extra-large class. The calculation is based on the area of the block.

5.3. Building Footprint

There were 4811 buildings in Yanesen that were analysed. The sizes of plots are omitted for the purpose of this analysis as the Tokyo maps do not have such information. The analysis has shown the highest level of diversity having all five classes populated.

5.4. Building height

This is an important element that contributes to the sense of scale in the built environment in addition to the building footprint. The calculation is based on the number of floors.

The analysis has demonstrated that there are maximum five classes of sizes, each calculated individually that were named xs (extra small), s (small), m (medium), l (large) and xl (extra-large) (Table 1). Spatial distribution of the classes of sizes shows how each of the elements contributes to the experience of the small as part of the noumenon. The smallest streets are grouped in the area of Nezu and Sendagi. The medium, large and extra-large classes of streets are scattered throughout all area, not generating any significant cluster in space. Blocks have only three classes of sizes. Small blocks are dominantly aggregated in Nezu and Sendagi with some small aggregations in Yanaka. Interestingly, both large and small blocks are dominating the area, with almost no blocks in the medium size. Although insignificant in numbers, large blocks take almost the same area as the small blocks. The classes of building footprint do not demonstrate any significant clustering, they are scattered throughout all area. Similarly, building height has no specific clustering in small and medium classes. However, the extra-large class as expended shows higher classification in proximity to the major thoroughfare Shinobazu Dori (Figure 1).

The spatial distribution of the classes and number of elements in each class show that Yanesen is dominated with small elements of built environment, however it also demonstrates that there are significant large elements that tend to group in Yanaka. Thus the next analysis will focus on mapping the clusters of the most different elements in the space applying the hot spot analysis in ArcGIS. The analysis is conducted separately for each element of the built environment. The aggregations are defined based on the sizes of elements and their proximity in space. Thus a cluster contains the elements similar in their sizes which are the most different from the average that are located in the proximity. The proximity of elements is calculated based on the whole assemblage; thus, all classifications are relative and depend on the whole. In addition, the cluster is not based on the elements of the same sizes, but on the similar sizes which are given on the degrees of small and large, and dependant on the whole assemblage.

Results show (Figure 2) that there are three clusters of the smallest streets all located in the Sendagi and Nezu and only one cluster of the largest streets. At the level of blocks there are two clusters of the smallest blocks located in Nezu and Sendagi and one cluster of the largest blocks that covers almost all Yanaka. At the level of buildings, the number of clusters is larger

Table 1.

elements/size	xs	s	m	l	xl
street	-	89%	5%	2%	4%
blocks	-	91%	3%	6%	-
building footprint	6%	85%	6%	1%	2%
building height	-	81	15	3	1

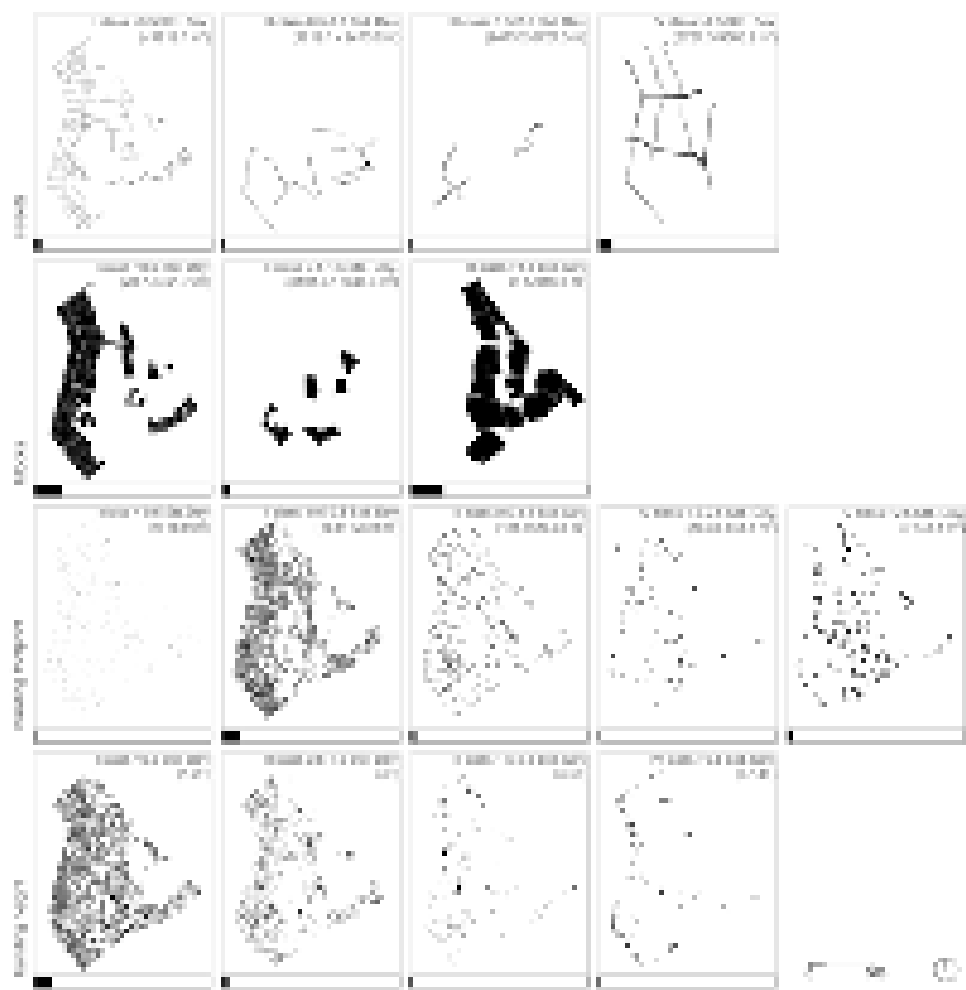


Figure 1.

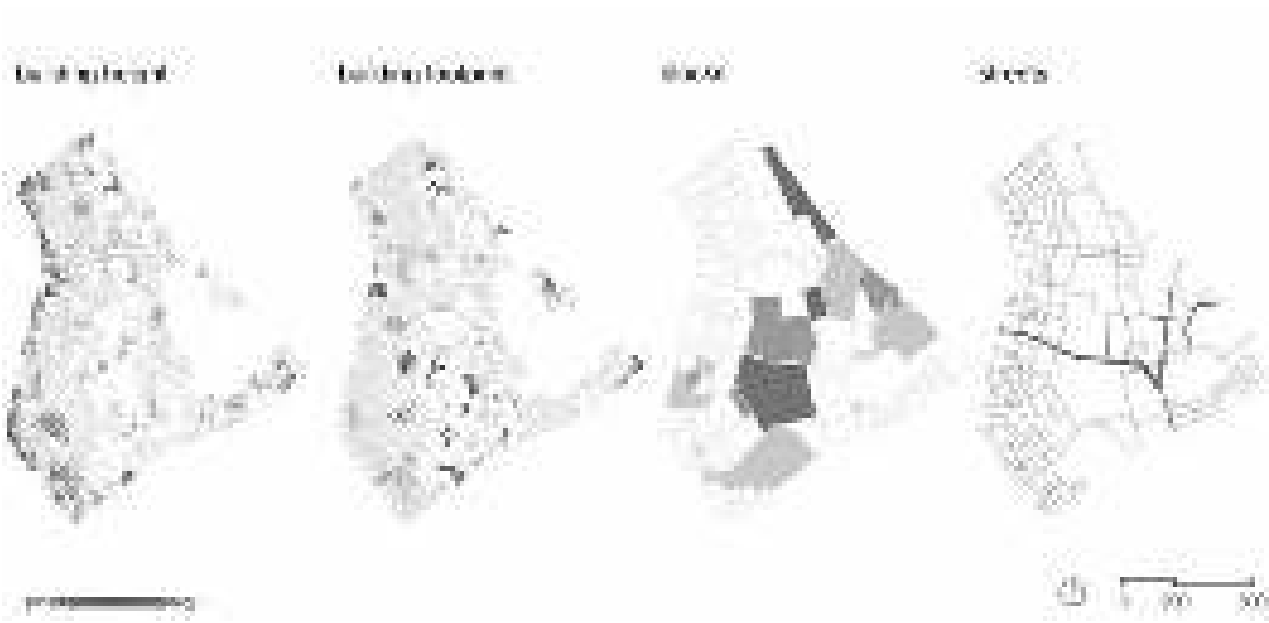


Figure 2.

due to the significantly larger number of elements. There were 8 clusters of smallest elements are dominantly located in Nezu and Sendagi and the largest aggregations 12 clusters in total are scattered throughout all Yanesen. The analysis of the building height shows 15 clusters of lower buildings scattered throughout all area and 13 clusters of highest buildings dominantly at the edges of Yanesen.

To demonstrate how each of those clusters are interacting we have separated the large and small elements and mapped their spatial connections. The analysis aims to map the significant connections between the smallest and largest elements that contribute to the experience of smallness. The results show that the relationships between the large elements in space do not demonstrate any significant grouping in space, they are scattered, while small elements tend

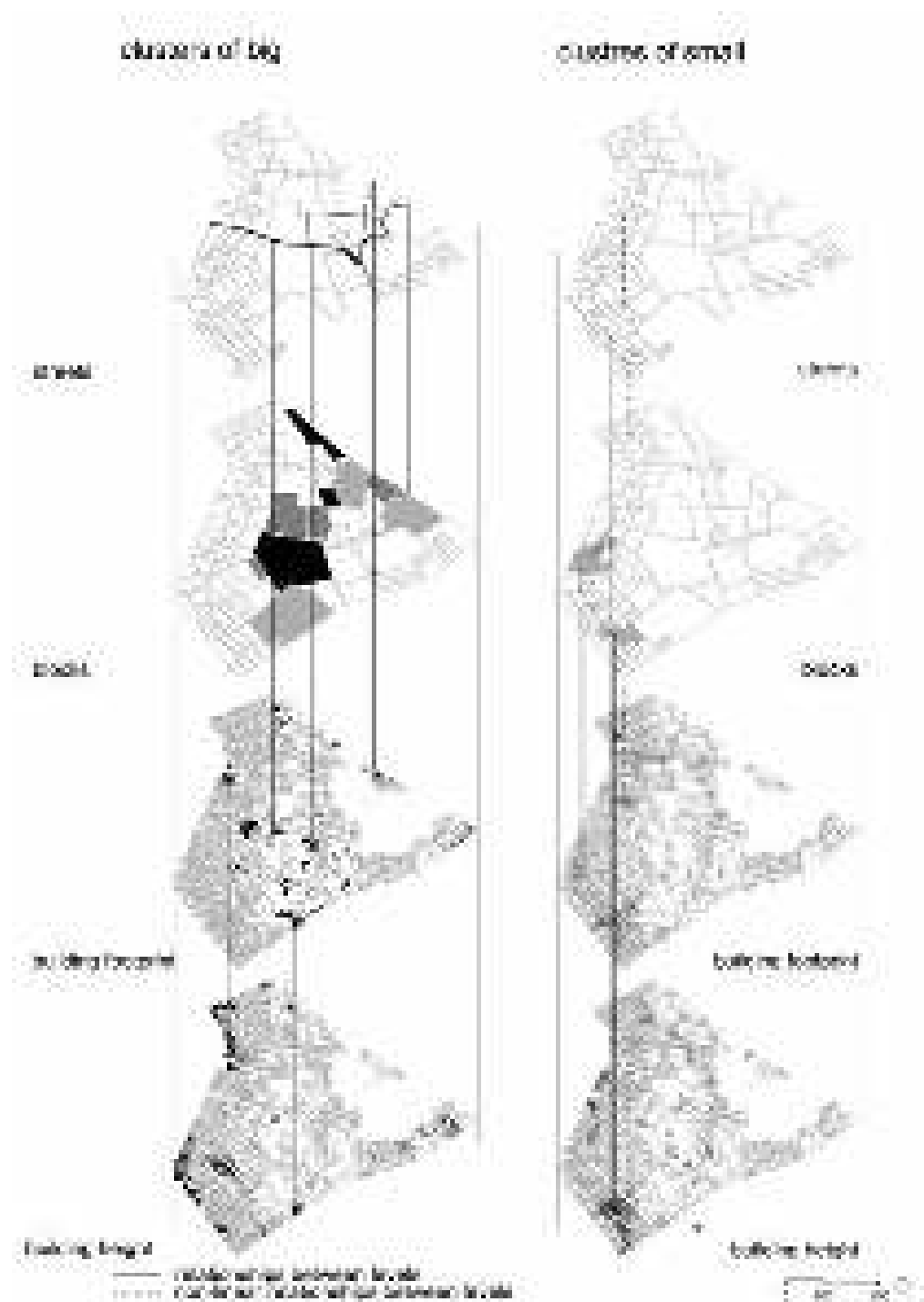


Figure 3.

to aggregate in Nezu and Sendagi. Those relationships appear between all elements of the built environment, the streets, blocks, building footprint and building height (Figure 3).

Once all elements overlapped with 50% of transparency, the intensive map of smallness is generated (Figure 4). The borders of the intensity are blurred as it shows the gradual transition from high to low intensity of smallness.

6. Discussion/Conclusion

This paper has tested various methods to generate the intensive maps. The analysis has focused on the intensity of smallness that has the statistical analysis to calculate groupings. In this particular case, the smallness is related to the urban character, thus it might be argued that inten-

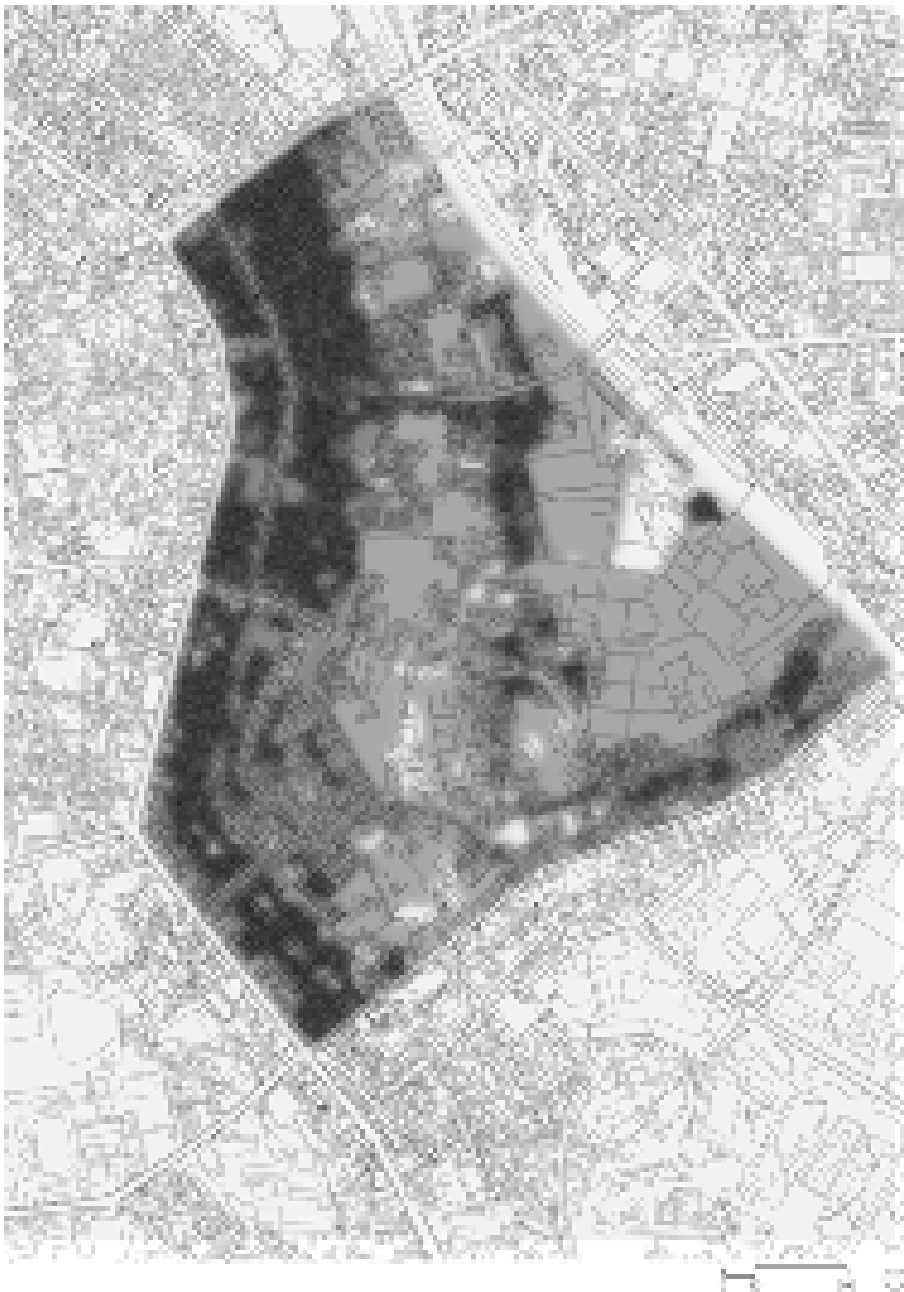


Figure 4.

sity of smallness is important feature that contributes to this character. However, the question on how to repeat analysis focusing on a different character remains. In addition, for this type of analysis the calculation demands numerical values.

The difference had important aspect to defining the intensity. The difference was also calculated based on the relative values that depend on the whole assemblage. Thus, the classification will depend on the assemblage, and there is no absolute value, no essence and class sizes will differ from location to location. On the other hand, the urban character in Yanesen is grounded in the smallness. This smallness has to be the dominant feature of the area, as it was confirmed within the analysis of the classes, that show that every element has more than 80% of small class. Furthermore, there are some areas that show concentration of the small and large elements. Thus, the assemblage is not homogeneous.

The aggregations of the largest and smallest elements in the space demonstrated the discontinuities or heterogeneities in the space. When the elements with similar characteristics are aggregated in certain area then based on the multiplication of similar elements the experience of that particular area might be amplified. Thus, in case of Yanesen the aggregation of smallest elements in space will generate the experience of the smallness or the intensity of smallness in spatial characteristics. The noumenon proposed in the assemblage theory is thus combining both material and experiential aspects through the intensity.

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A Typological Interpretation of Urban Design Method for Intensive Development Area

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Keywords: Urban Morphology, Typology, Intensive Development Area, Urban Design.

Abstract: How we define and interpret the physical form of our cities impacts on the methods of urban design. According to urban morphology, a traditional city is defined as the combination of “streets, blocks and buildings”. However, with limited land resources and the increasing population, contemporary urban development breaks through the limitation of plots and blocks, and expands three-dimensionally, resulting in the growing complexity and diversity of the urban elements. In the circumstances, we find that the traditional ways of describing urban elements, as well as the corresponding urban design methods and guidelines, are inadequate for some areas in contemporary cities. This article explores compact development strategy for intensive development areas. Urban design is considered an effective way of coordinating different elements in the whole area and improving the land-use efficiency.

This article uses typo-morphology as a way of deciphering the main characteristics of the intensive development area and exploring its cognition and design strategy in several urban design projects in China, in order to optimize and supplement the traditional ways of interpreting the urban form. Specifically, we first classify the urban elements, and analyze the mutual contributing or constraining relations among them. Secondly, we define the basic development unit, basing on which we set up principles of development control. Thirdly, the three-dimensional model is built to optimize the spatial efficiency. The methods of constructing the system model and establishing the systematic rules are revealed.

The design and the description of the urban form influence and restrict each other. How we understand and describe the physical form of the city determines how we design the city. Nowadays, the urban elements are increasingly complex and diverse, and the urban space is more often utilized three-dimensionally. Faced with such situation, we find that the traditional ways of describing the urban elements and the corresponding urban design methods and guidelines are inadequate for some areas in contemporary cities. Instead, urban design that explores the compact development strategy in intensive development areas becomes the crucial method of improving the land-use efficiency. This article uses typo-morphology as a way of deciphering the main characteristics of the intensive development area and exploring its cognition and design strategy in a number of urban design projects in China, in order to optimize and supplement the traditional ways of interpreting the urban form.

1. Background

The clear block pattern used to be one of the basic characters of traditional towns. The basic components of a town plan are identified by the urban geographer M.R.C. Conzen as “the street pattern, the land use pattern, and the building fabric” . According to the American scholar Anne Vernez Mouton, “urban form is defined by three fundamental physical elements: buildings and their related open spaces, plots or lots, and streets”.¹ Divided by streets, blocks are independent urban units with few interconnections, within which buildings are built. Karl Kropf used multi-level diagrams² to define the urban elements and their hierarchical relationship more precisely. In China, the conventional urban design and guidelines based on the similar idea. The block was used as the basic unit in urban planning and management, and was assigned with related attribute index.

However, with limited land resources and the increasing population, contemporary urban development breaks through the limitation of plots and blocks, and expands three-dimensionally. We find that in some densely populated intensive development areas, the overground and underground spaces of urban public streets are largely occupied, making possible the joint-development among the connected blocks, and freeing the building construction from the limitation of block boundaries; the urban public space (streets, for example) expands into the building interior, and grows in it three-dimensionally; the property relations among the blocks can no longer be clearly defined in two-dimensional ways, and the relationship between the private space of buildings and the urban public space also becomes vague. Thus, the traditional ways of describing and regulating the urban form are no longer adequate. One of the key techniques to improve the land-use efficiency is urban design which coordinates the different elements in the whole area three-dimensionally, and integrates design with management and regulation, exploring the compact development strategy for intensive development areas.

This article used several urban design projects from recent years as examples, including the Urban Design of Fish Mouth District in Nanjing, the Urban Design of the Central Core Area of Singapore Nanjing Eco Hi-Tech Island, and the Urban Design of the CBD District in Jiangbei New Town in Nanjing, all of which are located in intensive development areas in Chinese new towns. Urban design here is both a creative process and an in-depth technical means, which has significant value in the conception and realization of intensive development in new towns. The main characters of this kind of projects include: 1) the re-definition of development units which break through the limitation of block boundaries; 2) the maximized using and sharing of cross-block overground and underground spaces (Figure 1); 3) the three-dimensional public pedestrian system and public space system; 4) the complex relations among developers and the complex issue of the right to use.

2. Methodology

In intensive development areas, the method to achieve compact and efficient space utilization is the key technique to improve the land-use efficiency. Responding to this, we build in urban design three-dimensional models of the city basing on spatial efficiency. City is no longer defined as the combination of separate blocks, but is organized as an integrity, in which the most compact development is encouraged.

2.1. *Classifying the Element Types*

Strong infrastructure is the basic guarantee for the well-function of intensive development areas. Figure 2 shows several common types of infrastructural elements and their elevation requirements in the Urban Design of Fish Mouth District in Nanjing.

These infrastructures often either promote or prevent the cross-block connections, therefore can be classified into these two categories. The cross-block connection promoting elements help the blocks connect with one another without being divided by streets. These elements usually include: subway station halls, underground pedestrian passageways, overground pedestrian passageways, etc. The cross-block connection preventing elements hinder the blocks from expanding three-dimensionally. Due to their existence, the blocks cannot grow in a certain direction. These elements usually include: subway rails, vehicle roadways, underground utility tunnels, municipal pipelines, river courses, etc.

2.2. Defining the Basic Development Unit

In traditional cities, being cut by streets, city blocks exist as independent cells (Figure 4, left). In modern cities, the growing status of motor vehicles causes the conflict between pedestrians and cars. To mitigate this problem, it is often seen that blocks or plots are connected by underground or overground passageways. Therefore, although separated by streets on the ground floor, the blocks are linked as an integrity on the underground or overground level (Figure 6, middle). In some intensive development areas with small blocks and dense streets, the land is extremely valuable. Separate blocks means a huge waste of space resource, since they would require separate pedestrian entrances and vehicle entrances. In these areas, developers tend to develop several adjacent blocks simultaneously, or to conduct joint-development with the developers of adjacent blocks. The overground and underground spaces of city streets would be largely utilized, and the small blocks would “cohere” to form large blocks. (Figure 4, right)

In order to improve the urban spatial efficiency, urban design anticipates the future basic development units and provides suggestions, basing on the division of the development area by large infrastructures. Figure 5 shows the joint-development units suggested by the Urban Design of Fish Mouth District in Nanjing. The urban design suggested cross-block connections, marked out the areas for the possible connections and the areas for the necessary connections. The overall principles are as follows. 1) The interconnections among the blocks are encouraged inside a joint-development unit, in order to improve the land-use efficiency. As long as the connection-preventing



Figure 1. The cross-block use of underground and overground space in the Urban Design of the Central Area of Singapore Nanjing Eco Hi-Tech Island.

elements are bypassed and the safe operation of communal facilities are guaranteed, the space can be developed three-dimensionally both overground and underground. 2) The connections are limited between joint-development units. Urban design suggests the necessary locations and the ways of connection, in order to minimize the connections in between. (Figure 6)

2.3. Building the System Model

Urban design of intensive development areas is a highly three-dimensional, complex, systematic work. Detailed three-dimensional models need to be built and adjusted in the urban design process according to actual conditions.

The basic method of the elevation design and the model construction can be interpreted as follows. Firstly, the elevation requirements of different elements should be clarified according to their attributes. Apart from the effective space and the structural space required by the elements, other factors according to the engineering experiences should also be taken into consideration, including

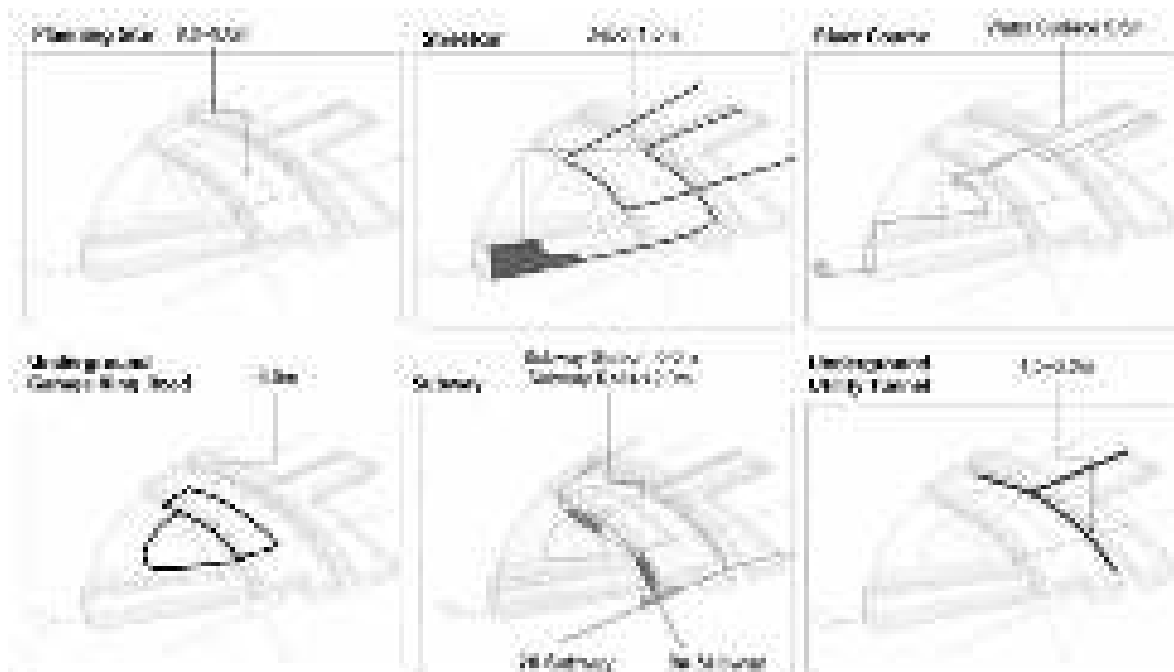


Figure 2. Infrastructural Elements in the Urban Design of Fish Mouth District, Nanjing.



Figure 3. Types of infrastructural elements.

3. Conclusion

The figure consists of three square diagrams, each representing a different urban form. The first diagram, labeled 'Traditional city', shows a grid of streets with four shaded squares representing building blocks. The second diagram, labeled 'Modern planned city', shows a more complex, irregular grid with shaded blocks and a central area with a cross-like pattern. The third diagram, labeled 'Urban sprawl', shows a grid with shaded blocks and several black squares representing commercial or industrial areas.

Traditional city
—Blocks independent & street of city

Modern planned city
—Urban structure is strong, urban blocks and commercial complex

Urban sprawl
—Urban structure is weak, urban blocks and commercial complex

Figure 4. *Different relationships among urban blocks.*

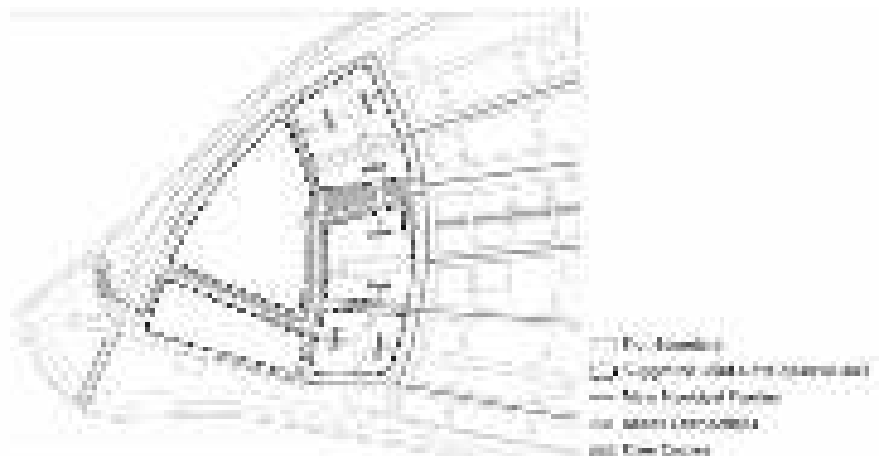


Figure 5. Suggested joint-development unit in the Urban Design of Fish Mouth District, Nanjing.

the integrative design strategy in this kind of urban design, using several Chinese urban design projects as examples. Distinguished from the traditional ways of interpreting urban elements, this article classifies the elements of intensive development areas, defines the basic development unit, and explains the methods of constructing the system model and establishing the systematic rules. It should be noted that, a complete urban design includes the overall process from the concept design to the project implementation. Thus, basing on the ideal concept project, urban design guidelines should be made in order to translate the design concept into practical rules which would effectively manage and guide the urban development in the future.

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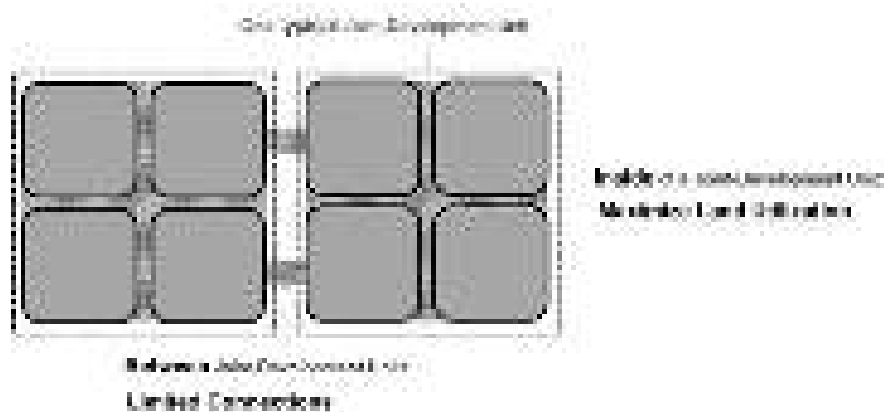


Figure 6. The development principals between urban blocks basing on the joint-development units.

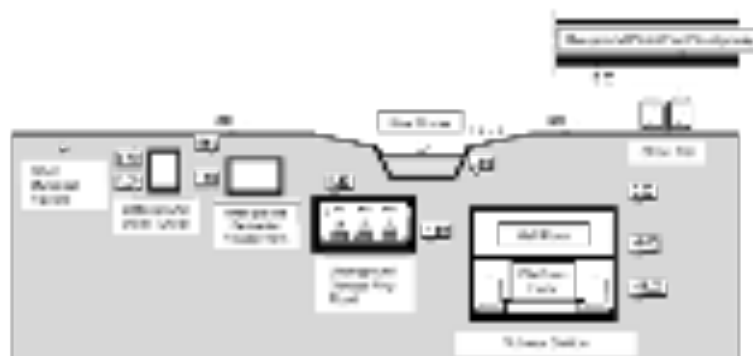


Figure 7. The elevation design of infrastructural elements in the Urban Design of Fish Mouth District, Nanjing.

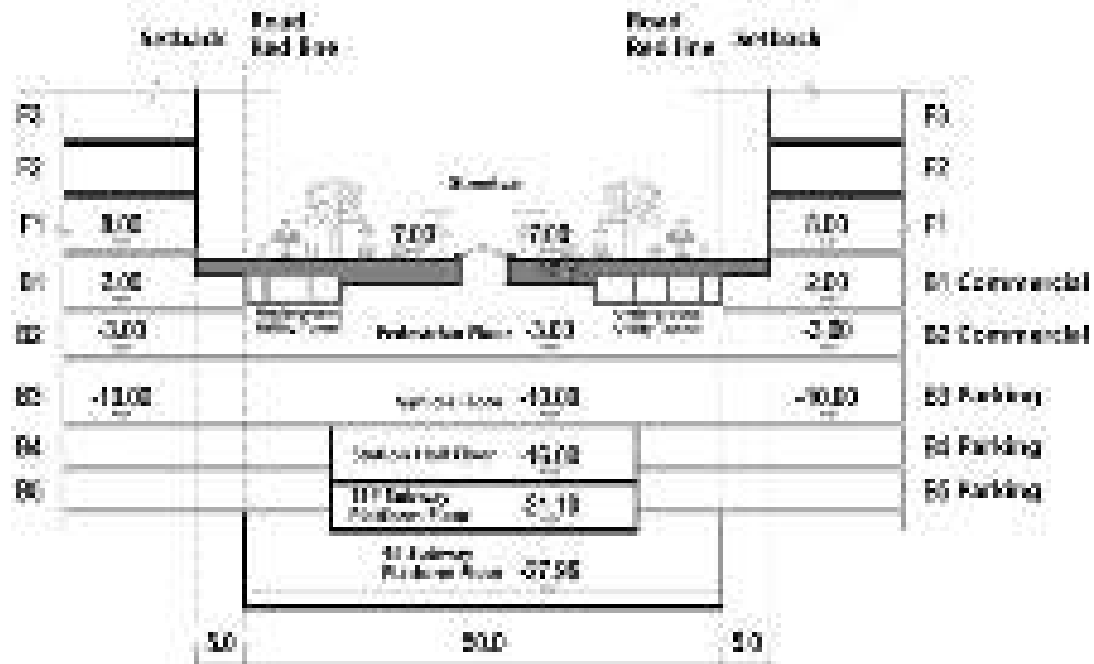


Figure 8. A typical section in the urban design of the CBD district in Jiangbei New Town, Nanjing.

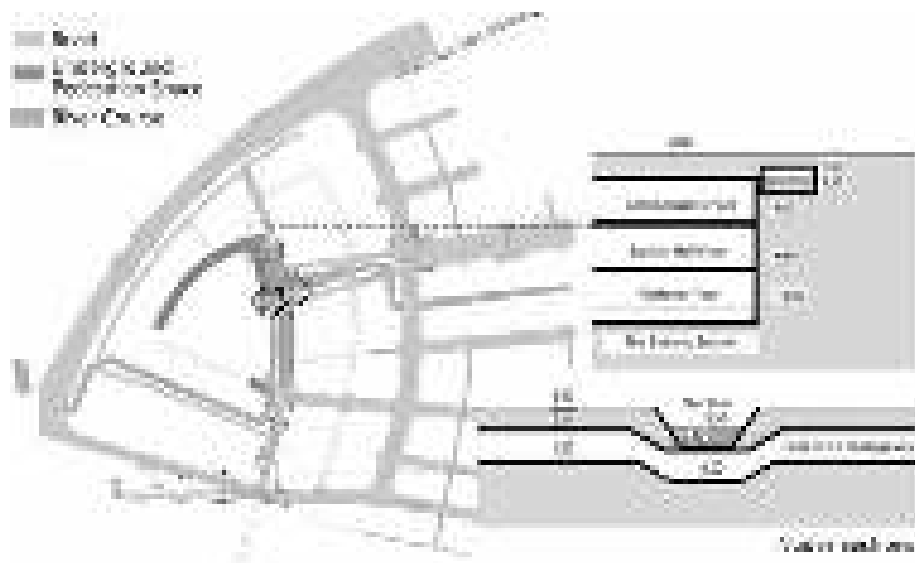


Figure 9. An example of solving the elevation conflict in the Urban Design of Fish Mouth District, Nanjing.

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Urban Tridimensional Special Fabrics: Formative and Transformative Process

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Keywords: urban tridimensional special fabric, multilayer, formative/transformative process.

Abstract: Situated in the contemporary city's formative and transformative processes studies macro area, especially looking for specialized parts, the paper focuses on the most complex and sophisticated example of contemporary urban fabrics: the tridimensional special urban fabric. The purpose is to trace an hypothesis of formative process, starting from the experimental innovation of the XIX century such as the introduction of escalators and elevators and the consecration of the suburban mall's type. Through the formation of wider multilevel fabrics in north-american, asian and arabic cities the process leads up to the actual phase, in which, tridimensional special fabrics, even subjected by several problematic questions, constitutes a source for transformation, aiming at improving urban life quality, very needed in the current suburban-digital urban environment. The last part of the paper is devoted to the current phase and to the analysis of problematics and critical elements of contemporary tridimensional special fabrics. As a result of the study of the formative/transformative process, by continuing critically it in a virtual "future phase" some transformation perspectives conclude the paper.

1. Introduction

The topography of the phalanstery traces an original site which is broadly that of palaces monasteries, manors, and great blocks of buildings in which are mingled an organization of the building and an organization of territory, so that architecture and urbanism reciprocally withdraw in favor of an over-all science of human space, the primary characteristic of which is no longer protection, but movement: the phalanstery is a retreat within which one moves. [...] The greatest concern of this organization is communication. Like the adolescent groups who live together during their summer vacations with constant pleasure and regretfully return home in the evenings, the societaries have only a temporary place for undressing and sleeping, warmed only by a brazier. In contrast Fourier describes with great predilection and insistence the covered, heated, ventilated galleries, sanded basements, and corridors raised in columns that connect the palaces or manors of neighboring tribes. A private place is allowed solely for lovemaking, and even this is only so that the unions made during the bacchanalias, get-to-gethers, or meetings for the purpose of selecting a companion, can be consummated – or 'sealed'¹.

1. Barthes R. (1989), p. 112.

1.1. *Routes and fabrics*

Movement, exchange and communication are at the origins of every human and urban aggregation at every latitude. Routes in its different roles and limits constitutes the permanent witness of the mutual dependence relationship between settlements and movement.

At all the different observation scale they act as vital lymph channels for the construction of the anthropic environment, diatopically, even in remote and distant cultural areas. While connecting these areas, on a territorial and global scale, a route emanates and propels, at the smallest urban and aggregative scale, on its pertinent stripes², the human settling work. A long pragmatism research work for controlling and appropriating the soil, dividing its fertile parts into lots, then defined through agricultural fences, up to substituting agricultural uses with building units, thus slowly reaching the formation of a mature urban fabrics.

The same interscalar route plays an important role at the territorial scale, but also produces and contaminates the urban fabric and its component parts, the buildings units. Both in base building and, more clearly, in its specializations, building production is largely based on a spontaneous and critical organization of external and internal spaces through hierarchies of routes and polarities/nodalities, all synthesized in the routes' system. Tridimensionally introjected into base units (row houses) or special ones with their nodes (stairs, elevators, escalators, all understood as nodalities and as tridimensional/vertical overturned paths) and internal polarizations-compartments, routes reproduce at the building scale the anthropic phenomenon of fabric production, a complex behavior characterized by a high degree of mutual solidarity and hierarchy between the component parts. This fabric can be investigated in its structural configuration as composed by travel lines (routes) which interconnect significative points (poles) in a network controlled at the intersections by other key elements (nodes), that express on their own pertinent stripes 'human settlement' activities. This dynamic system, at least in the western world, tends to be organized in blocks and related specializations/transformations, even at the smallest scales: from furniture to the scale of the domestic setting and objects³.

But, routes in contemporary built environment assumes an even more significant and important role than in the past. In a context where, real and virtual, accelerated movement of people, goods and ideas take progressively largely areas of interest and business, routes and movements represents themselves as first elements to be taken in consideration. As in the quoted *Utopian community* of Fourier, the places for exchange and communication conquered the very heart of the built environment, reducing individual residence to smaller and smaller units, almost only a bed to sleep.

Huge urban systems of contemporary world, from western ones like London, New York, Paris to those of the ever-growing eastern cities, such as Mumbai, Shenzhen, Hong Kong, Singapore or Tokyo, all manifest a behavior and a scenario assimilable to what just exposed. Even if located in different territories and cultural areas, once not very connected due to big distances separating them, both in an urban context and in a suburban context, all they are increasingly innervated and based on routes, physical and virtual communication channels.

After the end of industrial era, the substitution of the horizontal and linear development model that regulated the production of human settlements up that moment with the network model, gives the main role to the routes' network nodes and poles. Thus, the settlements that

2. Caniggia, G. (2017), p. 108.

3. Introjected urban fabrics; building scale, see: Strappa (2014), p. 119; Buongiorno V. (2019); smaller scales, see: Cipolla A. (2015), chap. 1; Regazzoni Caniggia A. (1982).

constitute such polarities and nodalities, know a progression and sophistication, carried on through processes of specialization and horizontal/tridimensional transformation.

New routes with unprecedented vehicular traffic flows quality and quantity strongly modify the existing route network and build new ones. The new specialized accelerated traffic flows and their incompatibility with traditional routes, leads to the formation of specialized route's surfaces designed to fulfill the new technical requirements (slopes, curvature radius, a layout conceived for automobile use), of new specialized territorial nodalities resulting from the *bypass* and the *flyover* route's specializations⁴. New specialized nodalities that project the network of routes in a tridimensional perspective, able to allow the access to the intersection for many users without interferences of different traffic flows and directions⁵ (see Figure 1).

The tridimensional nature of the network and its consecration in nodalities/intersection is an unprecedented fact and a harbinger of important changes. In the contemporary context, from XIX century, it is possible to observe the development of experimental projects for new fabrics, coherently with the changed character of the routes, which firstly become extremely faster (through the railway and car transport introduction), to dematerialize later with digitalization.

But the design for new built environment able to fit rapid changes of modernity soon clashes with difficult or almost impossible renunciations. The fabric is one of these problematic topics.

Fabric, an anthropic necessity, as indispensable and inherent in the deepest soul of man is the act of walking to reach remarkable places/poles (religious, civic, for trade, etc), and that of identifying walking lines-trails-paths-route, "reading" the territory, its topography and the lines and parts most suitable to be traveled.

To this urgent need, man of the contemporary age, member of a *car-oriented*, suburban society, having reached a state of maturity in which it is difficult to control an oversized urban phenomenon, responds with the formation of new fabric types, new urban nuclei that can satisfy the ancestral needs of urbanity even if inserted within the suburban organism, to give to suburban inhabitants a place for sharing and community activities, almost an extract of the old traditional city, with its thick fabrics, to which it had been accustomed for millennia.

This new fabric takes on a built and typological form, throughout the XX century, through a long and complex process in the new type of the Suburban Shopping mall⁶. It is a fabric positioned at the special routes network's nodalities/polarities and settled on specialized pedestrian routes within a *bypass* route which distributes traffic and vehicle parking on several levels, by extracting them from the internal pedestrian fabric. The suburban mall constitutes that piece of city to which the man of the XX century cannot give up, a city that is often a simulacrum and masks for private and commercial purposes, that in his morphology, meanwhile shows the resistant traces of spontaneous ancestral anthropic urban acts. Above all, Suburban mall has a foundational importance because it represents the first example of a specialized tridimensional fabric, resulting from the fabric's formation on routes, in proximity to the routes' network nodalities, which for their high specialization intersect and polarize each other, on several levels, through the use of bidimensional or tridimensional *bypass* knot that allow the total absence of mutual interference among the numerous traffic flows.

Special tridimensional complex fabrics will bring the innovative formative processual tools of the mall's specialized fabric to the extreme consequences. Using specialized and multilevel

4. *Bypass route*, see: Liebs C.H. (1995), *Flyover*, see: Hindley G. (1972).

5. Hindley G. (1972); Buongiorno V. (2019), pag. 27-37.

6. Buongiorno V. (2019); Strappa G., Buongiorno V. (2018).

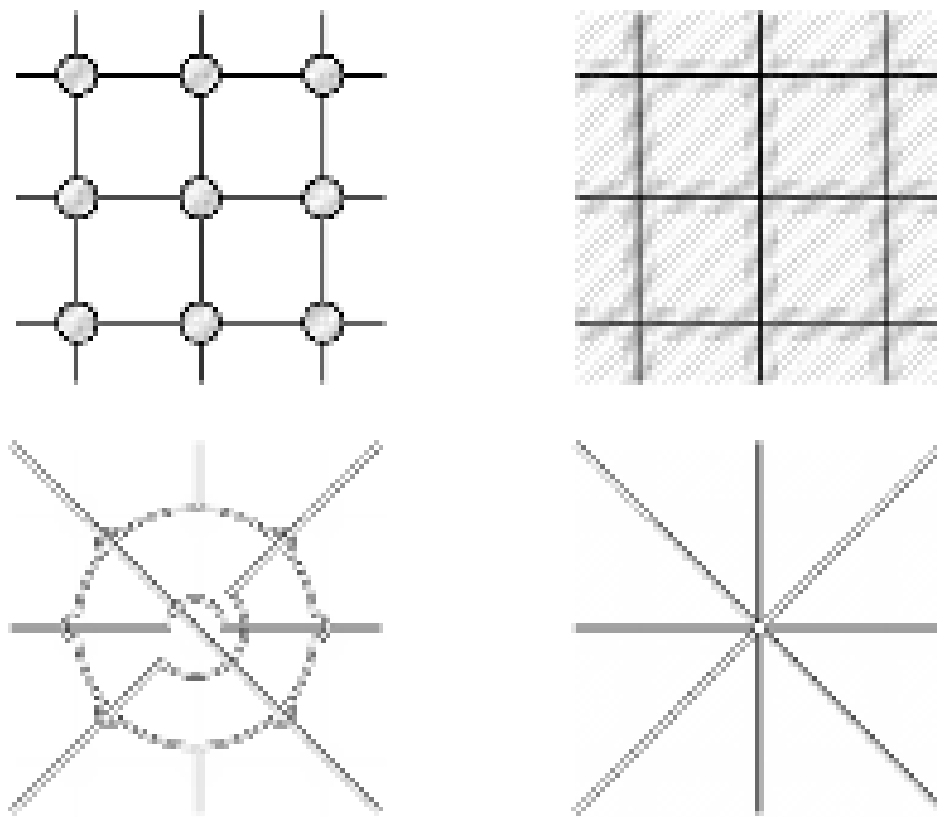


Figure 1. Routes networks compared morphology, by Buongiorno V. (2019) (a. Specialized routes network with main nodalities settled into bypass route rings; b. Traditional territorial routes network with settlement on the route's pertinence stripes; c. Specialize multilevel fly-over nodality; d. Traditional one level nodality).

bypasses and flyover nodes together with escalators, elevators and travelators, in contexts of high population density, in urban or periurban areas, since the late II postwar period, a new fabric type distinguished itself for its development on multiple levels, in height, and for the complex hierarchy of specialized routes that interconnects individual buildings (often towers) through walkways and bridges at high altitude and/or underground paths.

The evolution of new tridimensional fabric, from suburban mall up to its results of the third millennium along with its formative and transformative process are the subject of this paper.

The process will be illustrated by referring to case studies of cities characterized by the presence of fabrics located in North America, Asia and Arabia, built ensembles at high altitude such as Honk Kong, Shenzhen, Minneapolis or Ryahd or at underground level, such as Montreal.

2. Methodology

The interpretative work, in the conviction that it is useful and profitable for the scientific reading of the built environment, to carry out a structural analysis aimed at understanding its characteristics and operating processes as an organism, focuses on the methodological concept

of route as a supporting axis for settling activities in all eras, also and above all the contemporary one. Thus, the research is set within an horizon in which building, aggregates and urban organism are read as belonging to

[...] a process in which, after the formation of the paths that results from the recognition of the soil suitability and the orographic shape for travelling, the act of building as a further “finalized transformation of matter, can be read as a specialized modification of a part of the territory, particular technical-economic moment within the anthropization process: individual finalization of the operation, which will be followed by a collective finalization and an organic synthesis⁷.

Simultaneously to investigate the built environment, the reality of the organism is observed at the different scales, in its globality, taken into consideration beyond the single datum of route(s), by referring to dyadic couples of opposite and complementary elements of the settlement system.

It is possible to read the formation and first transformation of territorial structures through a fundamental dyad of opposite and complementary terms composed of ‘paths’ and ‘settlements’, linked to motion and to rest, according to the primordial needs of man to feed and protect himself and attributing to the term ‘settlement’ the meaning of a temporary or stable structure consisting of a set of dwellings organically linked to a complementary productive pertinent area⁸.

The interpretation, carried on through the comparative observation of emblematic case studies, is aimed at tracing an hypothesis of the type-morphological formative process that led to the current phase and configuration of these settlement organisms, by using the tools of the tradition of Italian processual typological approach studies in Urban Morphology⁹.

The goal is to observe the contemporary built environment organism in its globality and processuality, beyond contradictions due to changed economic, social and technical conditions, and searching instead for a deep genetic, diachronic, internal logic¹⁰.

In the critical reconstruction of the formative process the built reality of existing tridimensional fabrics is subjected to comparative analysis together with that virtually built and existing in the critical conscience of the modern architect-author, of unbuilt projects. The latter, although not concretized in the built reality, are considered as a fundamental part of the process. Therefore, for example, the case of Parisian *passages* specialized fabric and that of unbuilt tridimensional specialized fabrics like the London *Pedway* or Fourier’s *Utopian city* are simultaneously considered in the type’s formative process.

Finally, looking at a processual design perspective, in which the architect’s authorial design proposal is the result of a critical interpretative reading and conscious relationship towards the ongoing formative process¹¹, the paper proposes some future transformative perspectives.

7. Strappa G. (2016), p. 25.

8. Strappa G., Ieva M., Dimatteo M.A. (2003), p. 17; translated by the author from the original text: “È possibile leggere la formazione e prima trasformazione delle strutture di un territorio attraverso una fondamentale diade di termini opposti e complementari composta da ‘percorsi’ e ‘insediamenti’, legati al moto ed alla sosta in funzione dei bisogni primordiali dell’uomo di alimentarsi e proteggersi, attribuendo al termine ‘insediamento’ il significato di struttura provvisoria o stabile costituita da un insieme di abitazioni relazionate organicamente ad un’area complementare produttiva di pertinenza”.

9. Strappa, G. (2018).

10. Strappa, G. (2017).

11. Strappa, G. (2018).

3. Analysis/Results

3.1. Formative process

New specialized routes and fabrics

While the path in the “traditional” fabric acts as a *centralizing axis*, a generative line but at the same time also a virtual and permeable frontier between the portions of settlement arisen from its two pertinent stripes, the contemporary path is instead a *dividing line*¹², an impermeable border between the two parts of fabric, which generates division and segregation.

The clearest and most mature manifestation of a contemporary path is represented by the *highway*. In its mature, urban, extra-urban and territorial/landscape version, it is a divisive element, a specialized traffic channel, rather indifferent towards the territories it crosses, connected to the territory only through specific episodes, toll gates (poles) and flyover intersections (nodes). Such a specialized element, in a suburban context, produces a new settlement pattern, that of the suburban city in which the aggregation organism develops by placing the settlement unit (single-family house-bungalow) in the middle of the plot. No longer in adherence and osmotic solidarity to the route, no longer according to a row aggregative principle: the path is reduced to a mere transport channel, deprived of its urban generativity (see: Figure 1).

The formative process of highway route type, backwards, includes among the oldest examples of specialized route/fabric. An example is given, in urban context, by the Parisian Boulevards introduced with the transformation plan by Haussmann. In the dense fabric of narrow medieval paths, the plan adopted in 1852 introduces *break-through routes*¹³, which in their cross section's configuration (width and adjacent pertinent stripes arranged as a garden, almost analogous to what will take place in the modern highway more radically isolated from the territory) and longitudinal extension, proves to be designed for an increased traffic flow. Thus, they act as dividing lines, impermeable barriers for pedestrian and urban life, erected in the living body of the city.

In response to this problematic situation, the construction of *passages* system is the first attempt to create a parallel and superimposed network of specialized routes dedicated to pedestrians and the retail function to allows the rational separation of traffic not compatible (see: Figure 2). The *passage*¹⁴, progenitor of commercial galleries and Arcades has the advantage – similarly to what will distinguish, later, suburban shopping mall – of a tranquility in relation to the of the boulevard's high traffic flow dangers, for walking and making comparative shopping.

Almost simultaneously, Fourier's utopian community city¹⁵ prefigures, from another perspective, a development of specialized routes that bypass the ground floor level traffic and are dedicated exclusively to pedestrian use, indeed conceived as ‘*social condensers*’. These new aerial routes can be interpreted as a tridimensional evolution of several original experiences that go in a similar direction: on one hand, *passages*, built in the urban block's courtyard spaces as new specialized *contradas*, on the other hand the commercial galleries, arcades and department stores, set up in the courtyard space through a process of specialization and urban knotting borrowed by other typological processes (monastery, palazzo)¹⁶.

12. *Asse accentrante/accetrating axis* and *linea dividente/dividing line* notions, see: Strappa, G. (1995), p. 82.

13. Caniggia (2017), p. 115.

14. Geist, J. F. (1995); Lemoine, B. (1989).

15. Barthes R. (1989), p. 112.

16. Buongiorno V. (2019), p. 109-116; Strappa, G., Buongiorno, V. (2018).

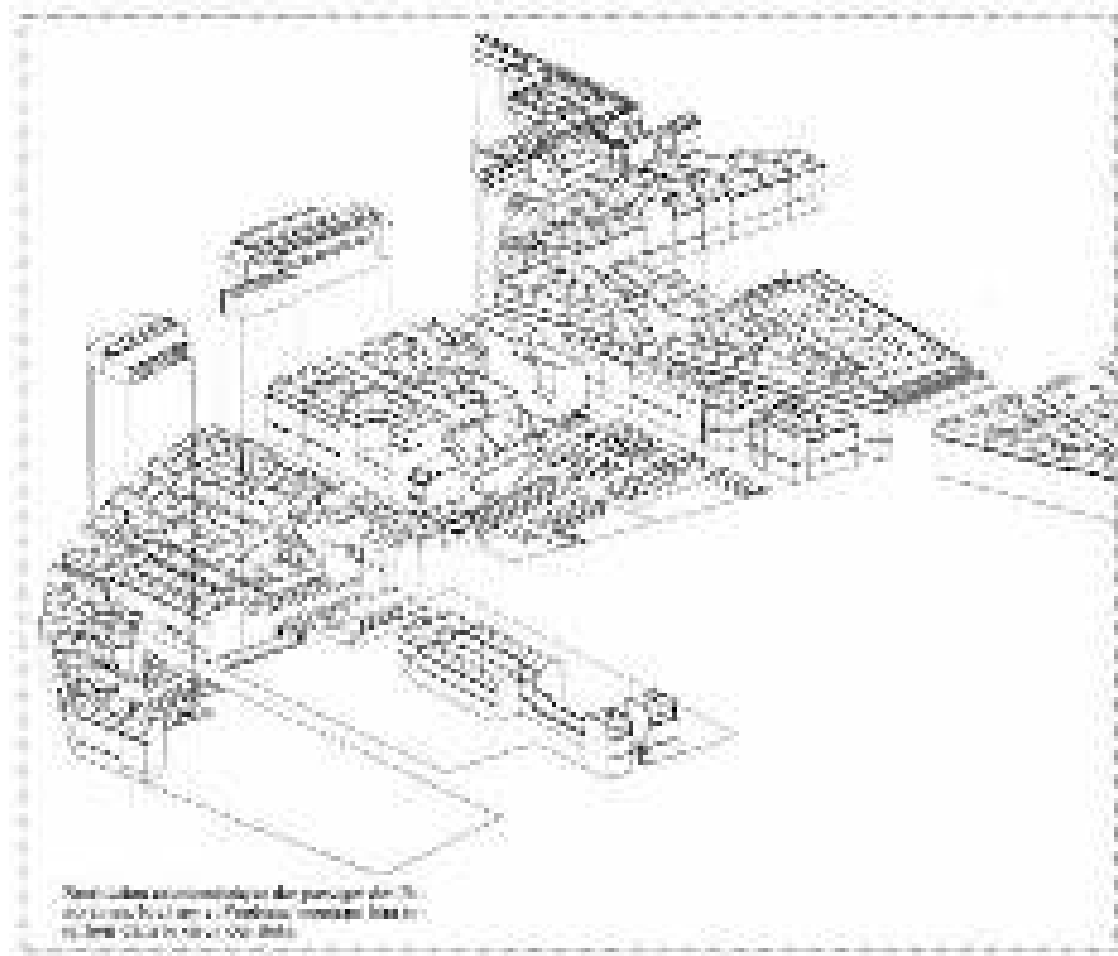


Figure 2. *Parisian Passages*, early special pedestrian routes network: Panoramas, Jouffroy and Verdeau sequence, by Lemoine, B. (1989)

The transition process, from path as a *centralizing axis* to *dividing line* has various and complex times and dynamics in the different cultural areas.

At different times, in all the cultural areas in which the process of transformation and specialization of paths and related built aggregates, between the two mature phases¹⁷, there is an intermediate phase which shows the tendency towards specialization of contemporary routes using tools and dynamics of traditional paths and fabric. This phase produces contradictory situations of clogging and incongruity such as those of American downtowns or European historical centers. Starting from the first decades of Haussmann Paris and then, more decisively, from Los Angeles region during the first decades of the XX century – a real experimental laboratory for the development of specialized routes and fabric – the simultaneous work of transformation and specialization of existing fabrics (downtowns) with the introduction of specialized motor vehicle routes within them¹⁸ along with the development of new downtowns in the suburban area such as the *Miracle Mile*, constitute a sort of compromise between old and the new, urban and suburban¹⁹. Only later the development of suburban specialized fabrics such as those of the *Suburban Shopping Mall* will lead to the formation of the mature type of tridimensional specialized fabrics.

Suburban fabrics specialization and bidimensional bypass routes

Located in polar and nodal positions within the grid of specialized routes that structure the suburban territorial organism, new fabrics are born in response to the incompatibility of the old urban fabrics – clogged for forced grafting of specialized motorway routes within them – to suburban life in its aspects of social, economic and cultural exchange.

Taking in consideration the experience of downtown and *miracle miles* clogged by the traffic flows of the suburban car-oriented city and the weak attempts at resolution through the creation of special bypass routes that distribute the fabric without clogging it, therefore allocating it to a non-exclusive pedestrian fruition, in the middle of the XX century, the formation of the modern suburban shopping mall constitutes a key point in the process of development of the contemporary tridimensional specialized fabric.

The *mall* constitutes the simplest form of highly specialized fabric in the contemporary city. Through the use of a special *bypass route* that excludes internal routes from vehicular use, it operates a separation of traffic, fruition and flows that will be the basic element in special tridimensional fabrics characterized by different simultaneous uses and traffic flows at various levels. In the mall, as in the others nodalities/polarities of the special route network, it is already possible to observe some important route's knotting devices, such as the *flyover* node, which allow the coexistence and the mutual and controlled exchange of different traffic flows otherwise confused and paralyzed.

On the smallest scale, inside the mall and specifically in its *anchors* – department stores²⁰, mindful of their downtown antecedents, it is possible to observe a tridimensional use of the routes, developed in continuity horizontally and vertically, by using the innovative perpetual movement allowed by escalators²¹.

17. Mature urban traditional paths and aggregates – mature suburban paths and aggregates.

18. Hindley G. (1972).

19. Longstreth R. (1997); Liebs C.H. (1995).

20. Coleman P. (2006).

21. Chung C.J., Inaba J., Koolhaas R., Leong S.T. (2001), pp. 337-369.

Mature tridimensional developments

The vertical overturning of paths, combined with their differentiation and specialization, within the mall, are the pre-set for the subsequent development, a specialization process at larger scale.

Being part of the same process mall's formation and specialized tridimensional fabric's development are closely interconnected. Looking at functional matter, for example, it is possible to evidence that from the first elaborations the tridimensional specialized city, similarly to mall, is experimented as a fabric, firstly in the field of leisure, space for pleasure and fun. Thus, Fourier's utopian city is clearly mindful of Palais d'Orleans' *Galleries de bois*²², the first case of specialized routes for pedestrians and for commercial use. Looking instead at more recent histories, in the mid-XX century, Victor Gruen²³ is a key figure of this close-knit relationship between the development of the mall, of which Gruen is considered the father, and that of tridimensional specialized fabrics. He simultaneously works in his prolific firm, on suburban mall projects such as *Southdale center*, (Edina-Minnesota, 1956), and pedestrianization projects for downtowns, degraded and abandoned after the migration of inhabitants to the suburb such as Multon Pedestrian Mall (Fresno – California). Gruen's importance in the gradual development of the idea of a multi-level specialized fabric by transforming abandoned downtowns is also evidenced by his active presence in the CIAM 8 congress²⁴. The application of the theory developed in the experimental *in vitro* mall fabric, at the urban scale of real cities will produce important results.

Europe and especially London is, for the quantity and quality of proposals produced during the immediate post-war period, the nerve center of the elaboration of multi-level specialized fabrics. In this city, rich in ideas also contributed by immigrants soviet avant-garde authors, escaped from stalinist Russia, it is possible to observe two distinct seasons devoted to the reflection on this topic.

A first thought school, inflated by orthodox modernity ideas, with analytical separation of traffic and faith on the Corbusier predilection for the straight path against the *donkey path*, is then followed by interesting critical elaborations which attempt a problematic dialogue between the demands of the modern city and those of the urban heritage coming from the European historical centers, where often the proposals were to be inserted to fill the gaps produced by the Second World War destructions. If the first group of reflections can be emblematically represented by the theoretical and practice expression by L. Hilberseimer (*Highrise city*, 1924), Le Corbusier (*Centrosoyuz building*, Moscow, 1928-33) and soviet architectural environnement (B. Lubetkin's *Avtostroy town*, 1932)²⁵, the second one can be instead exemplified by Team 10, Candillis-Josic-Woods (*Toulouse Lemirail*, 1963; *Project for reconstruction of Frankfurt Romemberg*, 1963), A. & P. Smithson (*Berlin Hauptstadt*, 1957-58)²⁶ proposals. London itself is also the subject of many proposals, such as that of the *Pedestrian way* and the project for the *Blitz area*²⁷.

As in almost all cases of proposals developed in the European context, even constituting important steps in the process, most of them remained unbuilt. They were mostly projects on existing historical areas and buildings or on areas located next to the historic city that

22. *Ibidem*, p. 32.

23. Victor Gruen (1903-1980), American Austrian architect, specialized in the design of commercial spaces and suburban shopping malls and in the last part of his career urban fabrics with commercial specialization through various pedestrian mall and tridimensional special fabrics projects for American and European cities; see: Wall A. (2005).

24. James V., Yoos J. (2016), pp. 96-99.

25. *Ibidem*, pp. 72, 40-41.

26. *Ibidem*, pp. 66, 78, 77.

27. *Ibidem*, pp. 214-215.

experienced the strong resistance to modern architecture and urbanism of the European conservation culture.

The rich and prolific phase of elaboration that took place in the second post-war period, mainly in London, had further overseas results, in former British colonies, such as Hong Kong (P. Abercrombie, *Preliminary planning report*, 1949; *Colony Outplan document*, 1969; *Connaught place project*, 1970) and Singapore (*People's park centre*, 1970; *Golden mile complex*, 1974)²⁸.

But the huge work on this topic had also other unbuilt outcomes, through the activities of teaching and professional transmission to future generations of architects trained in British/anglophone universities such as AA in London or, Harvard and MIT in US.

In these universities and in the important linked professional firms, the idea of a multi-level specialized fabric in its critical elaborations has populated debates and projects during many decades. Many Asian and North American students, such as the Canadian urban designer Vincent Ponte (1919-2006), designer of the “Ville Souterraine” underground system in Montreal²⁹, will find back in their birth countries fertile conditions for the development of multi-level ideas studied during university years.

North America and Asia resulted as the most important areas for the development of tridimensional fabrics. Some more recent developments are concentrated also in the Arabian area such as that of Riyadh aerial enclosed city. All these are contexts in which the specialization and creation of dedicated specialized pedestrian networks responds to the problem of the incompatibility among pedestrian use and vehicular dividing one (Mumbai³⁰, Hong Kong, Singapore), increased in many cases (Montreal, Riyadh³¹) by climatic conditions that, during long periods of the year, makes the pedestrian use of the mixed route uncomfortable, strengthening its character of dividing line (see: Figures 3 and 4).

4. Discussion/Conclusion

4.1. Current challenges and transformation perspectives

Regardless of their differentiated development, at high/aerial or low/underground levels, all special tridimensional fabrics constitute the mature evolution of the suburban mall: fabrics made up of special routes and polarizations that all together recreate a synchronic concentrated urbanity, sort of compensation to the lack of sociality and community sense of contemporary suburban digital society.

Although the intentions, these *in vitro* cities are actually facing big problematic issues produced by innovation and changes in each hosted activities. Generally, the digitalization process, for example the introduction of e-commerce or digital smart working, produces changes of needs for spaces in this special fabrics, that origin of a strong crisis. Furthermore, these fabrics share the problematic behavior and related future challenges due to an high level of impermeability in relation to the surrounding context and a strong autonomy.

While in the case of the mall, a further fabric specialization process aimed at diversifying the activities hosted within the fabric (beyond the mere goods' sale activity, nowadays carried out mainly via e-commerce) is still at the beginning, in the case of tridimensional fabrics, in-

28. *Ibidem*, pp. 113-115; 210-211.

29. Deglise F. (2008); Boisvert M. (2011).

30. N. Mars, *Landlink* project, 2013; see: James V., Yoos J. (2016), pag. 204-205.

31. James V., Yoos J. (2016), p. 206.

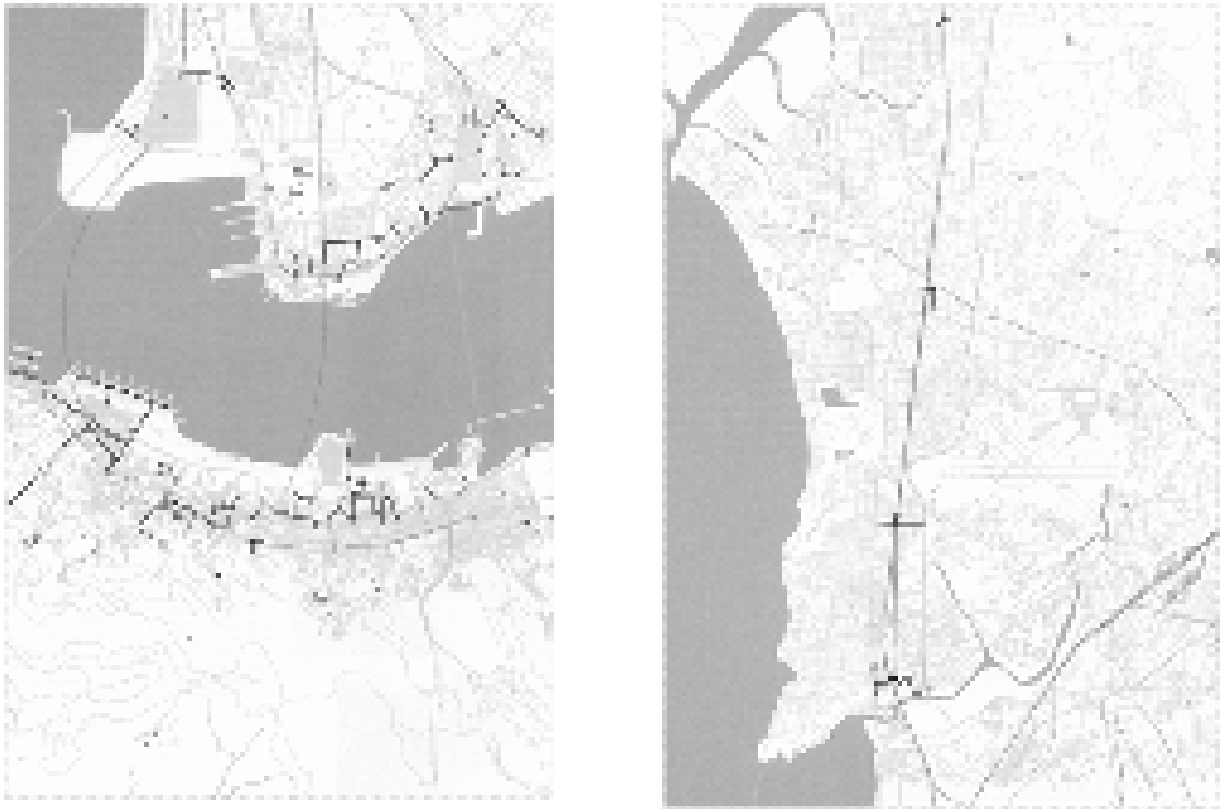


Figure 3. *Bypassing traffic flows: Hong Kong and Mumbai pedestrian aerial tridimensional routes fabric, by Yoos, J., James, V. (2016).*

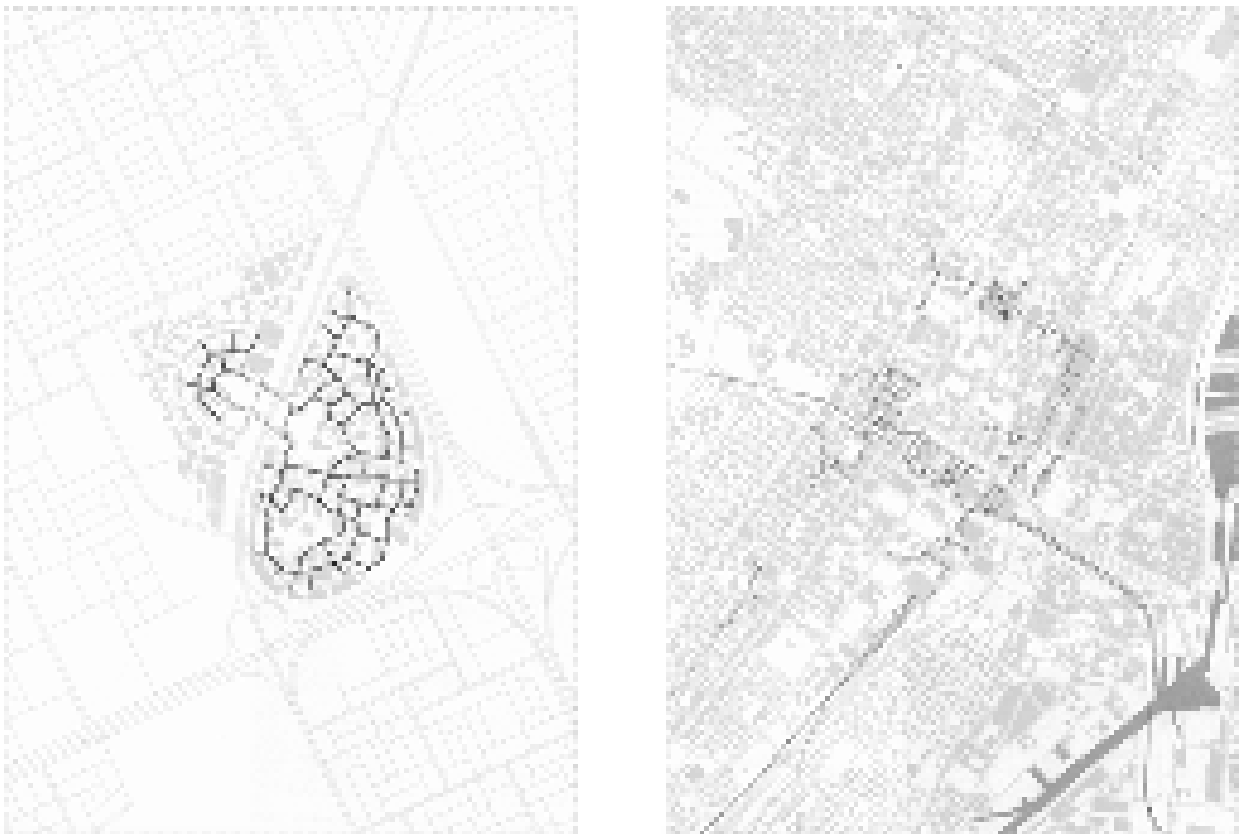


Figure 4. *Bypassing rigid climates: Riyadh and Montreal pedestrian aerial/underground tridimensional routes fabric, by Yoos, J., James, V. (2016)*

stead, a similar process is already been partially developed. The many cases of tridimensional fabrics that include community polarities, which favor the character of public space, testify a much more ancient reflection about this problem, in the context of planning practice and theoretical reflection³².

The suburban shopping mall and retail in general in its formative / transformative process is going through a delicate phase of redefinition of spaces, in which the activity of physical exchange passes to have a secondary role, surpassed by that of goods' cultural and sensorial experience. This fact leads to important physical transformations for the mall's fabric: as it is no longer necessary the storage of large quantities of goods in warehouses, the commercial units are consequently transformed, reduced in surface, multiplied/subdivided and at the same time the space dedicated to the public is expanded and acts, both at the building and at the aggregative scales, as a cultural community functions' propeller. In the perspective of accentuating this social and community condenser character of the commercial suburban mall, the fabric itself, in addition to the single building units, can specialize by knotting its courtyard spaces, previously dedicated to the storage and loading of goods³³. These spaces become community places, after the further specialization process, lead the fabric itself to act as a new urban core for the suburban city.

The future transformative perspectives for tridimensional specialized fabrics, similarly to those of suburban malls, go in the direction of a redefinition of fabric's main spaces and transformation of residual ones, such as spaces resulting from the introduction of *smart working*, with few need in term of office spaces, and *work digitalization*, with a strong decrease of needed space for archives.

These emptied spaces can become new places for community, true collective polarities that can act as new *anchors* for a non-commercial civil and social pedestrian flow.

The realization of these community polarities is a typological updating action for these fabrics, it drives them in the direction of greater connection, accessibility and enhancement of routes and polarities as public spaces. Meanwhile, it goes in the direction of counteracting the tendency of special fabrics to behave as closed enclave. This tendency is actually favored by the intrinsic development on several levels at different heights and, therefore, by the discontinuity of routes which even interconnected through escalators' perpetual movement, show a less spontaneous walkability.

The presence of strong community polarities on the upper floors, aimed at giving spaces for all citizens and not just closed groups of customers, constitutes a tool to confer, as in the horizontal suburban city, an urban core to the dense contemporary tridimensional city, by transforming special fabrics from being segregated "functional machines", to "new urban centers"³⁴.

In the described transformational perspective, specialized tridimensional fabrics, both those resulting from transformation and specialization of the old traditional downtown-historical centers, the ones newly formed in the suburban city or those located in the *edge cities*³⁵, after the proposed further specialization become new urban centers for contemporary city, with their routes and polarization's network as backbone of urban living.

32. Refer to the definition of the aerial routes' network as social condenser in Fourier, to the already quoted soviet works by B. Lubetkin, to those presented at the CIAM 8.

33. Refer to existing cases such as *Mall of America*, Minneapolis, US, and to the transformation perspective described in: Buongiorno, V. (2019), pp. 126-148.

34. By paraphrasing Victor Gruen's proposal for the mall's transformation, from "selling machine" to "new urban nucleus"; see: Wall, A. (2005).

35. *Edge cities*: large tridimensional fabrics located in periurban areas, next to large infrastructures, dedicated to mixed functions (offices, hotels, etc), see: Dunham-Jones, E., Williamson, J. (2011) pp. 172-200.

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The Street as a Three-Dimensional Urban Form

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Keywords: visual complexity, spatial information, design practice, interdisciplinary methods, street layout.

Abstract: In urban morphology research, as well as in practice amongst urban design professionals, there is often the challenge to understand the different elements of urban form as three-dimensional processes and not only as two-dimensional forms of spatial information. The purpose of this paper is to undertake an initial critical analysis of the street as the basic unit of space in our experience of the city as a three-dimensional urban form. The richness of subject matter presented by cities and their nature of street form and configuration has given rise to an equal richness in methods of investigation. As such, this research develops a measure for assessing the physical complexity of the built environment by generating cross-sectional data of streets comparing different cities. The first aim is to demonstrate an automatic, scalable and reproducible method to measure and visualize street cross-sections, revealing spatial patterns that are of visual importance. The second is to identify the morphological properties shared by clusters of cases, understanding aspects of urban design and development form. Findings of this study reveal a taxonomy of street typologies through classification, offering a composite view in which different morphological approaches are combined and providing a better understanding of how urban streets constitute the set of spatial relationships that determine the morphological identity of cities.

1. Introduction

The paper begins by reviewing literature that examines urban morphology from the point of view of its physical three-dimensionality, which has been prevalent in urban design practice, but often overlooked amongst studies in urban morphology research. Our focus on the three-dimensionality of urban form is the street. In a rapidly urbanising world, the challenge to better understand the relationship between urban processes and the built environment is through one of the most essential spatial elements of what composes the largest public realm of any city, the street. We believe that the street as spatial component of cities is the generator of different typologies of movement, a driver for facilitating economic transactions and the common denominator of creating place. To explore the spatial qualities of the street, a method to generate street cross-section, here after referred to as street profile, using data and analyzing cities in terms of data and analyse cities in terms of the visual complexity given by the variance of street profiles typologies within a local spatial unit.

Research aimed at looking at the element of the street can be distinguished in two main directions: Firstly, in urban morphology, typo-morphology and historical-geographical studies (Moudon, 1997; Samuels, 2008; Gil *et al.*, 2012) typically applying qualitative and descriptive approaches (Oliveria, 2016) and secondly, spatial analysis, displaying analytic and quantitative methodologies (Hillier *et al.*, 2012; Batty, 2013; Barthelémy, 2015). In this paper we continue the endeavour to bring these approaches together to a common framework of spatial information. Of particular importance to this endeavour is the idea of street profiles as representative of a city's urban DNA, which we believe is central to urban planning and design. However, on closer scrutiny of street typologies, in urban research and in practice they remain vague capturing most of the times a two-dimensional understanding of streets and its spatial layout rather than the three-dimensional performance and functionality of streets, which usually links aspects of density, vertical land uses, demand of types of mobility and even visual features that help ease of wayfinding (Conroy, 2003). Therefore, the aim of this paper is to propose a systematic and applicable methodology for generating street profiles from existing data sources, compare their spatial ordering and what this means to the character of place for each city, which is an essential driver of many urban processes (Hillier *et al.*, 1993) and relevant to urban design practice.

The paper is structured as follows: First, the role of complexity theory in urban morphology is given and the role of street types in the wider context of urban morphology research. Second, the methods for generating street profiles and measuring 'visual complexity' in terms of the variance of these profiles at a local scale are discussed. And third, the analysis and results are presented, where we analyse six different cities and compare them by both the typologies of street profiles present in them and their spatial distribution, which in turn draws our conclusions and formulate discussions for further research.

1.1. *Defining typology through spatial complexity*

Cities are an example of large complex systems (de Roo & Rauws, 2012) that display emergent phenomena and self-organized structure (Batty, 2009). On one hand, some of the principles to understand the complexity of cities have not only been focused in their planning and design, but also in the dynamics of emergent or spontaneous urban order, in the spatial structure of the city, its connectedness, accessibility, resilience, and robustness – factors which help linking qualitative theories of cities and quantitative studies of physical form, design and transportation (Portugali, 2006). On the other hand, the task in city planning has become less one of creating order through rational urban plans and spatial planning, but one of how to generate and maintain urban complexity that drive healthy urban processes.

Research on complexity theory of cities has found that to achieve a healthy urban environment, urban design and planning can encourage diversity, connectivity, resilience, and robustness (Batty, 2013; Barthelémy 2016). As Alexander (1977) states, one way of addressing this is to try to understand the underlying complexity and character of different places to better understand them. To help meet this task, we need to understand both the complexity of cities and the ways in which it could be generated through planning or design (Marshall, 2012).

1.2. *Street network measures and design*

Of importance to this endeavour is the role of streets, their spatial configuration and topology in articulating urban life, as they help organize the human dynamics within cities, influence travel behaviour, location decisions and the texture of the urban fabric (Giacomin & Levin-

son, 2015; Jacobs, 1993). Accordingly, researchers have devoted much attention to street network patterns, performance, complexity and configuration (Barthelemy, Bordin, Berestycki, & Gribaudi, 2013; Batty, 2005). Urban scholars and planners have studied street networks in numerous ways, most of which have focused on urban form and transportation, and others on the topology (Porta, Crucitti, & Latora, 2006), complexity (Boeing, 2018), resilience, and evolution (Murcio, Masucci, Arcaute, & Batty, 2015) of street networks. Yet, most of this stream of research has focused only on the two-dimensional nature of streets.

The role of streets in creating healthy urban environments is not only given by their spatial configuration and topology at a city-wide level, but also by the quality and character of the street space as experienced at eye-level. As Smailes (1955) highlights, it is through the third dimension that much of the distinctiveness and variety of urban spaces arise. Research in this area has been mostly focused in the streetscape as a basic urban element which plays a major role in the 'livability' of a city (Cavalcante *et al.*, 2014). The physical and perceptual qualities of streetscapes directly influence how people interact and locally behave in the city (Ewing & Handy, 2009; Ewing, Handy, Brownson, Clemente, & Winston, 2006).

There have been recent attempts to quantify streetscape quality at a local level in systematic ways. For example, street-view images together with machine-learning methods to quantify urban greenery (Stubbings, Peskett, Rowe, & Arribas-Bel, 2019), as well as street quality measurement using multiple sources of urban data proposed in Zhang, *et al* (2019). In the latter, the role of enclosure, the three-dimensional space created by the buildings on either side of the street is highlighted as playing a key role in urban vitality. However, this is often difficult to measure directly by the amount of sky view in street view images. There has also been little research into quantifying the change in enclosure as we transverse urban environments.

1.3. Measures of visual complexity in urban environments

Although various complexity metrics have been proposed at multiple scales (Boeing, 2018), we only focus here on those that capture visual complexity at the scale of the street. Ewing and Clemente (2013) relate visual complexity to the number of perceptible differences a person is exposed whilst moving through the city. However, to our knowledge there has not been an attempt to systematically measure it. Some attempts have been made in the past using manual techniques, such in the case argued by Cooper (2003) where a manual technique to segment street skylines (*i.e.*, edges formed between boundaries of buildings and the sky) and the fractal dimension of these skylines is used to assess the complexity. Here we propose a simple approach to capture the changing three-dimensional nature of the space between buildings by creating street cross-sections at regular intervals for the entire city and measuring the amount of change – visual information – as we move through the city by measuring the entropy of these cross-sections at a fixed spatial scale. We argue that this measure of entropy can be a proxy for visual complexity at a meso-scale.

Although the spatial structure and geometric properties of street networks play an important role in structuring human interaction and transportation processes, forming an important pillar of a city planner's search for spatial order (Rose-Redwood & Bigon, 2018), the visual cues and the three-dimensional space that is formed by the spatial structure, and not only of the street network, but by the buildings and their densities along the network, also have important functions for spatial cognition and visual complexity. Although complexity refers to the visual richness of a place, which depend on the variety of the physical environment, specifically the numbers and kinds of buildings, architectural diversity, ornamentation, landscape elements,

street furniture, signage, and human activity, here we will only focus on the physical environment, and specifically the sense of enclosure produced by the specific configuration of buildings along the street network and their variance through space.

2. Methodology

This paper shows how street cross-sectional entropy can be calculated for a series of cities and how the resultant numerical measurement can be related to the presence of certain morphological features that, in combination, effect the character of a place. We selected six case studies to test our methodology: London, New York, Madrid, Washington DC, Barcelona and San Francisco. One of our main restrictions is the availability of data relating to building heights for different cities. Nevertheless, the results allow us to create a typology of street sections and quantify a proxy for visual complexity by measuring the entropy of our case studies at a local scale.

2.1. Data

Street network data is retrieved from Open Street Maps. To maintain consistency we query all roads within each city's administrative boundary. From the street network data, we construct a graph where intersections are nodes and streets are edges using the OSMnx python library (Boeing, 2017). The topology of the graphs is simplified such that only intersections and dead-ends are represented as nodes, whilst edges represent street segments where the complete spatial geometry is retained. Figure 1 shows the spatial structure of these street networks, along with key metrics in Table 1: Number of edges in the network, which give a sense of the size of the network, the average street length, which serves as a proxy for block size and indicates how fine-grained or coarse grained the network is, number of buildings, and number of generated street profiles.

We also compile building footprint data along with height attributes from the following: Department of Information Technology & Telecommunications (DoITT), Barcelona City Council Geoportal, the City and County of San Francisco Open Data Portal, and Madrid City Council Open Data Portal. Building height attributes from all the data sources were created from LiDAR or photogrammetrically that represent the height of the roof above ground level;

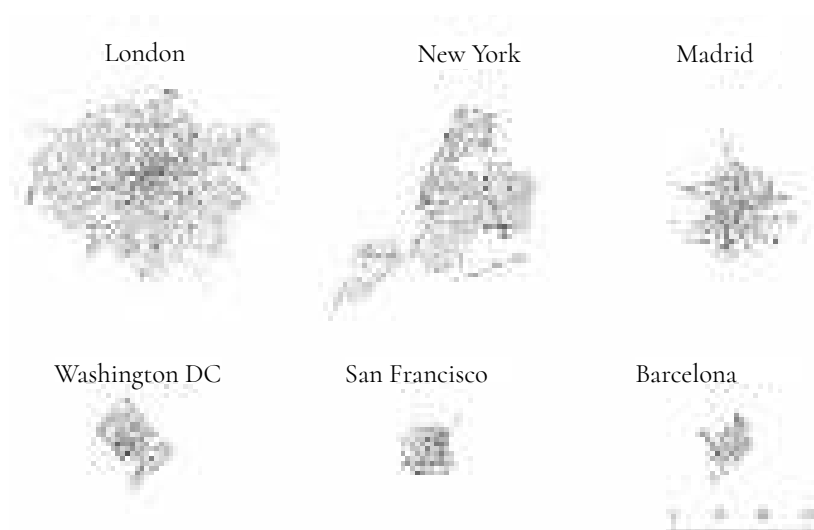


Figure 1. Street networks of analysed cities.

this gives a low level of detail (LOD-1) 3D model of the buildings. Both the street network data and building footprint data is projected to it's corresponding Universal Transverse Mercator (UTM) coordinate system and all measurements are given in meters.

2.2. Analysis

For each city we segment all edges from the street network every 40 meters. For each segment we calculate the geographic median and the azimuth , and create a new line that is perpendicular to at the point . The perpendicular line is used to create the street profile by intersecting it the closest building on either side of the street and querying the associated height attribute. This allow us to create a profile of the street at regular intervals along the network, as illustrated in figure 2.

In total we generated 1,275,254 street profiles. Once we have calculated the street profiles for each segment of all the streets in the six cities, we calculate the street enclosure as building height to street width ratio . We first compare the six cities by measuring the relative frequency of each of these variable (street width, building height, and enclosure). We do this by estimating the probability density function for each city through a kernel density estimation. These distributions are the simplest and first indicators that we use to compare the cities, as they capture both the physical scale at street level as well as the sense of visual enclosure.

Once we have compared the six cities we classify all the street segments and investigate how much these profiles change across space. In other words, we are interested in quantifying the experience of walking through these spaces by assessing the visual variance in terms of visual enclosure and scale within a local area. To achieve this, we classify the 1,275,254 street cross-sections into 64 categories that vary along three axis: Enclosure, height ratio of buildings at either side of the street, and scale.

We create uniform spatial units by dividing all the cities into 200 m hexagons, a 200 m hexagon was chosen as the unit of analysis as it captures the local area at which we experience the urban environment at street level. For each hexagon we calculate the Shannon entropy , of the different typologies of street profiles found. For each hexagon bin we calculate the entropy as:

$$H = - \sum_{i=1}^n P(w_i) \log_e P(w_i)$$

where represents the total number of street profiles typologies, indexes the typologies, and represents the proportion of street segments that fall in the typology weighted by the edge

Table 1. Data captured for each city.

City	Nº of Streets	Nº of Buildings	Avg. Street Length	Nº of Generated Street Profiles
London	299,450	649,747	99 m	463,042
New York	142,328	1,084,108	142.32 m	308,611
Madrid	63,175	401,869	63.17 m	173,250
Washington DC	28,720	101,039	122.65 m	92,635
San Francisco	27,064	177,023	117 m	74,635
Barcelona	17,658	239,698	104 m	57,053

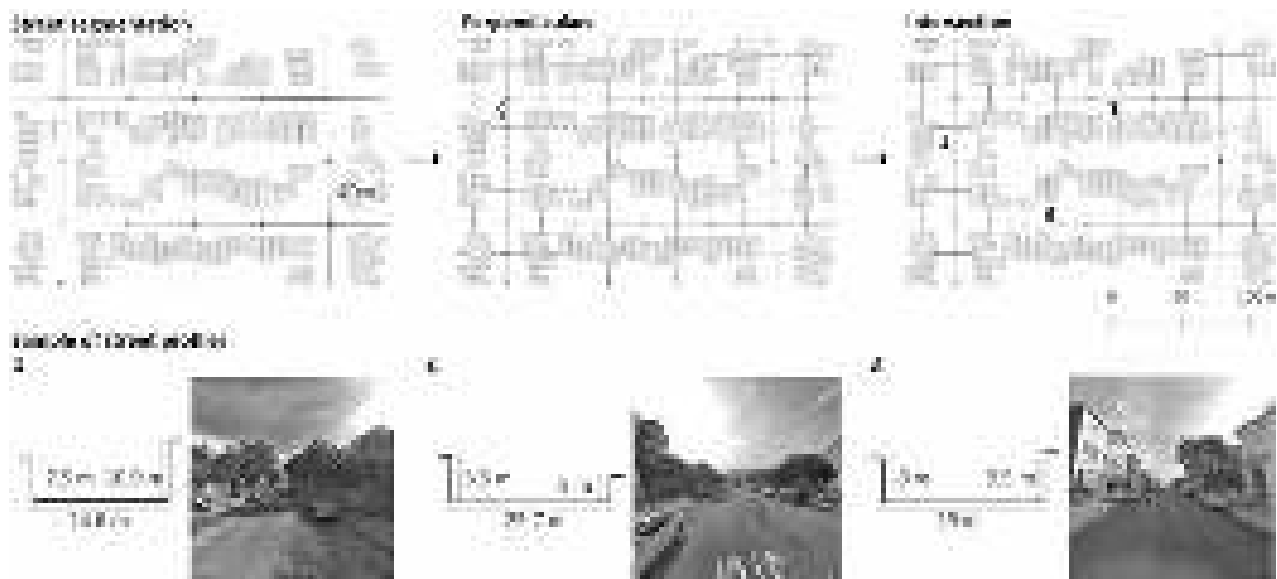


Figure 2. Procedure to estimate street profiles. Top row shows the procedure to calculate street network width from building façade to building façade and join height attributes. Bottom row shows samples of estimated street profiles along with google street view imagery of each.

length. The value of is dimensionless, and the maximum value it can take equals the logarithm of the number of unique typologies, while the minimum value is 0. Maximum entropy is achieved when there are equal number of segments that belong to each of the typology equal to 4.16, and minimum entropy achieved if all street segments fell into a single typology.

3. Results

3.1. City profiles

Figure 3a, 3b, 3c present the relative frequencies of street widths, building heights, and enclosure for each of the six cities studied given by the fitted probability density function. Three distinct trends can be seen. The first is similar for London, San Francisco, and Washington DC, defined by a street width distribution with two peaks, one around 20 meters and the second around 60 meters; building heights along these mostly range from 6 meters to 15 meters (equivalent to buildings of 2 to 4 stories) and enclosure values are centred around 0.4 (street profiles with a 1:2 building height to width ratio). The second is composed of Barcelona and Madrid. Both cities have relative high frequency of small streets of around 10 meters width, and building heights showing greater variance, with an average of around 18 meters or 4 story buildings. Lastly, New York shows a distinct profile, particularly for building heights that are higher than the rest of the cities with an average of 30 meters and an enclosure value centred around 1 (street profiles with a 1:1 height to width ratio).

Although the frequency of different types of street profiles for each city gives us a sense of the different urban characters of the cities, differentiating the prevalence of dense/sparse and high-rise/low-rise morphologies and different sense of enclosure at the street level, it fails to capture how these are structured in space. To account for this, in Figure 3d we plot the relationship of the street widths and average building height at either side of the street for each city to

get a more detailed view of how these unfold through the street network. Both street widths and average building heights at either side of the street are grouped into four categories. In the case of streets these are divided into: 0m-20m, 20m-30m, 30m-50m, and streets greater than 50m. Average building heights at either side of the street are divided into: 0m-9m, 9m-16m, 16-50m, and greater than 50m.

In the case of London, Washington DC and San Francisco streets that have a low-high street width – building height relations are concentrated in the central business district with the relation inverting as we go towards the periphery, London being the most extreme of these cases. New York, Madrid, and Barcelona on the other hand have a more homogeneous distribution of mostly low-high values. In the case of New York, we can see this is particularly the case in the borough of Manhattan and parts of Brooklyn, while most other places have a low-low relation reflecting what is shown in figure 3c of a mean enclosure value centred around 1 (1:1 height to width ratio).

3.2. Street typologies

After classifying all the street profiles, we find 64 clusters that vary along the three metrics of enclosure, ratio of building-to-building height and scale. In Table 2, we show the properties of the most prevalent cluster in each city. Madrid and Barcelona share the most prevalent typology of street, with enclosure of 1.5:1 and small streets. In general, most streets for all cities tend to have similar sized building at either side, but different cities have varied distribution of different typologies, with Barcelona and Madrid having a more heterogeneous mix of typologies.

3.3. Visual complexity

Table 3 shows the statistical properties of the entropy values for each of the cities studied. It is interesting to note that for the six cities statistical properties of entropy values are consistent. Madrid has the lowest mean entropy value, with a mean of 0.54, and New York has the highest with a mean value of 1.17. Although the statistical properties are similar for all the cities studied, there spatial distribution is varied, which reflect the unique urban character of each place.

London shows a radial pattern of street profile entropy with high values concentrated in the centre and along main corridors with values decreasing as we go towards the periphery. This result reflects the varied character of London's centre versus more homogeneous residential areas. In contrast, both New York and Barcelona show a more even spatial distribution of entropy

Table 2. Most common street typology for each city.

City	Enclosure	Building/Building	Scale
London	0.23	0.91	24m
New York	1.03	0.89	25m
Madrid	1.40	0.91	14m
Washington DC	0.28	0.90	36m
San Francisco	0.23	0.88	24m
Barcelona	1.41	0.87	15m

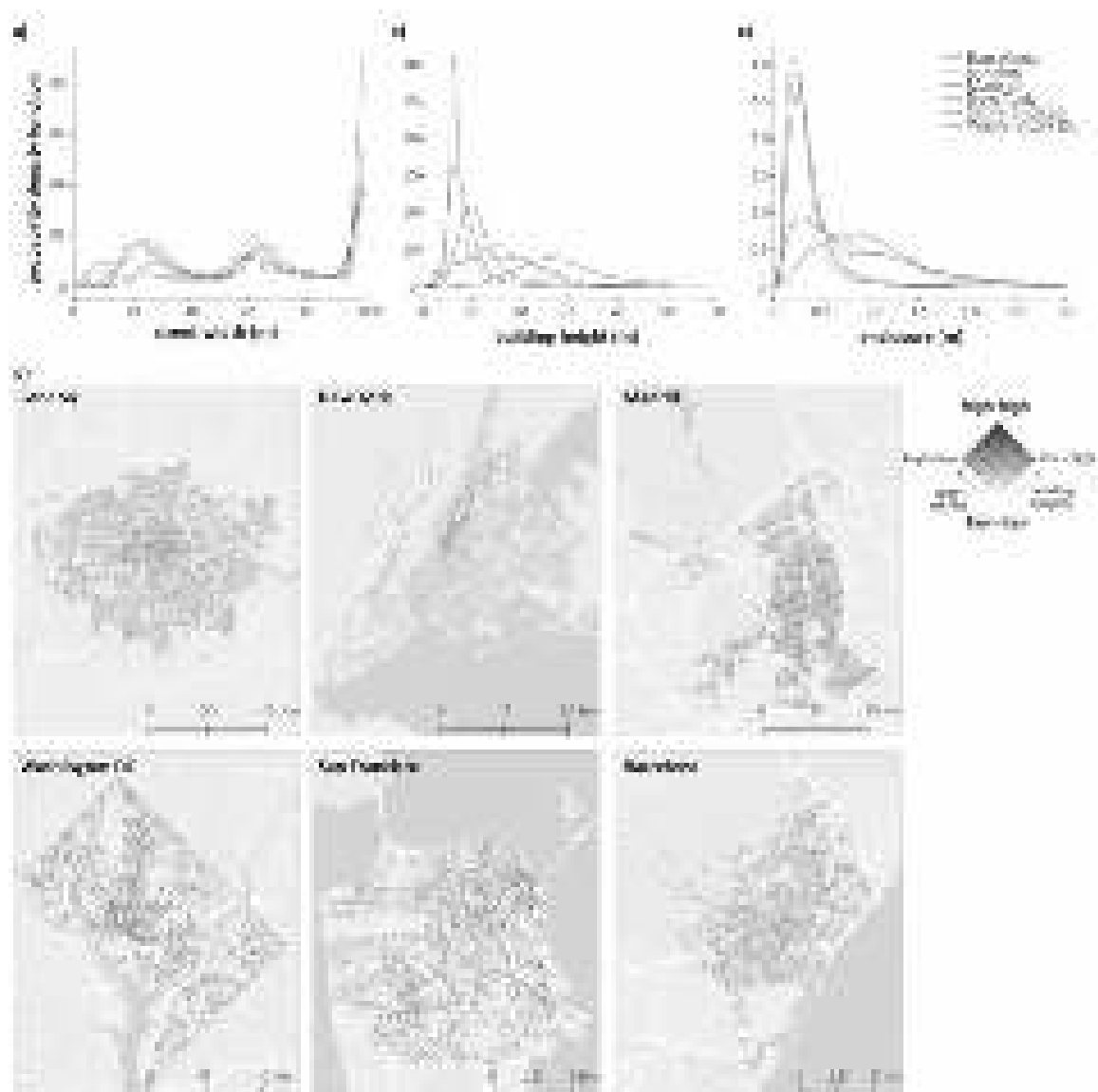


Figure 3. Relative frequency of a) street widths, b) building height along street, and c) enclosure. d) spatial distribution of street width to building height relationship.

Table 3. Statistical properties of entropy values for each city.

City			
London	2.73	0.53	0.91
New York	2.66	0.56	1.17
Madrid	2.53	0.66	0.54
Washington DC	2.28	0.75	0.78
San Francisco	2.28	0.57	0.87
Barcelona	2.73	0.73	1.03

throughout the city. In the Case of Madrid, we also see an even spatial distribution of entropy, however this is interrupted by the M-30 lateral motorway where there is a sharp change towards lower values east of the motorway. For San Francisco we can detect the residential area of mostly one and two-storey buildings in the west, versus the vibrant areas in both the Financial District and Mission District.

4. Discussion/Conclusion

4.1. Concluding remarks

This study proposed a method for generating street cross-section data by combining readily available street network data and building footprints with height attributes and assessing cities in terms of the typology of these street cross-sections as well as the visual complexity at a local scale as they change through the street network. The results show the similarities and differences in urban character of the space between buildings within and across six cities. The benefit of our approach is that it fuses existing data that are usually studied independent of each other to create a metric that can be used to assess visual complexity at a meso-scale. This resulting measure can be useful to urban designers interested in pursuing a more quantitative approach, as well as researchers interested in understanding how the physical qualities and spatial configurations of streets affect people's perceptions of the urban environment.

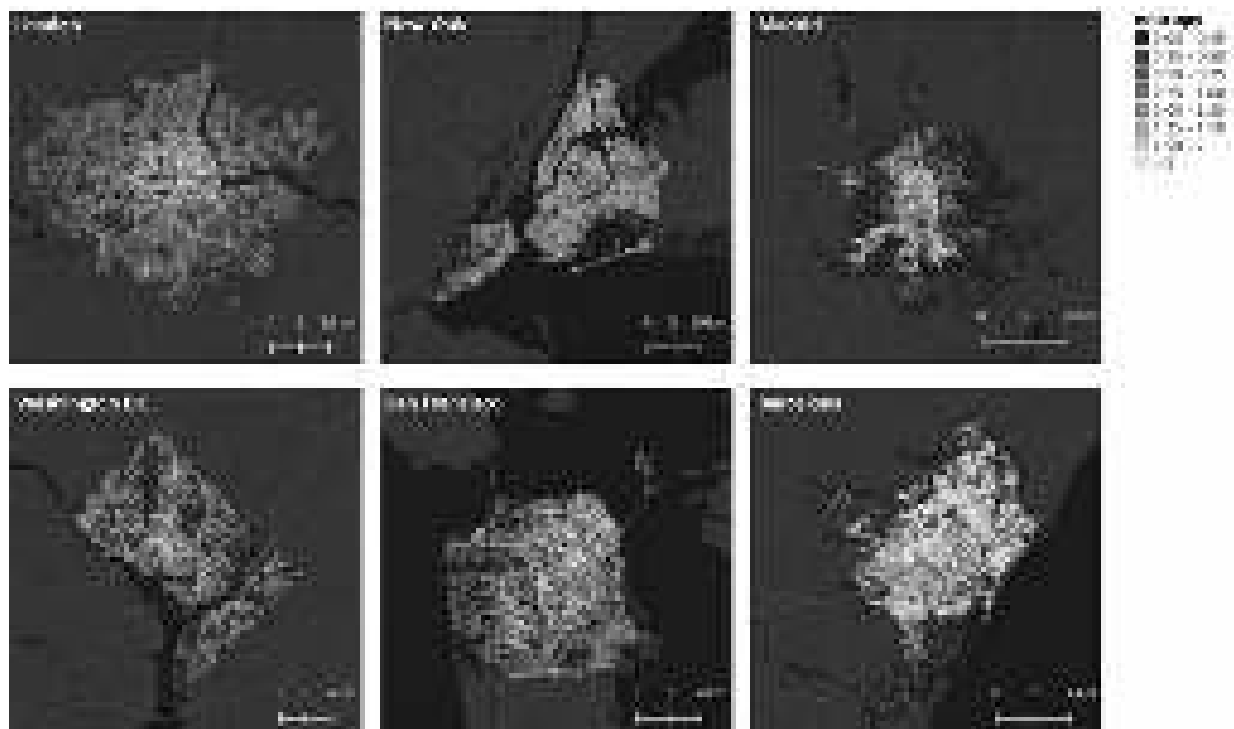


Figure 4. Spatial distribution on street cross-section entropy for London, New York, Madrid, Washington DC, San Francisco, and Barcelona.

4.2. Limitations and future research

Whilst the method proposed here is a first attempt to analyse streets as perceived at eye-level and systematically quantify visual complexity at a meso-scale there are many other aspects of the physical environment that influence the perception of space and contribute towards the visual complexity streets and its architecture, which include: Numbers and kinds of buildings, architectural diversity, ornamentation, landscape elements, street furniture, signage and human activity. Here we have only focused on the overall space created between buildings across the street network. Future research can combine this approach with more micro-scale and design features captured through street imagery. In addition, future directions of this research aim to enhance our studies in relation to how the entropy on street profiles can relate to other urban metrics such as land use diversity, network connectivity, population and built up density, among others. Overall, the complexity sciences hold promising potential to enlighten urban morphology theory and advance in the different morphological approaches, yet further efforts should be devoted to understand the heterogeneity of what street design entails that drive the spatial complexity of cities.

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Cultural Heritage in Conflict Narratives in Urban Development Plan

The Case Study on Shezih Region, Taipei City

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Keywords: urban resistance, cultural heritage, Taipei.

Abstract: Taipei's Shezi Island is a case of suspension of development, visions (or fantasies) from authorities and alternative vision from residents. The region's development has been restricted since 1970 when it was designated as flood buffer zone of Taipei City. The restriction prohibited new buildings in the region. From 1980, Taipei City Government raised several urban development plans for the region. These development plans were all embedded in visions based on famous cities in western world, and most of them are famous with their relation to water, such as Venice and Manhattan. However, these visions neglected Shezi Island's urban morphology, and were all discarded due to conflicts of land expropriation and other issues. The suspension of future development makes Shezi Island into a spatial limbo. By discourse analysis on urban development plans and news release, I tried to figure out landscape narratives of Taipei City Government under different regimes after 1980. By field research and participatory design with local residents, several students from my institute and I inspire different possibilities of landscape narrative, and understand the conflicts between different actors in the development process. "Ecological Shezi Island," the latest version of development plan is also creating debates and conflicts in the region. Coalition of local residents, scholars and professionals are finding the alternative vision while resisting the newest fantasy from city government.

1. Introduction

Shezih region (社子島) is a peninsula on the downstream converge point of Tamsui River and Keelung River, the most important rivers in Taipei metropolitan area. The region usually gets public attention only in typhoon season, when media would check if the region floods. The region's landscape is very different from other parts of Taipei City. Houses are built in bricks with iron sheet roofs and no more than 3 floors. Factories also built by iron sheets are settled in the middle of farmland. People can find many temples in the region, some of them are still the religious center of local settlements.

Shezih region's development has been restricted since 1970 when it was designated as flood buffer zone of Taipei City. The restriction prohibited locals to build new buildings and renovate original housing. From 1980, Taipei City Government raised different visions when a new mayor takes the office. Some of the visions were embedded in visions based on famous cities

in western world that are famous for their relation to water, such as Venice and Manhattan. However, these visions neglected the region's original landscape, and were all discarded due to conflicts of land expropriation and other issues. When Wen-Je Ko (柯文哲) took the office in December 2014, he seems to have a different way dealing with the region. Ko raised three plans and the option of remain current status to residents in Shezih region. Although concerns on settlement plan, land expropriation and different issues raised during discussion, the city government held a voting in the region and claimed that *Ecological Shezi* (生態社子島) would be the plan despite low voting rate.

The main purpose of this paper is analyzing how heritage is used in the narratives of different stakeholders in conflict in the process of new urban development.

2. Methodology

In Taiwanese context, urban development plan is usually a threat for the region's cultural heritage. Huang (2016) reminded us that in most of the discussion of future development in Taiwan, cultural heritage preservation plan and urban development plan are often in parallel and disregarding each other. The Cultural Heritage Preservation Act. Heritage preservation movement on new urban plan does not only calls for attention on local heritage, but also reminds authorities not to ignore development and planning history of a place.

There are researches on how authorities recognize cultural heritage. Smith (2006) raised the concept of Authorized Heritage Discourse (AHD). AHD emphasizes on aesthetically pleasing tangible objects, places, sites or events. AHD also prefers heritage with clear historical context and single historical narrative. Authorities build their heritage discourse and exclude heritage that cannot fit into the discourse. Also in the process of defining heritage, AHD chooses narrators for the meaning of heritage. To Harrison (2012), authorities try to redefine cultural heritage through various methods of memory selection. Harrison noticed heritage associated with small-scale societies and the everyday practices is rarely credited as heritage due to various reasons. Heritage which falls into the category of daily ritual can be seen too regular to have the value to be preserved. Smith (2006: 82) pointed out that heritage is a constitutive social process which is dissonant. It is about regulating and legitimizing, but also about contesting and challenging a range of cultural and social identities, sense of place, collective memories, values and meanings that prevail in the present and can be passed to the future. Heritage activism and advocacy can be engaged with social movement against urban changes that threaten original cultural context. There are studies on the importance of heritage activism and advocacy to contest and resist enforced urban change ignoring local histories and cultures (Casari & Herzfeld 2015; Hammami & Uzer 2018; Herzfeld 2009; Ingram 2016; Mozaffari 2015; Non 2016). Heritage activism and advocacy which engaged with resistance movement gives alternative narrative for communities to against exclusion and oppression caused by top-down planning.

This paper combines discourse analysis and participatory research method to analyze the narratives from different stakeholders in the conflict of Shezih Region's development. Discourse analysis is based on urban development plans, news release and heritage nomination document. Participatory observation has been done in Shezih region and Taipei City Government Urban Planning Commission (TUPC). My main participation time was from October 2015 to June 2016 with the studio course *Landscape Survey of Urban Islands* lead by Professor Min Jay Kang from National Taiwan University Graduate Institute of Building and Planning (NTU-GIBP). Kang has become one of the scholars raising concerns on the upcom-

ing urban development plan and assisting residents to raise their opinions. The course raised my research interest on Shezih region and the Earth Gods' Parade. It also gave me the chance to become an observer collecting empirical data through observation, discussions with residents and personal analysis.

3. Analysis/Results

Shezih region is a religious region that pays respect to gods and ghosts. The Earth Gods' Parade (夜弄土地公) is one of the most significant festival in Shezih region. It is also a day of reunion for local families. The parade is held by four settlements in Si-jhou-di, Gang-cian-zih, Wun-liao, Jhong-ku and Si-tai-kou. Every year on the day of lantern festival, settlements carry out their Earth God and rally through Shezih region. Firecrackers are set by the routes of the Earth Gods' Parade to welcome the Earth Gods and people carrying the gods. People also carry and watch lanterns at night. The Earth Gods' Parade has unclear origin and evolution history. Archives of Shezih region's religious events are insufficient. It is only confirmed that the ritual was originated from Han immigrants and has lasted more than a hundred years. Earth God is usually the protector of a certain region and highly related to agricultural society. In Taiwanese tradition, Earth Gods are in charge of a region's harvest, fortune and prosperity. The purpose of parade could be also related to the region's high flooding risk in the past. According to former Taipei City Councilman Bi-Feng Chen, there were local elders saying that the firecrackers in the parade was meant to wake up earth gods to protect the region from land loss⁷. As for now, local residents pray for protection and fortune in the following new year. People also believe that setting up more firecrackers contribute more fortune. Kang mentioned the difficulty portraying the depth and width of history of the Earth Gods' Parade in an interview⁸. The challenge comes from not only the lack of archives, also settlements that participated in the ritual varies due to settlements development. For example, Gang-cian-zih, one of the four current settlements, only developed into an independent settlement in recent years. There are also settlements that participated in the ritual before but not anymore. Sia-jhu-wei was one of participating settlements in the ritual, but the settlement does not join the parade anymore. The main reason is the loss of younger generation in the settlement due to the restriction of development.

Taipei City Government Department of Cultural Affairs announced that six buildings in Shezih region would be designated as municipal cultural heritage in March 2016. The five historical buildings were recorded and traced reports by Department of Cultural Affairs before designation. On June 17, 2016, Taipei City Government released *The Main Changed Plan on Shilin Shezih Region* and *The Detailed Changed Plan on Shilin Shezih Region*. There is a section on local culture and folklore in the main changed plan which takes four pages. It (19) starts with an introduction summarizing the history of Han immigrants in the region and comparing settlement names to the past. It then mentions that religion and worship circles shaped the settlements. It does not mention the kinship in these settlements. In the end, it says that "settlement buildings, worship circles and cultural performances are the soul of settlement" (19), and "there are several buildings and several intangible culture with historical values". (19) The section then makes local cultural heritage into three categories: 'historical buildings', 'other buildings with cultural meanings' and 'cultural heritage with cultural value related to traditional arts and folklore.' The description on the Earth Gods' Parade is short, vague and contains mistakes on basic ideas, just like description on other cultural heritage.

With the inspiration of the studio course, residents in Shezi started to collaborate with professionals and activists, and takes cultural heritage into the narrative of resistance. The first phase of the course can be divided into two parts. While in classroom, we made structural analysis from second-hand materials of development plans, governmental policies and historical documents. We also discussed and categorized first-hand materials from the field. Some of the materials would be presented as pictures, photo collage and other things that will be mentioned in the following paragraphs. While visiting Shezi region, we met local residents in visiting and did non-structural interviews. It built up the social network that would be helpful for the following research and actions. We visited temples in Shezih region and spent most of the time in Kun-Tian Temple. We met the Completion Jiu of Kun-Tian Temple and joined in one of the nights. We tried to describe the cultural identity of Shezih region from its religious culture. In this phase, we also found Marshal of the Central Altar could be a metaphor for Shezih region's development.

In phase two of the course, we tried to create a landscape narrative of Shezih region after the field research from phase one, such as local memories, mythology, historical events, images and local residents we talked to. The narrative was expected to inspire multiple interpretations from local residents (Kang 2017: 59). We made a photo collage scroll with illustration based on our research in phase one. We brought the scroll into the region and shared with local residents. We got many feedbacks from local residents. They told us our feelings and thought toward the scroll. Some of them even shared more memories and information of Shezih region. We met Mr. R in the process, who inspired us the main figure of our next version of scroll. Mr. R's story was a miniature of a group of local residents who do not own land or even property. He was born and raised in Shezih region after his mother divorced and brought her children back home. He raised his three children in the region and let them study in local elementary school and junior high school. Mr. R and his family would face departure from the region, as they rent house from family member and do not have property ownership. Mr. R, like many people who recognized themselves as Shezih people, have faced the same crisis in the new urban development plan. With Mr. R's permission, we took him as the model of our main character in the story. The main concept of the story was originated from a line in the movie *Interstellar*. "Once you are a parent, you are the ghost of your children's future". We adapted the idea of complex time-space imagination from the movie and compared it to the Shezih's culture of ghost. Ghost was also a metaphor for local residents like Mr. R. These people live in the region for decades, even over generations. However, the urban development plan does not take them into consideration. Most of them would be like ghost because they couldn't afford new housing in the future and left their hometown forever. In our story, the main character tells his story in first-person narrative. He is permitted to go back to Shezih region by Jade Emperor (玉皇大帝). In the short visit for only three days, he sees a Shezih region under uncertain future. The narrator sees places and people he was familiar with. He sees residents being rushed to decide their future in I-Voting in limited knowledge and information. In the end, he watches the documentary of last year's Earth Gods' parade with residents on a silver screen at Si-tai-kou. He tries to manifest himself within the image of earth god when light and smog at their fullest and wish that could see him. The story was co-created in magical realism, as it was originated by field research but adapted elements of fantasy. We named the scroll *Along Rivers of Shezih* (社子上河圖), which was inspired by *Along the River During the Qingming Festival*, the most famous scroll painting in Chinese art history. The scroll came along with a board game. During the course discussion, we thought the future development of Shezih region is just like a big game. Most of the residents were like chesses controlled by other stakeholders. By creating board game, we tried to encourage resi-

dents becoming players of the big game of Shezih after playing it. We adapted the game rule of Ticket to Ride, a famous board game. In Ticket to Ride, player who builds the longest railroad wins the game. In our version of board game, player who connect the longest route of firecrackers wins the game. The earth god and the father's ghost would come up in the smoke of firecrackers. People can play the board game without knowing the story. But with the prequel story of the scroll, players can have a better understanding in Shezih region and the development issues. The first version of the scroll was presented in the final presentation of fall semester in January, 2016. The second version was created with hand-drawn line illustration instead of photo collage. It was printed out as a large scroll lengths 15 meters. The course chose to display the scroll and the board game to the public for the first time in Fu-An Junior High School (福安國中). The display was held with presentations by foreign students in the course. Students from China, Spain and Sweden shared stories about culture differences and their hometowns to students between 12 to 15. After the sharing by foreign students, the scroll was hanged in the hallway. Course members read out the story to students, parents, other local residents and Mr. R and his wife. After this, we invited students to write down their own stories or memories of Shezih region on Post-it notes. We also invited them to draw themselves into the scroll, as we left blank it the ending part of scroll. After the display in Fu-An Junior High School, the scroll was displayed twice in Kun-Tian temple and Si-tai-kou. When the scroll was displayed, residents gathered and started to recognized scenes in the scroll. They found out places and people they were familiar with, and told us about more places and stories of the region. The third phase of the course started after the school year ended. The initial coalition between Shezih residents, scholars and professional was established in the studio class. Kang and students mainly from NTU-GIBP cooperated with Self-Saving Community of Shezih Region (社子島居民自教會), a group organized by residents who had concerns on future development plan and demand city government to reconsider the plan. They attended Taipei City urban plan commissions and presented petitions to city government. These people along with professionals and scholars later joined in would become Professionals Coalition on Shezih Planning (專業者關注社子島陣線). Two important incidents happened before the Earth Gods' Parade in 2017 due to the coalition. First was on the parade itself. After the course members discussed with representatives from four settlements participated in the Earth Gods' Parade, they decided to find volunteers and filming team of Our Island to help filming the Earth Gods' Parade. These filming materials would later become a short documentary and two episodes of Our Island. In this meeting, people from the four settlements also made an agreement that four earth gods would gather together during the parade, which has never happened before. These efforts were made to preserve memories of the festival and raise awareness from citizens of the city. The coalition also contributed a workshop in January, 2017. The coalition believed that a professional and responsible plan for Shezih region should be originated from the real problems the region is facing and based on a sufficient, meticulous site analysis. Based on the idea, Professionals Coalition on Shezih Planning and Self-Saving Community of Shezih region organized a workshop together. *A Blueprint in Microcosm Workshop and Forum for an Alternative Future of Shezidao Settlement* was a five-day workshop held in Shezih region. Students from urban planning, landscape, architecture, hydrology and related fields were divided into three groups. In the first four days, participants of workshop work intensively with interviews, field research and group discussions in daytime. Participants and local residents gathered in Kun-Tian temple at night. Each group presented their work, and residents gave feedback from their perspectives. On the last day, every group proposed their alternative plan for settlement in front of local residents. Professionals and scholars were invited to give suggestions. From the workshop and

alternative plans proposed, the coalition declared to the city government that there were more possibilities for the future of Shezih region and the it was trying to figure out. The studio class made some inspirations and created possibilities for alternative discourses in the place's future. In the studio class, we approached local residents that rarely had the chance and courage speaking out for themselves. Residents like Mr. R were encouraged to share their memories and experiences as a Shezih people. They shared their worries and expectation for future, which ironically were ignored while the city government tried to communicate with local residents. Some of the residents started to participate in the self-saving community and speak out in public hearings and urban commissions. Another effect of the course was highly related to Kang. His professional network was motivated as the course goes on. As a scholar and activist in urban movement for a long time, Kang's professional network is widely across universities, research institutes, public administrations and NGOs. He was one of the Director of Board of OURs at that time, an NGO worked on urban planning and housing policy for a long time. Professionals Coalition on Shezih Planning and the following international workshop in 2017 recruited students and scholars who were concerned about Shezih region and wanted to help. Finally, some of the works in studio class reminded local residents that the cultural heritage in their region was important, and it should not be excluded in the future. The reminder was one of the reasons that local residents nominated the Earth Gods' Parade as municipal intangible heritage.

In general, the file tries to build up the history of the parade, its value for the region and the city. The file tries to prove to the committee that the parade's history should be a strong reason supporting it to be cultural heritage. This is caused by the disadvantage that there were no archives which can give clear picture of the parade's history. The file also emphasizes the importance of the parade to Taipei City. It makes efforts on changing the image of Shezih region from an underdeveloped and poor place restricted by building prohibition. The nomination is not only a legal step preserving the parade, but also a tactic resisting the upcoming urban development plan. The tactic is both 'rooting' in to preserve local heritage and 'routing' for support out of local communities (Kang 2017: 58).

The New Shezih Urban Development Plan has faced confrontations since its debut in the 692th meeting of Taipei urban Planning Commission (TUPC) on July 29, 2016. Local residents filed petitions to the committee with their concerns of the new plan. Scholars and professionals represented by OURs also filed a petition and listed 12 questions on the plan. In these questions, one of the points was the potential threat of the plan to local heritage (3-4). OURs argued that Intangible Cultural Heritage and the spirit of place raised in ICOMOS Quebec declaration were ignored in the plan. The original social relations, routes and nodes would vanish or be destroyed. Some members of the TUPC also noticed this concern and responded it during the review process. In the 694th commission, LC Chen (陳亮全) urged that the development plan should consider keeping the communities in Shezih region and reconsider the spatial form of high-rise buildings. He claimed cultural heritage and memories of Shezih region may be better preserved with reconsideration and adjust of plan. Chen-Meng Kuo (郭城孟) also suggested the city government to invite OURs into the project, as the group had strong ability in working and communicating with communities. Taipei City Government responded to the concern of heritage preservation twice during reviewing process of the urban development plan. In the first meeting, Department of Urban Development stated that folklore events in the region could be preserved and lasted. It claimed that since four settlements that participated in the Earth Gods' Parade would be in the second stage of future development, the ritual could be lasted for another while. It also guaranteed that since most of the cultural heritage buildings and religious centers would be preserved on-site, the parade and other ritual would be lasted

too32. In the last meeting in TUPC, the city government restated that historical buildings and religious centers would be land used for park. The city government also assured that the parks would meet the demands of religious rituals such as the Earth Gods' Parade.³³ The responses from city government revealed its optimism or carelessness in heritage preservation as we look into the future of the Earth Gods' Parade. Although three temples are preserved as religious center in the plan, none of the earth god temples is appointed as religious center or historical building. The routes and nodes of the parade have not been neither investigated nor considered into the plan. The social relationship in and across settlements could dissolve, since many residents may not stay after development due to disqualification and unable to afford rents.

4. Discussion/Conclusion

The future of the Earth Gods' Parade and the social bonding of several settlements is under threat due to the ignorance by the city government. The Ko government have tried bottom-up strategy in policy making since taking the office. But in the case of Shezih region, the i-Voting and following planning process reveals that the city government cares more on efficiency. From zone expropriation to resettlement plan, Ecological Shezi has similar solutions comparing to former development plans. The main concerns in the past could not be solved. The Ko government however was satisfied with Ecological Shezi and determined to accomplished it with all costs. The vague culture and heritage preservation policy in the future plan revealed the planning authorities' limited understanding on cultural heritage. These threats resulted in resistance and different discourse on the Earth Gods' Parade.

The Earth Gods' Parade in Shezih region gives us a look on how a place's heritage is related to local development. Shezih region's marginality in Taipei City's spatial development history made the region the first choice to sacrifice under the city's flooding prevention policies. The Earth Gods' Parade is also preserved due to the bonding within settlements in Si-jhou-di and the preserving efforts made by local residents. The bonding is strengthened as the parade being held every year. The event is under threat as Taipei City Government ignores the risk of settlement disintegration. The development plan is lack of solution to the risk and preservation of the parade. The plan's potential threat to the Earth Gods' Parade became one of the arguments for coalition of resistance resisting the plan. The parade however has never become the main focus for both the city government and the coalition of resistance. There are reasons that the Earth Gods' Parade has not become the main focus in the future development of Shezih region. The controversy on land expropriation and settlement plan during construction has been the main issue since Taipei City Government raised their vision of Shezih region in 1988. The issue is still the main concern for residents and stakeholders in Shezih region under Ecological Shezi. The long time efforts made by local residents like Hsieh and help from activists and professionals is still inspiring people in the region to discover its culture. However, the further discussion and persuasion of the place's future is hard as Ko's government forces the agenda of development going faster than former mayors. As the Ecological Shezi doesn't solve some of the residents' worries on land expropriation and settlement plan during construction, the Earth Gods' Parade is hard to become top issue in the conflict. Finally, the coalition of resistance paused the nomination for the Earth Gods' Parade as municipal intangible heritage. The event will still be reviewed under limited view from city government in the process of resistance and negotiation. There could be some difference if the coalition of resistance finds a strategy of shaping discourse apart from AHD and gains more support from people in the region and other parts

of Taipei City. However, the tense relationship between Ko's government and cultural heritage preservation activists can offset any efforts from the coalition. The city government claimed that the upcoming cultural heritage census in the region would prevent heritage preservation groups from nominating new cultural heritage, but the census could delay the development process. It is not a sign of friendliness from city government, since it blamed nominating cultural heritage in advance as a possible reason of development delay. We can observe strategies from different actors during the census in the coming days, and if the Earth Gods' Parade can become the main battlefield in Shezih region's future development. The effect of the nomination of the Earth Gods' Parade should be analyzed in several perspectives. The nomination tried to emphasize the importance of the parade and its relationship with current settlements. But the city government did not face the questioning on the plan's potential threat to communities and cultural heritage. On the other hand, land expropriation and resettlement plan during in future development process are still main concerns for local residents. It made the coalition difficult to set the future of cultural heritage as the main battlefield in the resistance. On the other hand, works from the studio course inspired residents to notice the possibility of losing cultural heritage if the development plan being realized. The narrative of future vision now has a chance to be more related to local culture, and more diverse opinion can be included.

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Conceptual Modalities of Architectural Rewriting Techniques

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Keywords: Critical urban transformation, architectural rewriting, design techniques.

Abstract: In architecture when the criterion of revitalization prevails over the conservative approach, one would wonder if it is possible to identify a series of design practices to be followed in the development of the architectural project. The research here displayed investigates these practices through the technique of rewriting, here conceived as a creative path, which aims at transforming an architectural or urban structure across a critical textual reworking of its formal elements. It is thus a generative technique that entails the recognition of the physical features of architecture, in order to reorganize them into a new narrative system, according to the evolutionary process of the city's urban settlement. The purpose of this study concerns the identification of general principles for a critical transformation of the morphological and figurative features of the original architecture; identification that occurs through a critical analysis of several case-studies emblematic for architectural rewriting procedures. Developing such a critical analysis means to recognize the elements engaged in the architectural transformation processes, defining by comparison an admissible order of the employed design tools. Through a systematic reorganization of these tools, the result of this paper aims to define the conceptual modalities of architectural rewriting technique.

1. Introduction

To define the methodological aspect of a problem it is admissible for the scientific research to use models as tools of verification, knowledge, and reproduction of certain phenomena, despite the fact that the complexity of reality cannot be traced back to rigid modelling schemes. The search of categories and experimentation of critical models to investigate the different expressions of experience represent a basic step in order to comprehend (decipher) and decode the structure of the phenomenon itself. The purpose of this short essay is to explore some conceptual modalities, a kind of theoretical model, in order to recognize the generative principles adopted by those projects aimed at transforming, through a process of rewriting, the structure of an existing architecture. What do we intend exactly when we talk about architectural rewriting?

The generative grammar processes suggest that a writing, and more generally any syntagmatic element, a union of signified and signifier, can be transformed into a second syntagmatic element, starting from a critical reorganization of the units that compose its narrative structure.

This critical process is called rewriting. The same happens in architecture when the criterion of revitalization prevails over the exclusive one of preservation of the historical artefact. That is when an act of transformation (re-construction, re-form, re-arrangement, etc.) is the result of a critical re-elaboration of the formal features belonging to some precedencies.

Specifically, in the field of architecture, we could recognize different attitudes in rewriting techniques, with different operational modalities similar to some rhetorical figures or tropes, such as the allegoric transpositions of forms, figures and typology.

So that in architecture the allegorical attributions consist in depicting an element with the appearance of another that is in a symbolic relationship with what it wants to represent (for example the cross plan with the basilica); the metaphorical allocation in transforming formal systems that occur in attributing several figurative properties through the substitution of elements with others; the synesthetic act of semantic estrangement that promotes a non-conventional perception of urban spaces; the substitution through periphrasis, with the transformation of a single existing part or the entire structure of a building with a dialectic combination of heterogeneous forms and figures, and so on.

2. Paradigms of rewriting

Witness, for example, the critical process of abstraction such that the form of architecture is directly determined by a superposition of a series of textual elements, architectural figures, settlement models, or paradigmatic plans. We can find in such a process the Peter Eisenman's projects exposed in the essay *Cities of Artificial Excavation*, especially about production highly varying types of drawings, conceptual diagrams, models and texts for the development of projects such as the one for the International Seminar of Design for Cannaregio in Venice (1978); for the reconstruction project of Friedrichstadt district (1980-1981); for the Romeo and Juliet project exhibited at the 1985 Venice Biennale; and finally for the project of the University Art Museum at Long Beach, California (1986). This apparent collage of irregular forms suited to a variety of uses is instead a rigorous layout of the generative procedure that tends to a level of abstraction such that the form of architecture is directly determined by a superposition of a series of textual elements, architectural features, paradigmatic quotations, that Eisenman reduces or enlarges, reshaping them through a compositional scaling process. To quote Eisenman's words, *"My projects created what can be called superimposition, which is a simultaneous existence of two or three formal and historical layers to produce another condition which is totally artificial – a hypercondition, if you like, that has nothing to do with whatever was there, or could be there, but exist only in the juxtaposition"* (Eisenman, 1994; 119).

Eisenman outlines artificial places in which the architect acts freely without formal constraints, that is, without taking into consideration the iconographical values of forms. In this process of re-composition, the formal features of the new intervention appear as an allegory of architectural presences enclosed in the urban structure.

As Michael Hays refers, *"the sequence of appropriation, devaluation, rejuxtaposition, and redistribution of depleted signifiers transforms these signifiers, allegorically, into new emblems, redeems them through the very logic by which they were first devalued. Allegory appears, then, as a displacement of or compensation for a disappearing and irretrievable past, a past foreclosed by the historical and social present"* (Hays, 1994, p. 108).

So that, in architectural design, the allegory also represents a process aimed at transforming, displacing, superimposing, engaging forms and figures extracted from a textual and critical

analysis of the urban form. These formal units acquire a new iconographic value, becoming a direct expression of the memory of the place, its absences, and its transformational processes. In other words, the allegorical construction process of the architectural form generates an ideal place, an architecture that evokes the history of the site, the succession of events that have marked the evolution of the city, evoking its narrative structure through the transfiguration of elements belonging to the urban memory.

Likewise in the project for The City of Culture of Galicia in Santiago de Compostela (2011), we can recognize some attitude in rewriting the historical core of the city through a new proposal within a displacement of the original structure and a transformation of its features (figure 1).

At Santiago Eisenman identifies this code by translating the transformational processes contained within the historical core of the city into a series of illustrative figures through a diagrammatic process.

Three deceptive diagrams of the medieval plan of the city, of the shell and of the pilgrims' path are the original genetic source of the project. The deformation of the first diagrammatic layer (the city grid) by superimposing the next two and the final torsion process induced by the introduction of deformation and flow lines creates an internal genetic program that transforms them into coding devices (Eisenman, 2005, p. 174).

Eisenman extracts from the historical core of Santiago the setting principles of the new architecture juxtaposing these diagrams in the same frame of space and time.

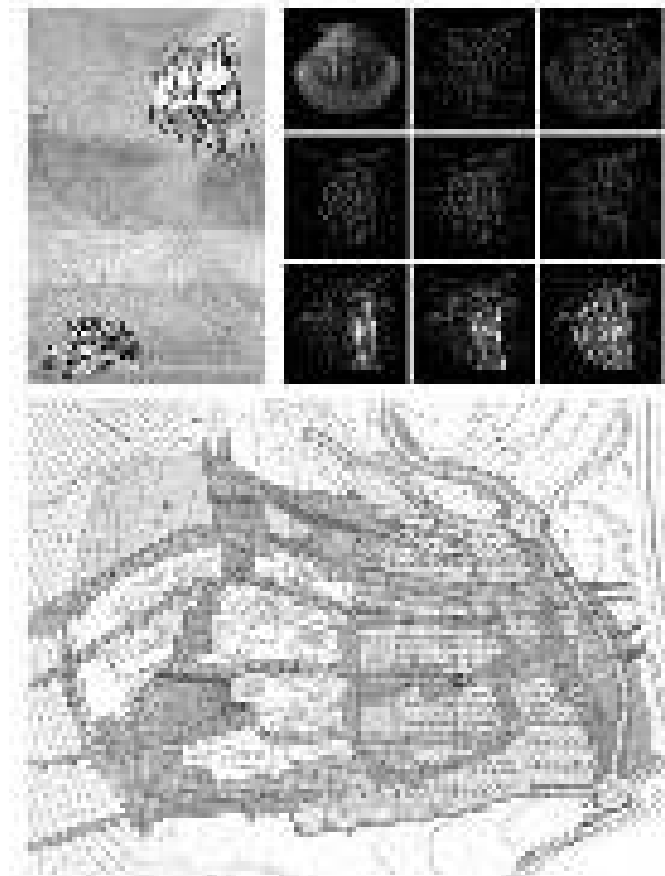


Figure 1. Peter Eisenman, *The City of Culture of Galicia in Santiago de Compostela*, 2011.

While the project at Santiago begins as a series of plans overlaid as a palimpsest, an archetypal form of an index, these overlays are then extrapolated into a three-dimensional matrix. Whether as a palimpsest, a photograph, or a cut in a building, indices are precise records of former presences. At Santiago, the indices become scrambled by a series of deformation and flow lines extrapolated from the original tartan grid. These represent the activity of a new digital – as opposed to analogic – code: a code that scrambles the prior notations. Neither geometry nor planimetric, they are analogous to the strands of the nucleotides of a molecule (Eisenman, 2004, p. 51).

One of the most significant attitudes in the rewriting process is the relationship that links the pre-existence with the new intervention. This connection does not simply endure in a certain aspect of formal or typological correspondence but rather in something deeper; something related to the generative principles that underlie the nature of the formal features of the architecture.

3. On some recent rewriting examples

To exemplify this process of rewriting we can use certain rhetorical figures able to clarify the essential steps of the design act. Specifically, it is necessary to define these creative steps in presence of some monumental pre-existences that inevitably affect the architectural project.

In the analysis of the historical city and in the binary type-morphology relationship, aimed at affecting portions of territory with no name – which have gradually been called widespread city, city of extension, etc. – the project had to appeal for rhetoric figures, due to the metaphorical nature of construction, to activate authentic processes of architecture recognition. On the other hand, this is nothing new. The so-called French revolutionary tradition with “L’Architecture Parlante” (above all Ledoux and Boullée) or the Soviet one with the Russian constructivists (specially Mel’nikov, Leonidov and others) had already been used to apply elementary but recognizable figurative archetypes, such as the hammer, the sickle, the axe, and other tools of the trade.

By considering what Paul Ricoeur was conceiving about the supply of new meaning in some terms in literature –,

a word receives a metaphorical meaning in specific contexts within which they are opposed to other words taken literally; this shift in meaning results mainly from a clash between literal meanings, which excludes a literal use of the word in question and gives clues for the finding of a new meaning which is able to fit in the context of the sentence and to make sense in this context (Ricoeur, 1974, p. 99).

– similarly it occurs in architecture when new elements acquire meaning within the system of relationships in which are grafted only through a change, a collision of significance with the replaced element: a metaphor can be conceived indeed as a contextual change of meaning (see, for instance, the role of column in the Adolph Loos Chicago Tribune building proposal).

Specifically, in a rewriting operation, it occurs that a metaphorical figure integrates the pre-existence structure through a morphologically and typologically defined element, in such a way as to acquire a new functional and aesthetical meaning, through the new critical association that establishes in the context where is inserted.

Let’s take into consideration the extension of the San Telmo Museum by Fuensanta Nieto and Enrique Sobejano (2011) (figure 2).

The morphological features of San Sebastian’s historical center required some specific choices for the expansion of the San Telmo museum. In fact it was required “*more than a volumetric*

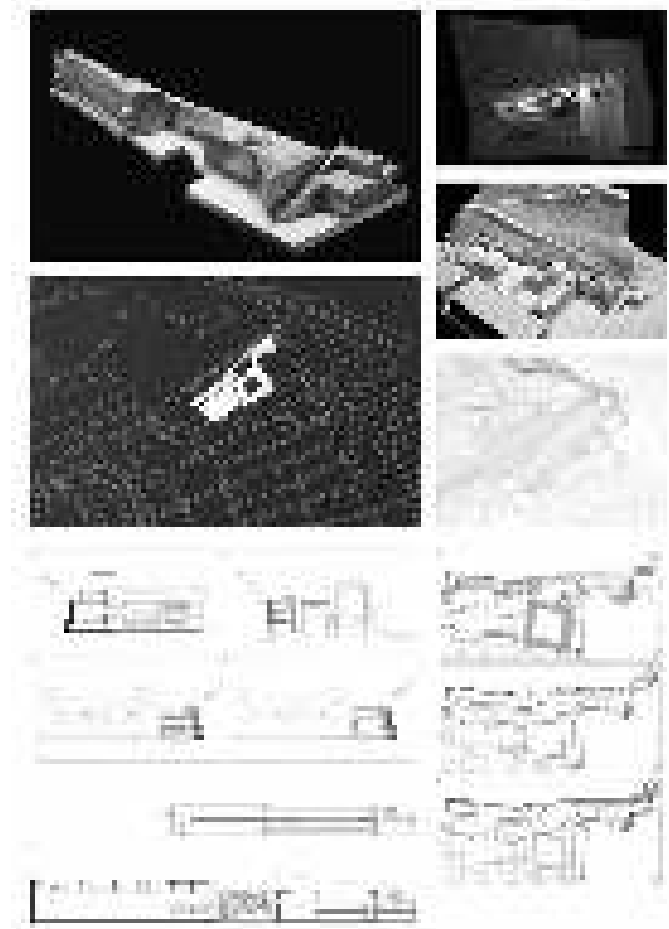


Figure 2. Fuensanta Nieto and Enrique Sobejano, *San Telmo Museum*, 2011.

and functional adaptation to the project, a conscious architectural response to the issue of the edge as main question of site” (Nieto-Sobejano, 2014, p. 191). The ancient Dominican convent of San Telmo is located on the edge of the urban center, leaning against the slopes of Mount Urgull, on top of which there are the ruins of the ancient military bastion.

This condition of margin, of limit between natural and artificial, country and city together with a declared desire for dialogue between old and new, between invention and memory, determines the features of the new intervention, as

a long wall animate on whose plan evokes the irregular geometry of the cloister and the nearby military bastions at the point where they approach the mountain ... the expression of a new discontinuity, seen as a manifestation of the dualism between nature and artifice, between contemporary sensibility and historical memory... unusual metaphor of the indefinite border, where architecture and city match the landscape (Nieto-Sobejano, 2014, pp. 191-192).

Naturally, there are some other rhetorical figures aimed to deal with the process of rewriting. These include that of Synesthesia, a rhetorical process based on the association of two images, words or syntagms belonging to a different sensorial category that creates an effect of estrangement. In architecture, a similar process of estrangement can be seen when two different figures in terms of form and language are juxtaposed to generate a new spatial condition within the urban fabric, in which the observer perceives, in the same frame of space, different moments of time. Specifically, synesthesia can be conceived as a compositional procedure of paratactic type, aimed at creating a structure through a dialectical juxtaposition of architectural elements and figures

belonging to different formal languages, distant in time and space. This occurs especially when the project insists within the historic city by using a formal repertory coming from a reinterpretation of the canons of the architecture. In these cases a rewriting process assumes the character of synesthesia when the project aims at integrating the pre-existence through the grafting of a new architectural system whose formal and figurative components differ from the original architecture, creating a sensation of estrangement in perceiving the building within the urban fabric.

It is not hard to find examples of such tendency, aligned solely with visual impact expedients. The project of O.M.A. for the Extension of the Dutch Parliament (1978) can be conceived as an emblematic example of this rewriting process type. Located in the city of Hague, the project addresses the relationship between pre-existence and new intervention grafting an architectural structure composed of figures and forms drawn from the catalogue of modern architecture. At the time of the project, the Dutch Government and Parliament were located in the same architectural complex in the center of Hague, called the Binnenhof. It consisted mainly of a monumental system developed around a rectangular courtyard, inside which was the Ridderzaal, the iconic building of the Dutch Parliament. As Koolhaas himself pointed out, *“through historical circumstances, government and parliament are intertwined in this architectural complex in a way that denies their political opposition”* (Koolhaas, 1981, p. 15). The aim of the project was to correct this situation of functional and symbolic ambiguity of the architectural system through the addition of two linear structures.

Within them a presence of different independent architectural figures can be noticed: the parallelepiped of the assembly, taken as an element of conjunction between the two linear bodies; the cylindrical volume, where a system of vertical connections links the three floors of the horizontal plate, used mainly for public activities; the autonomy of the pathways, marked by the axonometric projection of the interior spaces.

The same characteristic of autonomy distinguishes the elements that denote the figurative features of the project. It follows that every element appears thus legible, both from the formal and functional point of view, as a single unit with respect to the entirety of the whole.

Therefore, the project renounces the idea of an architectural system with defined margins and limits, abandoning *“all claims of harmony and global coherence”* (Koolhaas, 1990, p. 162) in order to *“pass on in new qualities the tensions and contradictions that tore the historical city”* (Koolhaas, 1990, p. 162). The architecture of O.M.A. is composed of a heterogeneous set of fragments, figures, and forms. It is thus an architecture conceived by parts.

4. The reconstruction of Aleppo's Souk as an applicative case study of the rewriting techniques

The technique of rewriting has found a paradigmatic applicative case study in the reconstruction of the city of Aleppo in Syria. On the other hand, the social, political and economic difficulties that occur to be faced in those particular contexts where the architecture of the city is compromised, mutilated or heavily damaged by acts of deliberate hostility, require a design proposal aimed at safeguarding the architectural heritage. The theme of reconstruction in the transformation of the urban settlement establishes a relevant factor in regaining the identity and the self-identification of local populations and city's symbolic places. The rewriting experimentation as a critical transformation technique of the urban settlement is capable of giving a tangible contribution through operative modalities that has guided the project. As an experimental test in the case of Aleppo, it was decided to operate in the monumental cores where

the continuation of the Syrian civil war caused not only considerable damages to the artistic and architectural heritage, but it has also compromised the foundations of the local economy.

Therefore, the projects for the reconstruction of the monumental system of the Souk area of Aleppo here displayed, are conceived as an experimental and methodological verification of the theoretical assumptions described above concerning the architectural rewriting process.

It is well known that in the past Aleppo's economic fortune came from its strategic position as a trade crossroads between East and West. Since ancient times the city has always been an important center along the Silk Road. Because of this strategic position the city has undergone the expansionist aims of several populations, such as Hittites, Assyrians, Greeks, Romans, Omayyads, Ayyubids, Mameluks, Ottomans until it passed into modern times under the rule of the French government. For this reason, Aleppo cannot be defined only as an Islamic city, since represents the concurrence between occidental and oriental culture. A critical reading of the urban structure reveals indeed how its current condition is the outcome of a stratigraphic accumulation of different cities distant in time that, as a kind of palimpsest, are superimposed one over the other in the same frame of space. A similar phenomenon can be observed in the formation process of the Souk's monumental complex, built during the Ottoman period along the ancient *via recta*, leading axis of the first Hellenistic urban settlement, and involved in transformations, extensions, and integration up to the 1930s.

The architectural development of the Bazar, and in particular the structure of the Souk, appears then as paradigmatic of the generative processes implied in the evolution of the urban fabric of Aleppo. Therefore, the destruction of the Souk, economic and commercial center of the city, appears than also as a symbolic aggression to the city identity, its history and its memory.

Rebuilding this part of the urban fabric assumes thus an emblematic value, a possible motive of self-recognition of the city in one of its most important symbols, as well as providing a possible relief to the social precariousness considering the unique condition of the monumental center.

The project proposal attempts to meet two essential requirements: firstly, to restore the architectural system adapting the old structure to new functional needs, updating the typological and figurative code by sublimation of those settlement features that defined the original building; secondly, to propose a design experiment that does not consider the result itself, rather the methodological procedure adopted in order to be able to accredit this solution in cases and contexts analogues to the one here experimented, which could be generalized, giving the possibility to deduce some indicators compatible with other similar circumstances (figure 3).

As a first step, the study here displayed moves towards an analysis of the permanent features of the urban settlement. In particular, the typological evolution of persistent and long-term factors in the city's history (madrasa, khan, mosques, etc.) belongs not to a strict Islamic repertoire, but rather to a code that transversely intersected the entire history of architecture, from the Hellenistic period to the French protectorate. So that, the rewriting formula adopted in the Bazar structure acquires an experimental connotation precisely in this sedimentation and revival process of permanent characters: the continuous device with alternation of commercial spaces; the relationship between the depth and the extension of the section of the Bazar in a way that it would potentially accommodate different functions displaced also on different levels; the device for natural ventilation and lighting of large spans etcetera (figure 3).

This set of references, aimed at revoking the recurring elements of the city, intends to ensure continuity in the settlement structure between the new proposal and the pre-existing environment, although it was mutilated.

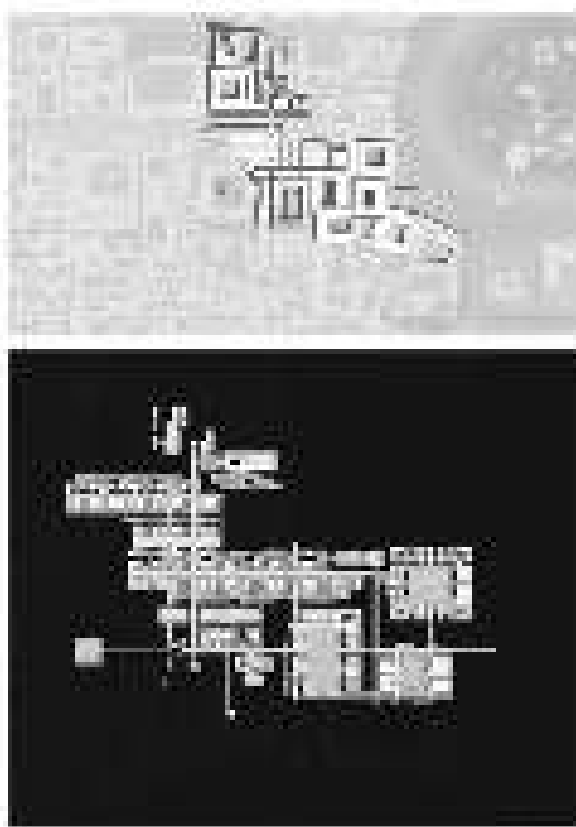


Figure 3. *Project for the reconstruction of Aleppo's Souk, master thesis by Stefano Davolio, roof plan and underground level, 2019.*

At this point, some clarifications are required. The project does not unlawfully appropriate the elements of history as typological and formal solutions to be restored uncritically. This process of rewriting emphasizes the figurative potentialities of these settlement principles gathered from history, predisposed to be reinterpreted experimentally through a critical process of transfiguration, hybridization and functional integration. It is an act that incorporates certain modalities of literary rewriting where, for example, some rhetorical figures and tropes intervene to mark the transformation processes by admitting, for example, allegorical transpositions, metaphorical allocations, and symbolic reductions. To be more relevant to the field of architectural design, these operative modalities would allow the project practice to consciously address the creative act on pertinent solutions to the nature of the context, through the conception and the reproduction of unconventional architectural solutions and at the same time free from the subjugation boundary with history. To act as a solvent in this process of rewriting is the freedom offered by the creative path that positively conditions the transformation project of the city, working with critical awareness between the acquired values (heritage and traditions) and the potential values (responsible freedom, awareness of the possibilities of development allowed by the given context).

The procedure adopted in the intervention on the city of Aleppo has followed some phases here briefly described.

In the first phase, the project assessed the recovery of some damaged buildings through an intervention that took into account the settlement issues of the entire city.

A second phase considered the opportunity of installing new architectural structures to complete the destroyed parts of the Souk that, as well as ensuring the renovation of the building, would have allowed the existing fragments to host new activities.

In a third phase has been involved the arrangement of new structures able to interact dialectically with the preexisting ones, and to induce the verification of the coherence to the assumptions of the critical transformation around the various experimented settlement hypotheses.

Therefore the new Souk retraces the original structure along the axis of the ancient Hellenistic *via recta*, at a later time *decumanus* during the Roman era, which connects the gate of Bab-Antakia with the monumental complex of the Citadel.

Seven thick walls retrace the remains of the preexistence in an east-west direction along the urban axis of the Roman *decumanus*. A succession of vaulted arches replaces the typical 'barrel' form of the tunnels. The structural pace, rhythm and original proportions of the Souk are preserved, while a process of attenuation on the architectural mass is applied through an updated use of traditional construction techniques thanks to a reduction of the load-bearing structure due to the application of new material (figure 4).

The pathways of the new Souk are no longer composed of a single structure but of a juxtaposition of several architectural elements which together virtually rebuild its original form.

These compositional choices allow extending the existing paths ratifying the figurative autonomy of the new intervention while maintaining unchanged the invariant elements of the original architecture. The aim of the project is indeed to create a combination of new and old figures by encouraging a dialectical relationship between the historical building and the new one. It has been also planned to add other functional solutions to ensure new modes and behaviors in the use of spaces.

This occurs due to a doubling of the internal paths: a single space on two levels, which gets light and air from the openings placed on the roof of the building, connects the ground floor with the underground level (figure 3). The elements that compose the architectural complex are linked through a system of pathways extended upon the basement of the buildings. This connection takes place thanks to an orderly succession of triple-height tunnels, corridors, and large open-air spaces. Transferring in the basement part of the secondary activities of the Souk

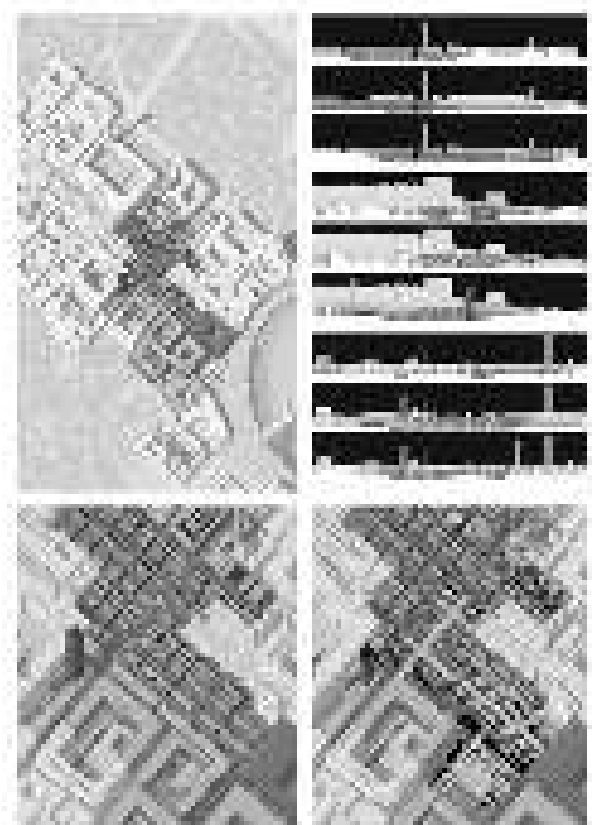


Figure 4. *Project for the reconstruction of Aleppo's Souk, master thesis by Stefano Davolio, sections and axonometric projections, 2019.*

allows the project to acquire new spaces, although contained in the geometry of the original encumbrance section.

The new architectural structure is, therefore, a complex system that, besides reconnecting the parts of the ancient Souk, is able to distinguish its figurative potential from the ensemble of preexistences and at the same time offer new spaces and volumes for the development of market activities. This distance between the new and the old, exalting its own figurative autonomy according to the previous one, induces that process of semantic estrangement in perceiving the new architectural organism within the urban context. The structures used to complete and replace the severely damaged or mutilated segments of the Souk and, more generally, of the whole Bazar also have this estrangement effect (figure 4). A similar phenomenon can be perceived in the new architectural structures placed to substitute the Khans, courtyard buildings mainly used for trading activities, specifically conceived as places for goods storage. New spaces and surfaces connected by a distribution system articulated on several levels allow, even in some cases where deemed necessary by the proposal, a different use than the original one. The adopted typological invariant is that of the centrality of the open space, organized around a courtyard, but with greater levels of complexity in the arrangement of spaces.

In some cases, in the construction of the elements that compose the figurative apparatus of the new buildings, in particular those placed to substitute or complete the preexisting Khans, it is possible to observe a further compositional process, more similar to an operation aimed at exalting the architectural mass through stylistic simplification, or through attenuation of figurative devices (figure 4). This process takes place through a formal synthesis that allows a transfigured condensation of the pre-existence figurative features, aimed at exalting the stereometric structure of the architectural mass instead of the purely linguistic aspects. Let's observe the operative procedures adopted in completing the mutilated part of Khan Al Farayin. The typology of the courtyard was maintained in the recovery project while integrating the structure through the addition of a basement that links the whole building to the rest of the complex. The rhythm of the original colonnade remains unchanged in the new part of the building to ensure syntactic uniformity to the space of the courtyard. The walls, as well as the interior spaces, are conceived in continuity with the figurative features of the historical architecture, highlighting yet the gap between new and old through a distance, a deviation due to a process of stylistic simplification, of a figurative depuration.

Through these compositional techniques, the project aims at corresponding to a dual mandate: on one hand, it proposes to revitalize the architectural system of the Souk integrating the existing structure with new elements; on the other hand, it endeavors to assume a monumental role in the overall redesign of the city. The same ideal motivations move towards the conception of the two towers placed along the axis traced by the Roman *cardus*: both acquire a more symbolic than functional role, becoming at the same time a religious emblem and a metaphor of the civil war.

5. Conclusion

The conceptual modalities of rewriting here analysed do not frame a set of categories to classify, in a taxonomic way, the case-studies adopted for the development of this research. Let's think about the experimental procedures adopted in the rewriting practices of a literary text (trans-textual practices). They do not divide the texts into different groups. In literature, the act of rewriting involves a critical assumption of these procedures by the interpreter. His task

is to choose the creative path to undertake, giving a specific methodological direction to rewriting, accentuating certain features to the detriment of others. The prevalence of a trans-textual practice makes it possible to recognize the affinity of a rewriting to a specific literary field, to recognize thus the intentions that guide the rewriting process but does not deny that within the same text more practices are recognizable other than the dominant one. Similarly it occurs in the rewriting processes in architecture. It means that in a single case study can be recognized more than one conceptual modality of rewriting.

We conclude underlining how the reflections carried out in these pages, naturally, do not claim to exhaust the cases of architectural rewriting process, traceable in the contemporary conditions nor to provide a comprehensive list of the operational tools of this generative technique. On the contrary, they mean to lay the methodological basis for more in-depth development of research. The types of rewriting identified thus provide a set of experimental procedures to analyse the case studies according to the generative processes adopted in the re-construction architectural project. The critical analysis of few architectural models would potentially allow the recognition of several design practices that, once organized in a systematic way, establish a set of compositional techniques to be declined according to the specific problems required by the context in which the architectural project is placed.

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Quantitative Study on Perception of the Public Space's Morphological Characteristics of Urban Existing Residential Neighborhoods in China Based on Psychophysics

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Keywords: Public space of urban residential neighborhood, morphological characteristics, psychophysics.

Conference topic: Urban Design: urban morphology, building typology and design/planning.

Abstract: In the past 10 years, considerable attention has been paid to the interrelationship between physical environment and human perception, cognition, preference and behavior. This study established the research framework of "physical form – psychological perception" of the public space in existing urban residential neighborhoods by introducing into the theory of psychophysics. Six quantitative indicators were proposed to measure the morphological characteristics of the public space in existing residential neighborhoods in China. The comparative analysis of the spatial vitality of the public space as well as the morphology in the existing residential neighborhoods indicated that four of the indicators were efficient to measure the morphological characteristics of the existing residential neighborhoods which were: the sky view factor, visible ratio, D/H index, and the total depth value index. There was a significant logarithmic relationship with the index of sky view, visible ratio and the D/H through the curve fitting study between the objective attributes of public space morphological features and subjective psychological perception evaluation value of the elderly, which conformed the Steven's law. This would provide a basic data support and more scientific and rigorous research methods for the optimization and transformation in urban existing residential area.

1. Introduction

With the acceleration of urbanization, the compactness and the congestion will be an inevitable trend for cities in China and other Asian countries. People's behavior and the perception of the residential environment are being influenced by the dense and vertical living pattern. (Huang Yiru *et al.*, 2016). In China, urban public spaces have become an important places for the daily social activities and participation of the elderly. Its' morphological characteristics as well as the high quality can increase the opportunities of communication among the elderly in residential neighborhoods, and it will play a vital role in regulating the emotional health of the elderly. Existing studies have shown that the changes of building facade, the open space and the sight to the green space have become the key factors affecting users' perception of the space.

Among these factors, the naturalness of residential neighborhoods (Gregory N *et al.*, 2015), the proximity to green space (Mireia Gascon *et al.*, 2018) and other factors can be more effectively in alleviating the physical and mental pressure of the elderly. Expressing perceptual and subjective spatial perception through rational and objective methods have lately received great attention in the field of urban morphology and public health. Based on the psychophysical's "mind-matter" theory, the paper aimed to investigate the relationship of morphological characteristics of the public space in existing urban residential neighborhoods in China and the evaluation of psychological perception of spatial form by the elderly. Through statistical analysis, it aims to find out the relationship between the morphological characteristics of the public space in existing urban residential neighborhoods and the psychological perception of the elderly. Overall, finding out the best threshold of the indicator of the morphological characteristics in the public space in urban residential neighborhoods.

2. Methodology

2.1. Psychophysics

The goal of psychophysics is to describe the relationship between external physical stimulation and sensation and perception in the form of precise mathematical functions quantitatively. Weber's law, Fisher's law and Stevens' law are the three most classic researches. Spatial form, light, color and sound can be used as physical stimuli to trigger users' psychological perception of shape, brightness and loudness. Physical stimulation is equivalent to the form value of public space in existing urban residential areas, while psychological perception is the perception and evaluation feedback of the perception subject to the form of public space in existing urban residential areas

Modern psychophysics has been applied in the fields of environmental psychology, landscape scenery evaluation and urban spatial morphology. Zhou Yue *et al.* (2012) proposed the algorithms of interface density, near-line ratio based on Weber's Law to describe the overall cognitive difference of street interface; Huang Yiru *et al.* (2016) obtained the relationship model between spatial perception density and "gap-ground sunshine intensity" and "gap-ground sunshine intensity/building number" by regression; Han Junwei *et al.* (2015) found that the relationship between visual entropy and preference value in visual evaluation of pedestrian street landscape conformed to Fichner logarithm law.

In recent years, researchers have been more inclined to study the interaction mechanism between urban form characteristics and environmental perception, cognition, preference and behavior from the perspective of path-finding, location, congestion, security and other spatial organizational structures (Bechtel, 2002; Kubat, 2015), but ignored the impact of interface, enclosure and labeling on users' spatial perception in micro-scale space. In this research, psychophysics was used in the study of the morphological characteristics of the public space in existing urban residential areas in China to seek the quantitative relationship between the attributes and the perceptual response of human beings. Compared with other psychophysics, the main task of psychophysics is to explain the inherent meaning of the mechanism of "environment-psychology-behavior", and to establish subjective views and reflections. The relationship between the characteristics of natural objects is governed by laws. In the process of measurement, the use of physical and mathematical methods can effectively avoid the experimental

errors caused by personal preferences and life experience, only focusing on the evaluation of fitting results, and help researchers simplified the evaluation process.

3. Analysis

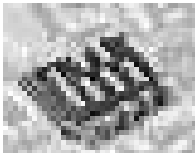
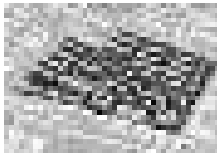
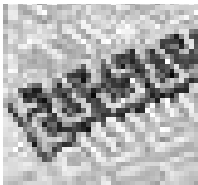
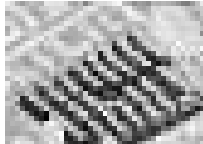
3.1. Research objectives

As one of the most serious aging cities in China, Tianjin has become a representative research city. According to the spatial distribution characteristics of the elderly population in Tianjin in 2017, Hongqiao District, Hebei District, Hedong District and Nankai District have the highest proportion of the elderly registered population, which were 31.38%, 31.4%, 29.4% and 28.33% respectively. The Zhaohuli residential neighborhood, Xinyuancun residential neighborhood, Santandongli residential neighborhood and Yuxianli residential neighborhood of Tianta Street in Hexi District were selected as the research areas. The information of the four selected districts was shown in Table 1.

3.2. Morphological characteristics attributing to the public space in urban residential neighborhoods

In the field of urban morphology research, the correlation between typical forms of urban residential areas and environmental perception was identified through cross-analysis of different dimensions such as street turning number, environmental diversity, destination accessibility, building height, street width ratio *et al.* For urban designers and environmental psychologists, it is of great significance to do research from the point of micro-scale. According to the visual perception characteristics, this research divided the research interface of public space in existing urban residential areas into the bottom interface (including roads, enclosure greening, etc.), the horizontal enclosure interface and the top interface. By upholding the principles of systematicness, independence, observability and reflecting public aesthetics, this research chose the following six morphological attributes to study:

Table 1. Information of the selected residential areas.

Residential Location	Zhaohuli	Yuxianli	Santandongli	Xinyuancun
				
Basic Information	Construction Year:1986	Construction Year:1985	Construction Year:1991	Construction Year:2000
	Floor area ratio:1.6	Floor area ratio:2.36	Floor Area Ratio:2.23	Floor Area Ratio:2.1
	Ratio of green space:10%	Ratio of green space:20%	Ratio of green space:10%	Ratio of green space:10%
	Aging rate:21%	Aging rate:22%	Aging rate:18%	Aging rate:17%

(1) Sky view factor

Sky view factor is an important urban morphological parameter as well as an important factor affecting the thermal comfort of urban public space. Its practical significance expresses the degree of closure of urban space. The smaller the value of sky view factor, the more closed the space is. At the same time, the larger the occupied area of buildings entering the visual range of human eyes, the stronger the sense of psychological oppression. In the research, the ratio of the projection area of the sky on the sphere to the whole hemisphere area was calculated by the spherical area ratio method.

(2) Variation of roofline

The variation of the adjacent roofline reflects the fluctuation degree of the roofline on the top of the building relative to the human viewpoint. For the public space with smaller scale, the larger the fluctuation of the roofline on the top of the building, the more information the fluctuation of the scene reflects, which reflects the richness of the space. In this study, the standard deviation formula $\rho = \frac{\sum_{i=1}^n (h_i - \bar{h})^2}{n}$ was used to calculate the variation of roofline. (where h_i represents the building height and $\bar{h}$ represents the average height of the enclosed building around the public space)

(3) Spatial openness

The index of D/H can describe people's different spatial openness feelings, which is related to human visual cognitive characteristics. In the research, the D/H index which was proposed by Yoshinobu-ashihara was used as an index to measure the degree of external space openness, which was, the ratio of the distance between observation points and buildings (D) to the height of buildings themselves (H).

(4) Spatial visibility

The visual part of urban space refers to the area covered by the observer when she/he acts in the city. The higher the visibility of space, the less the occlusion area in the viewer's field of vision, the higher the spatial pleasure. In this study, the calculation formula of Niu Xinyi *et al.* (2011)¹ was used.

(5) Accessibility of the public space

The study of spatial topology pay attention to the implicit structural characteristics of space. The total depth value represents the convenience of reaching destination. The total depth value of the existing urban residential public space is the sum of the average depth values of each node. The smaller the global depth value, the more convenient the location of the space in the system is.

(6) First layer interface density

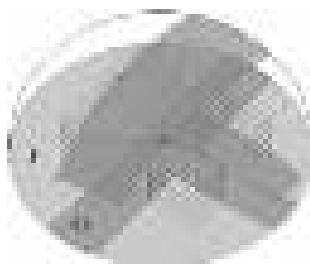
The index of interface density on the first floor is closely related to the degree of dispersion of enclosed buildings around public space in residential areas. The longer the interface is, the

fewer opportunities for the public space to connect with the environment, in the same time the fewer natural light, landscape and a single feeling of external space can be obtained. In this study, the first floor interface density is the ratio of the total length of the first floor interface of all surrounding buildings to the total length of the public space boundary.

3.3. Selection of the Public Space Morphological Index of Urban Existing Residential Neighborhoods Based on Spatial Vitality Index

(1) Geographical distribution characteristics of the spatial vitality in residential neighborhoods

According to the behavioral characteristics of the elderly in the public space of residential areas observed regularly and at fixed points in the field survey, the spatial types of high, medium and low vitality indexes were identified and put into ArcGIS system by referring to Jianglei's² spatial vitality calculation formula. It was determined that the zones which are graded 10-20 are high vitality, the zones graded 5-10 are medium vitality, the zones graded 1-5 are low vitality.

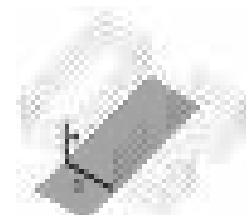


(1) Indicators of Sky View Factor: S_1/S



(2) Indicators of variation of roofline:

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (h_i - \bar{h})^2}{n}}$$



(3) Indicators of spatial openness: D/H



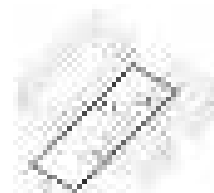
(4) Indicators of spatial visibility:

$$I = (I_a + I_{a+120} + I_{a+240})/3$$



(5) Indicators of accessibility:

$$\Lambda_1 - \Lambda_2 - \Lambda_3$$



(6) Indicators of first layer interface density: $(C_1 + C_2 + C_3)/C$

Figure 1. Characteristics attributing to public space morphology in existing urban residential areas.

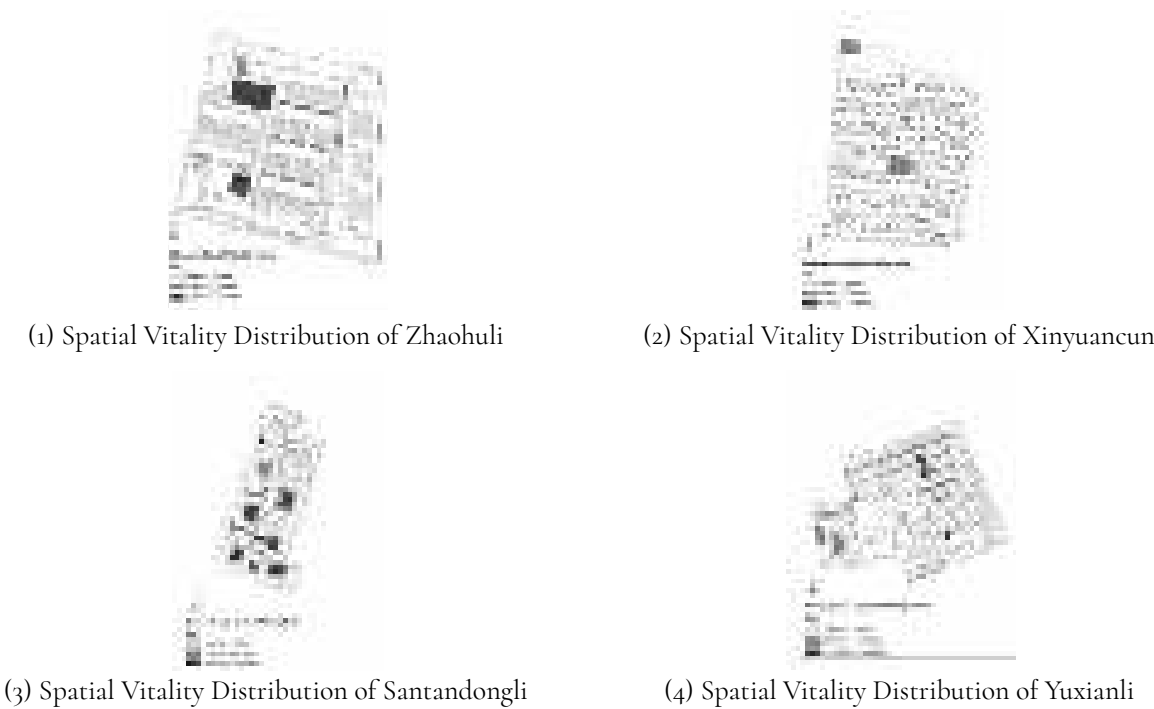


Figure 2. Geographical distribution characteristics of spatial vitality in residential neighborhoods.

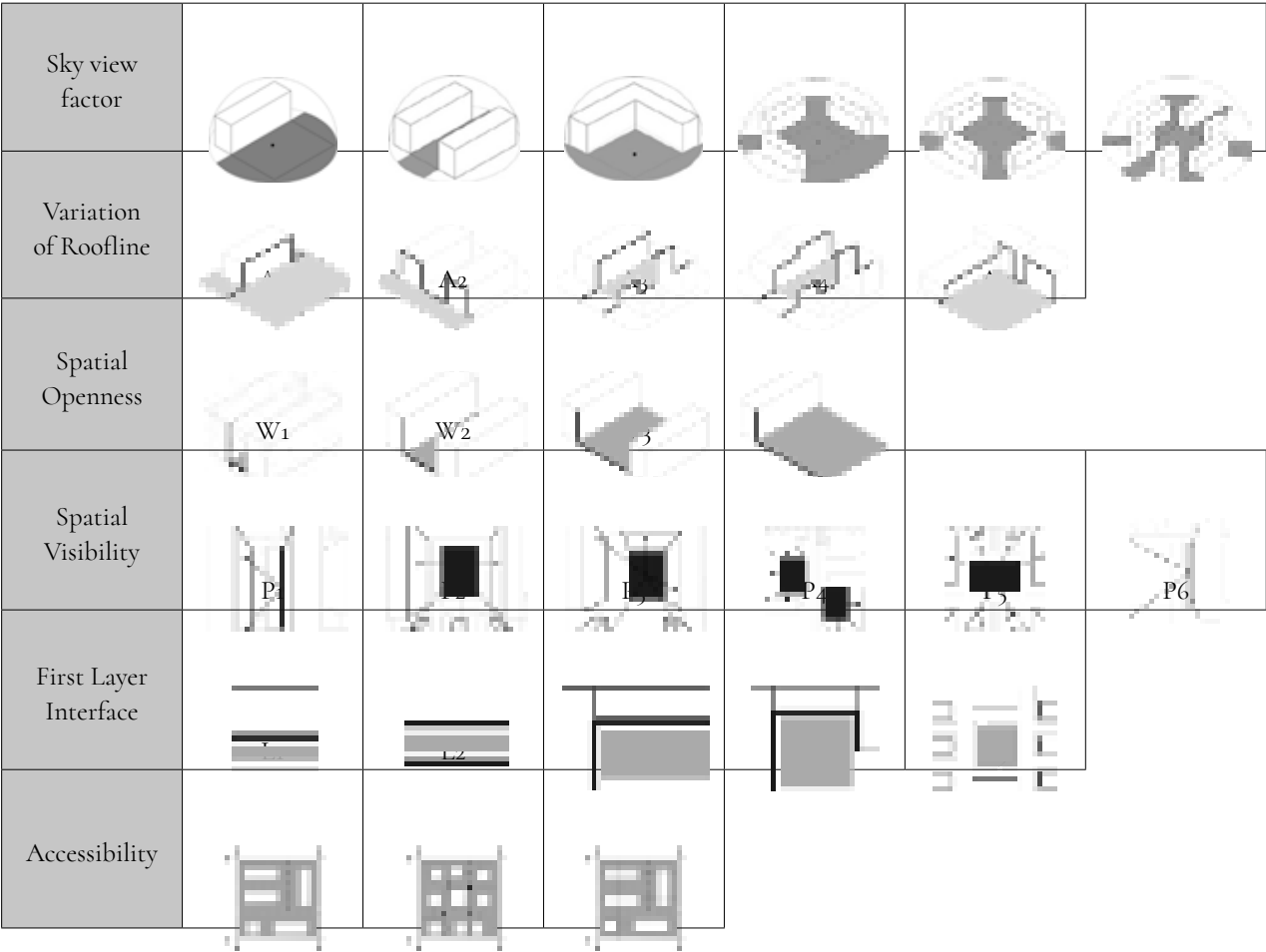


Figure 3. Morphological characteristics of public space in existing residential areas.

(2) The correlation analysis between the morphological characteristics and the degree of spatial vitality in existing urban residential neighborhoods

The first category: the spatial vitality index had little correlation with the first floor interface density and the variation roofline. According to the distribution law, the spatial vitality index had little correlation with the first layer interface density and the change of roofline. With the increase of spatial vitality index, there was no significant regularity in the change of these two index of the public space in residential neighborhoods.

The second category: spatial vitality had strong correlation with sky view factor, spatial openness, accessibility and spatial visibility. The correlation between spatial vitality index and sky view factor, spatial openness, total depth value and spatial visibility were similar. When space vitality index was low, the morphological characteristics of open sky, spatial openness, spatial accessibility and the spatial visibility were clustered in the first three spatial types. With the increase of space vitality, the spatial type characteristics converged gradually backward to the last three spatial types.

In summary, sky view factor, D/H index, total depth value and the space visibility index had strong impact on the vitality of the public space in existing urban residential neighborhoods, while the correlation between the variation of roofline, the first floor interface density and space vitality were weak. Therefore, this research chose the four highly correlated indicators to quantify the perception of morphological features.

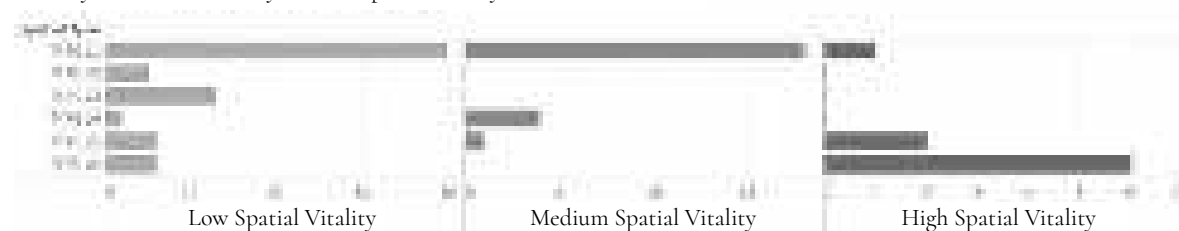
4. Results

4.1. Quantitative Study on Perception of the Public Space Morphological Characteristics in Existing Urban Residential Areas

In order to explore whether there existed the three functional relationships between objective stimulus and subjective perception proposed by psychophysics between stimulus (spatial

Table 2. The correlation degree between spatial vitality and first layer interface density, roof curve value.

First Layer Interface Density and the Spatial Vitality Index



Roof Curve Value and the Spatial Vitality Index

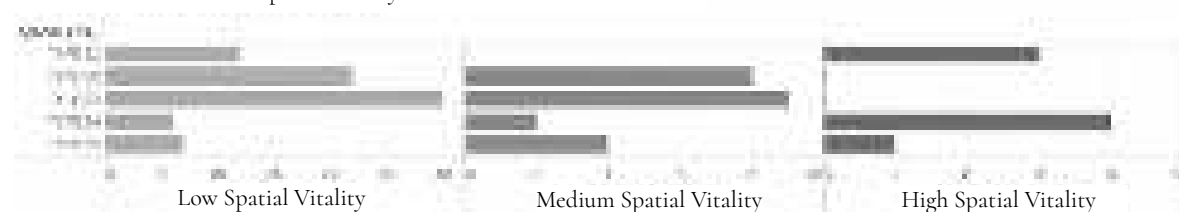
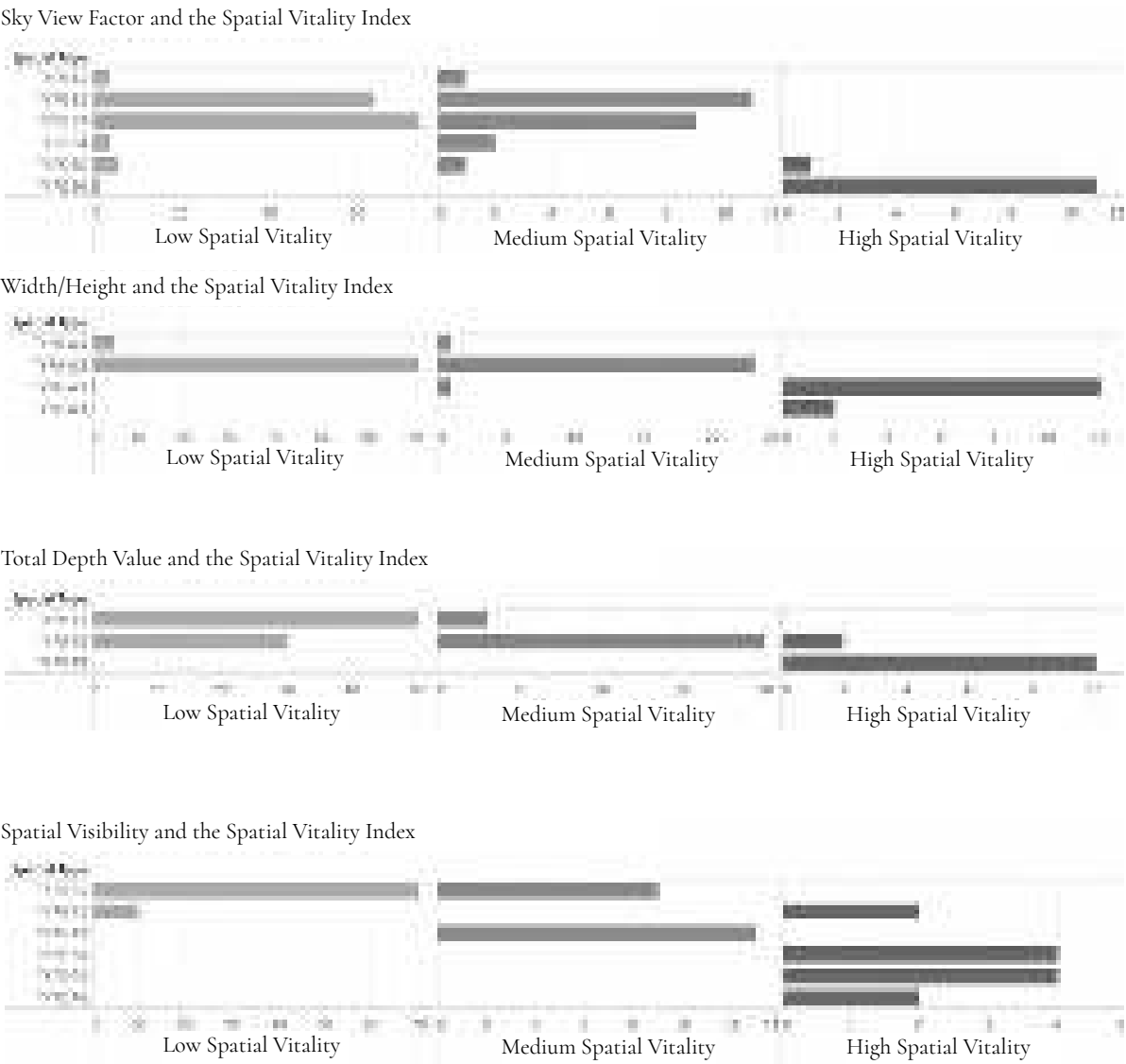


Table 3. The correlation degree between spatial vitality and sky view factor, D/H, total depth value, spatial visibility.



attributes) and sensation (evaluation value Table 3. The correlation degree between spatial vitality and sky view factor, D/H, total depth value, spatial visibility. s), 20 high and moderate vitality index public spaces in four residential neighborhoods were selected. Through random invitation to the elderly who were using them. Generally, 30-40 copies of questionnaires were controlled in each residential area, and a total of questionnaires were distributed. 160 questionnaires were selected and 139 valid questionnaires were collected. The questionnaires were formulated by Lickett Scale 7. A total number of 48 elderly people completed the questionnaires. At the same time, in conjunction with the research group of the researcher, a series of symposiums on community public space for the aged were organized. Fifty-six elderly people participated in the perception and evaluation of community public space. Semantic Differential was used to analyze the content of the symposium by comparing the Semantic Differential Scale with the Semantic Differential Scale. With the help of statistical software SPSS, curve fitting were carried out. The results were showed as follows:

(1) Curve fitting between sky view factor and sky openness evaluation

The fitting results showed that the power function relationship between sky view factor and sky openness evaluation was stronger than the linear relationship and logarithmic function relationship. Shown in Fig. 4., and there were significant advantages. Sky openness had a positive effect on the spatial penetration of the subjects. The bigger the front space is, the better the psychological feeling. At the same time, when the sky openness index reached 10%, the user's psychological feeling grew slowly.

(2) Curve fitting between D/H and interface space openness evaluation

The fitting result showed that the power function relationship between aspect ratio and the evaluation of enclosure interface openness was slightly stronger than that between linear and logarithmic functions, as shown in Fig. 4. Spatial aspect ratio had a positive effect on the spatial openness feeling of the subjects. After the index peaking 1.4, the spatial user's openness feeling increases slowly.

(3) Curve fitting between spatial visibility and spatial permeability evaluation

The fitting results showed that the power function relationship between spatial visibility and spatial permeability evaluation was slightly stronger than that between linear and logarithmic functions. The power function model reflected that the degree of public space penetration in residential areas was an important factor affecting the perception of spatial penetration. As the degree of penetration increases, the complexity of spatial interface decreases.

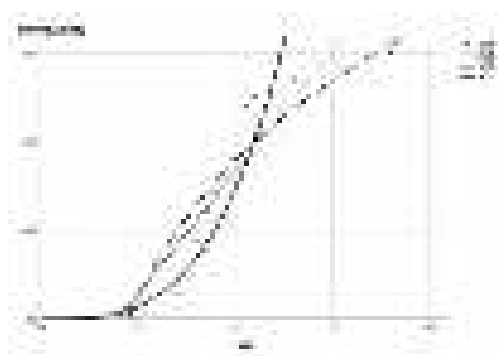
(4) Curve fitting between total depth value and spatial convenience evaluation

The fitting results showed that the linear relationship between global depth and spatial convenience evaluation is stronger than that between logarithm and power function. Global depth had a negative effect on spatial convenience. The lower the global depth, the better the psychological feeling. The linear model reflected that spatial accessibility evaluation would decrease by 1.69 for every increase of global depth.

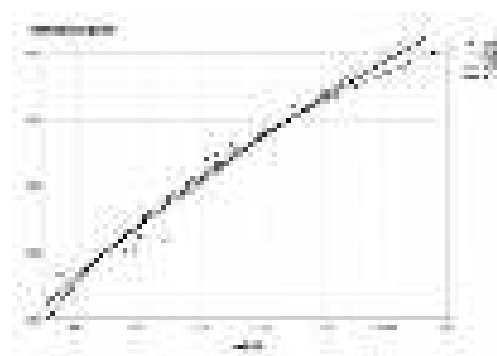
5. Conclusion

The results showed that the morphological characteristics of urban public space had a significant impact on the spatial perception of the elderly, and the impact can be quantified and described, forming a corresponding relationship function, which is in line with the classical functional relationship of psychophysics. Based on the analysis of the correlation between spatial vitality and public spatial morphological characteristics, it was found that the sky openness, aspect ratio, global depth and spatial visibility have the objective values of physical morphology which are meaningful in the framework of "space-behavior-perception" research.

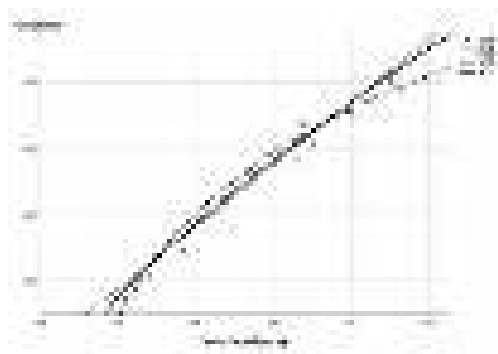
Sky view factor, D/H and spatial visibility can reflect the positive impact of elderly people on the psychological perception of the public space in existing urban residential neighborhoods: when the stimulus increased in accordance with the geometric level, the perception increases in accordance with the power function level. At the same time, from the trend of fitting



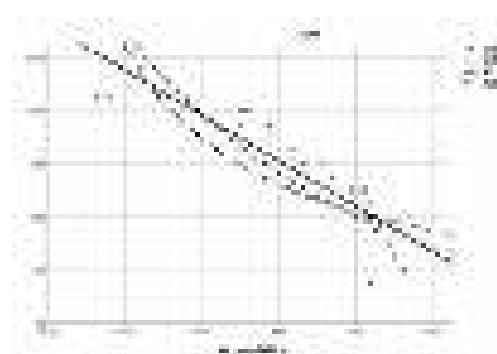
(1) Fitting results of permeability evaluation and sky view factor



(2) Fitting results of spatial openness evaluation and D/H factor



(3) Fitting results of complexity evaluation and spatial visibility factor



(4) Fitting results of convenience evaluation and total depth value factor

Figure 4. Curve fitting results

curve, the psychological perception produced by increasing the shape eigenvalue of the same magnitude tends to decrease gradually, and the total depth value had a negative linear impact on the spatial psychological perception evaluation of the elderly.

6. Discussion

In addition, the experimental results showed that the intensity of logarithmic function and power function were similar individually. There may be two reasons: (1) the sample size is not large enough to show a longer function curve, which makes the fitting difference between the two functions incapable of being reflected; (2) the measurement accuracy is not accurate enough, and the subjective perception and psychological quantity collected from questionnaires and interviews are not accurate enough. There were some errors, which affect the later fitting effect.

Notes

¹ The calculation formula proposed by Niu Xinyi *et al.* (2011): $I_o = \frac{O}{N} \times 100\%$, Among them, O is the observation point, P is any point on the field of view, and N represents the total number of lattices constituting the field of view. Considering that the user is in the public space of the residential area and is affected by the 360 degree viewing angle space, the viewer's viewing

angle range is 120 degrees each time. The final formula for calculating the spatial visibility is: $I = (I_a + I_a + 120 + I_a + 240) / 3$.

2 Data were provided by Tianjin Committee on Ageing of the Tianjin Government.

3 Referring to the scoring method of vitality index formulated by Jianglei: vitality index $Y = Y_1$ (number of static activities) + Y_2 (number of interactive activities) + Y_3 (residence time). Among them, Y_1 scoring criteria: the number of people participating in static activities within 15 minutes, each person scored 1 point; Y_2 scoring criteria: the number of interactive activities within 15 minutes, each person scored 1 point; Y_3 scoring criteria: each person staying for 0-1 minutes scored 1 point (time scored 1), each person staying for 1-5 minutes scored 1 point (time scored 3), each person staying for 5-10 minutes scored 1 point (time scored 7.5), each person staying for 10-15 minutes. Personal score is 1 point (time is 12.5), and each person who stays for more than 15 minutes is 1 point (time is 15).

4 Learning from Wu Xi's research: when the boundary surface of public space is equal, the sky openness is positively correlated with the shape ratio of open space. In this research, different types of projection shapes of open sky on the ground were used to refer to the shape types of sky openness.

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A Quantitative Approach to Morphological Research Based on Public Space

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Keywords: Quantitative approach, morphological research, urban form, urban space.

Conference topic: Methods 1: embedding different approaches into the study of urban morphology.

Abstract: Understanding urban form generation process could add a strong ability for architects and urban designers in urban design, especially in urban renewal projects. Morphological elements, such as block/streets, plots and buildings, play important roles in the form changing process, which are also the elements in urban design projects since they play the role for forming the urban space. Due to tightly integrated together, morphological changing process must cause changes in its spatial characteristics that urban designer cares. Therefore, it is worthwhile to study urban spatial characteristics based on its morphological changing process.

This paper aims to investigate urban spatial characteristics changing process in the urban center based on its morphological study. As the center of Nanjing, Xinjiekou area is selected as the case for morphological integrated study on the physical form of spatial characteristics. Based on deeply studied of its form changing process and social background, we introduced an analytical model to assess the spatial features of the public space within these blocks through the time line of form changing, some spatial characteristics judging indicators including area, average width, circularity and openness have been developed. The results may provide urban designers and architects with not only the changing rules or trends of urban space, but also designing tools, and make them better understand the relationship between the urban form and urban space, and finally may put forward new ideas to morphological research.

1. Introduction

Urban morphology provides a method for studying the process of urban development through the investigation of urban form. Studies in urban morphology focus on the tangible results of social and economic forces (Moudon, 1997), and extensively analyze the buildings, city blocks and streets. By investigating these elements, urban form was shown to be amenable to systematic analysis (Kropf, 2009).

Despite the quantity of research in urban morphology, on the other hand, research on the voids between built structures has been limited (Çelik, Favro, and Ingersoll, 1994; Moughtin, 2003a, 2003b; Woolley, 2003). Osmond introduces the notion of a parallel hierarchy of open space to support urban analysis, planning and design across multiple scales of investigation

(Osmond, 2010). It can describe hierarchy of open space, but cannot express the change of open space. The change of urban form brings about the change of urban space. People feel the change of the city through the change of urban space. Therefore, it is meaningful to make a research on the change of urban space.

On the other hand, China is currently in the process of rapid urbanization. As the result of urban and architectural design, urban form has undergone dramatic changes. However, widely acknowledged principles pertaining to the composition of urban form and the processes that underlie it have been slow to become established (Whitehand, 2009). Due to the lack of theoretical guidance, urban construction is blindly operated, which causes chaotic urban landscape. Under such circumstances, to understand the urban form changing process and urban spatial characteristics based on its morphological changing process is necessary.

As the first step of the research, this paper focuses on public space. Public space is the place that is generally open and accessible to people. The Nolli map represents the city's urban form by figure-ground plan and expresses an understanding of urban structure, urban fabric and public space of Rome. It is actually a relationship between public space and entities. The black part of the map represents the building entity, while the blank part is the public space (Li and Feng, 2017). Unlike Nolly Map, which takes indoor and outdoor public spaces into consideration, this paper focuses on outdoor public space, such as square, streets and path.

2. Method

2.1. *The research area*

As a city in economically developed area of China, Nanjing was chosen for the case study. It is a city with a history of more than 1800 years. As time goes on, the urban functional structure and physical form have undergone profound changes. Like other cities in China, the urban fabric of Nanjing can be recognized as the composition of four main morphological categories: historical blocks, scenic area, residential blocks, and commercial blocks (Zhang and Ding, 2013). Since the different functions of sites within an urban area tend to be differentiated by physical form, each morphological category tends to have distinctive form and can be studied individually (Whitehand, 2009). Among these morphological categories, the space in commercial blocks is particularly complex and has changed dramatically, which has great research value. The Xinjiekou central area is located at the center of Nanjing and has become the business center of this city since 1929. Based on former studies of this area (Zhang and Ding, 2013, 2018), a quarter of Xinjiekou central area was used for this study (Figure 1).

2.2. *The research period*

Since the urban construction in China was influenced by the political, economic and land policies at the time, the development of the city can be divided into four period. In 1949, New China was founded, and the planned economy system was gradually formulated. With the Reform and Opening-up Policy in 1978, the planned economy system gradually disintegrated. After 1988, trading of land-use rights through land auctions was legalized, and the former land policy of free allocation began to be phased out. (Zhang, 2018). After decades of economic development, the urban form of Xinjiekou has changed significantly. Therefore, 1949, 1979, 1988, 2000 and 2019 were selected to show the change of urban public space.

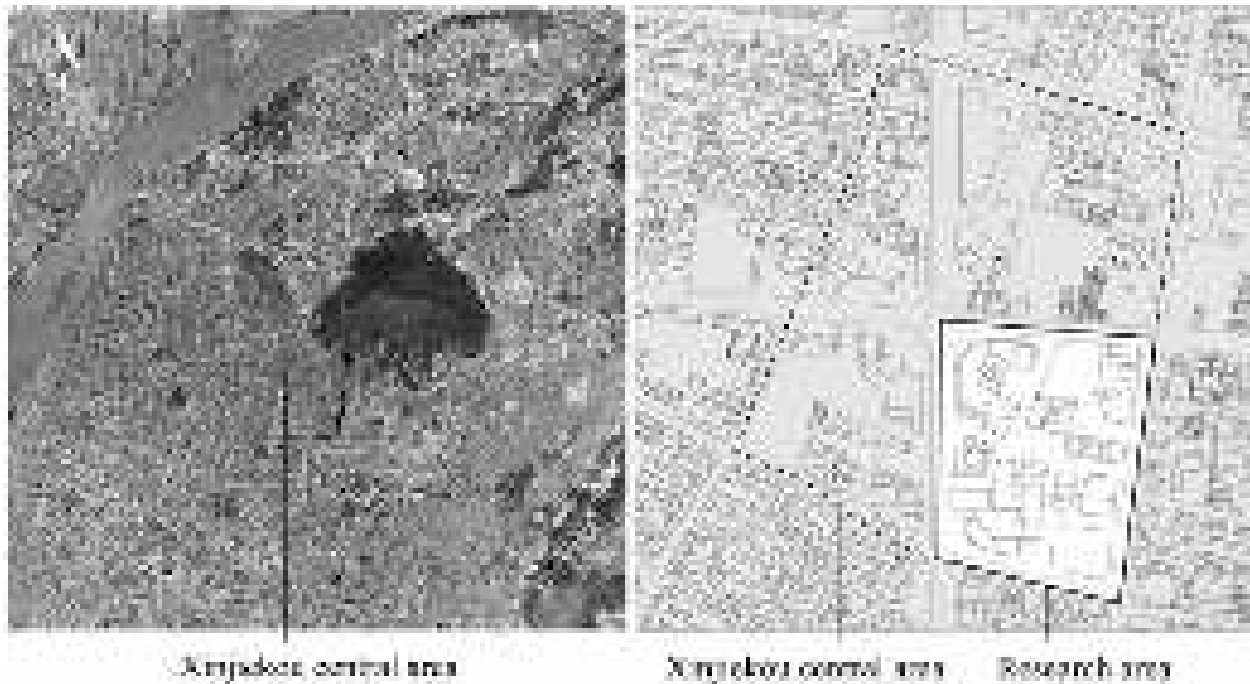


Figure 1. The research area and its location in Nanjing. Source: Google image from 2004 and land-use map of 2019 from the Nanjing planning Bureau.

2.3. Confirmation of public space and sources of the research

Not all open areas are public spaces. Public space is the main place where people are active in the city, including active streets (surrounded by commercial buildings), squares, parks, etc. Private courtyards and internal roads of residential areas are not the public space. The judgment of the current public space can be achieved through on-site investigation, while that of the past public space is more difficult and needs the evidence to infer.

Through the field investigation, the location of public space in the block in 2019 was confirmed. Figure 2 shows the drawings and photos of the spaces in the block in 2019. Among them, all except No. 6 (the dump) and No. 16 (the construction site) are public spaces.

The location of current public space can provide reference to judge the location of the public space before. Some public spaces have not changed during the development of the block, so that the former location was still the public space. While further research is needed on the changed space.

Morphological investigations depend heavily on historical maps and other tangible evidence. It is necessary to synthesize various information to infer how public space evolved in the past. The first step is to collect maps of past corresponding stages. The maps were collected from the Nanjing Urban Construction Archives (NUCA), which is the organization in charge of all urban planning and construction documents in Nanjing. NUCA can provide documents including land ownership and building block-plans in 1952, examination and approval archives of land use planning and engineering planning in 1979 and 1988, and digital map in 2000. Based on these maps, we can get maps containing information about buildings, walls, roads and some land use function in 1949, 1979, 1988, 2000 and 2019. In addition, through interviews and collecting photos from the past, the land utilization can be further distinguished (Figure 3).

During the study of judging the past public space, we find that the information of the 'work unit system', or danwei, is a very important reference. After 1949, danwei became the basic unit



Figure 2. The drawing of the public space and the photos of the spaces in the block in 2019.



Figure 3. Different maps and photos of the research area. Source: (a-b) Nanjing Urban Construction Archives (NUCA); (c) Local chronicles of Jiangsu province; (d) www.picturechina.com.cn. (a. Land ownership and building block-plans in 1952; b. Examination and approval archives of lengineering planning in 1988; c. Aerial view of Xinjiekou distict in the 1930s; d. The photo in the 1950s.)

and subsystem of urban society in China (Bray, 2005). A danwei is actually a social tax payment entity, such as a department store, cultural institution, government body, factory or school. For the sake of security and privacy, danweis usually build walls on the boundary of the plot.

Therefore, the method for determining the public space of the block is as follows. Firstly, according to the position of the wall on the map, the inside and outside of the danwei are determined. The inside of the wall is basically the private space, and the outside of the wall may be the public space. Then, according to the land use of the surrounding plots of the space, and referring to the distribution of the public space afterwards, the distribution of the public space of each research period is finally determined (figure 4).

3. Analysis on changes in public space in the block of Xinjiekou

3.1. Three types of public space

Since 1949, there have been three types of public space in the block: street, semi-square, and square (figure 5). A street is a strip space and a public thoroughfare in the built environment.

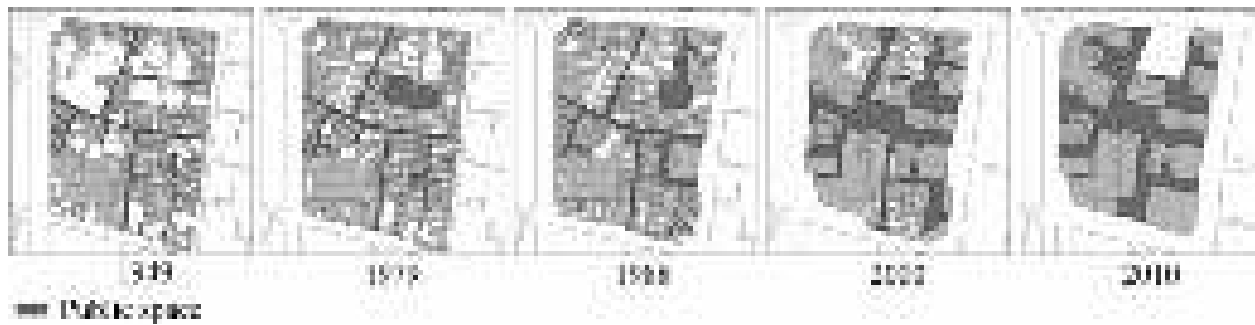


Figure 4. The transformation of public space in the block of Xinjiekou central area.

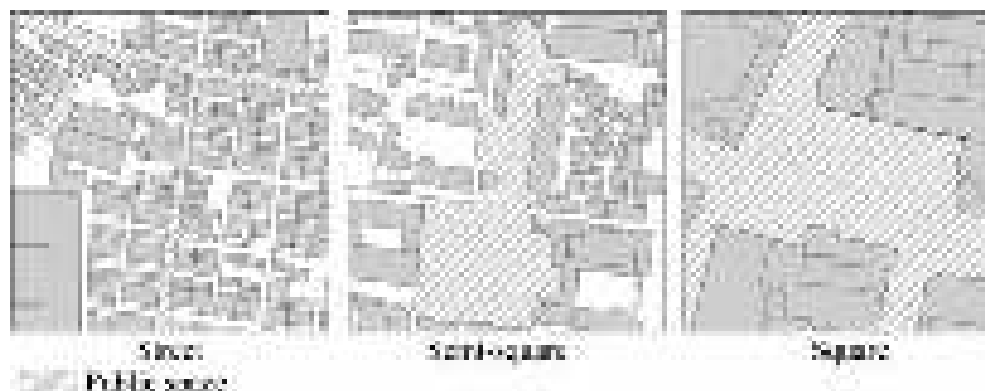


Figure 5. The types of public space: street, semi-square, square.

Semi-square is the square inside the danwei, such as Workers' Culture Palace. Semi-square is closed by walls or gates and is only open to specific groups of people, such as workers. A square is usually a flat open place for people to meeting or rest. In ancient Chinese cities, apart from the front of the temple, there is a lack of squares.

Kropf proposed a multi-level diagram to represent the generic structure of built form (Kropf, 2018). It also highlights the three types of void that constitute the 'usable spaces' of the built environment: rooms, open areas and street spaces (Figure 6 a). Based on the void in the multiple diagram, this paper further defines the scope of outdoor public space: semi-squares, squares and public streets (Figure 6 b). It helps to understand the meaning of different kinds of public spaces.

3.2. Preliminary comparison

According to the maps of the public space from 1949 to 2019, the changes in the area of the public space, the area of the different types of the public space, and the length of the streets are calculated and compared.

Figure 7.a shows that the area of the public space is constantly increasing from 1949 to 2019. There is a sharp increase from 1949 to 1979, and from 1988 to 2000. While in the 10 years from 1979 to 1988, there was basically no change in the area of public space.

By comparing the changes in the area of specific types of public space (Figure 7.b), we can find that semi-square appeared in 1979 and disappeared in 2000. The semi-square belongs to the Workers' Cultural palace. At the beginning of New China, the palace was inserted into this central city area as a symbol denoting the improvement in social status of the workers. With the development of the city, the palace has lost its past glory. After many times of government

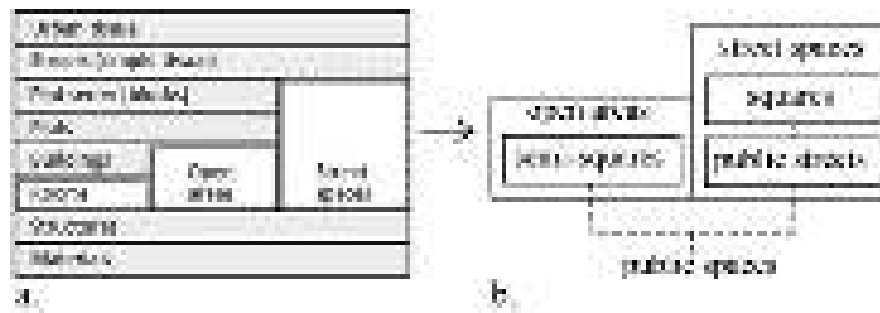


Figure 6. (a) The multi-level diagram of generic structure (Kropf, 2018). (b) The scope of public space.

planning and demolition, the area of the palace has been shrinking and moved to another location finally. The first square appeared in 2000. When land markets were authorized after 1988, the creation of new danweis gradually ended and the past danweis are gradually relocated and demolished. The Xijiekou central area has gradually developed into a commercial center gathering commercial complexes. The square surrounded by many commercial buildings appeared.

The streets have always existed from 1949 to 2019. Although the area of streets is getting bigger and bigger, the length of the street is almost constant (figure 7 c). This implies that the width of the street has increased.

4. Quantification of spatial morphological characteristics

4.1. The object of comparison

During the development of the block, there are three streets that have always existed, namely Pubuying, Zhenghong Street, and Zhenghongli (figure 8). Among them, Pubuying and Zhenghongli were renamed Xijiekou Pedestrian Street after 2000. Zhenghong Street is an east-west street, and the other two are north-south streets. Only the public space that has always existed has the comparability of spatial morphological features. Therefore, the three streets are chosen as the object of quantitative comparison.

4.2. The method of comparison

There are many methods to quantify the characteristics of space. Various simulation tools have been developed based on the concepts of 'convex space', the 'viewshed' and 'isovists' (Turner *et al.*, 2001). As a network form, the accessibility, proximity, integration and connectivity of urban space can be analyzed by means of the "space syntax" methodology. Wowo Ding (2011) proposes a new kind of pattern: street spatial related line to indicate the street spatial characters based on the viewshed analysis in GIS. Starting from the human movement within an urban configuration and the visibility of spaces, the Space Syntax method analyzes open spaces by isovists, which are 'the set of all points visible from a given vintage point in space' analyzed according to six parameters: area field, perimeter, visible perimeter, compactness, occlusivity, variance and the skewness of radial distances (Benedikt, 1979). Batty suggests a new approach to analyzing isovist spaces. In this approach, the polygonal structure of an isovist field is changed with tessellation based on a regular grid (Batty, 2001).

Due to the complexity of urban space, the indicators for measuring spatial characteristics are

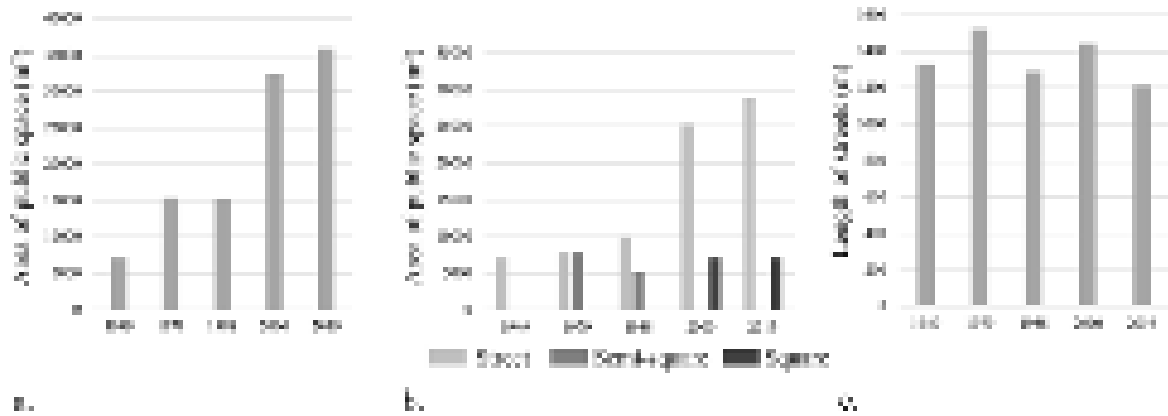


Figure 7. The statistics of the transformation of public space: area of public space, area of 3 types of public space, length of streets.



Figure 8. Three streets in the block from 1949 to 2019: Pobuying, Zhenghong Street, and Zhenghongli.

diverse. For urban activities, the size of space determines the function and carrying capacity of space, affecting the perception of space and the physical environment. In the case of the same size, the shape often determines whether a space is a square or a street. Even if the space is the same size and shape, the degree of enclosure can determine the nature of the activity, changing the openness and ventilation quality of the space.

Based on the former research (Ji, You and Ding, 2018), a new analytical model to assess the spatial features of the public space within the blocks has been developed. The model uses four indicators including area, average width, circularity and openness to quantify spatial features.

The area is the area of the enclosed space. The average width is the average of the width of the street taken every 30 meters. The circularity is the ratio of the perimeter to the area. The openness is the ratio of the length of the opening to the total length.

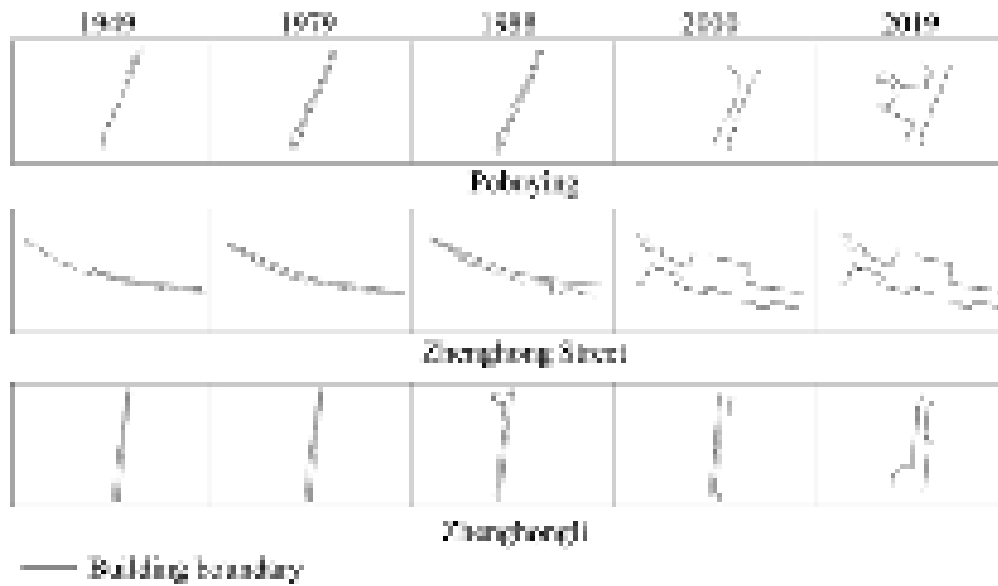


Figure 9. Three streets for comparison: Pobuying, Zhenghong Street, and Zhenghongli.

5. Experimentation on three streets in the block of Xijiekou

6.1. The three streets

Figure 9 illustrates the three streets: Pobuying, Zhenghong Street and Zhenghongli from 1949 to 2019 respectively. Building borders of the space are indicated by solid lines and the openings are indicated by dashed lines.

5.2. Data calculation and analysis

There are four measures to describe the configuration of the public space: area, average width, circularity and openness. We calculate the measures and use these data for comparison and analysis (Table 1).

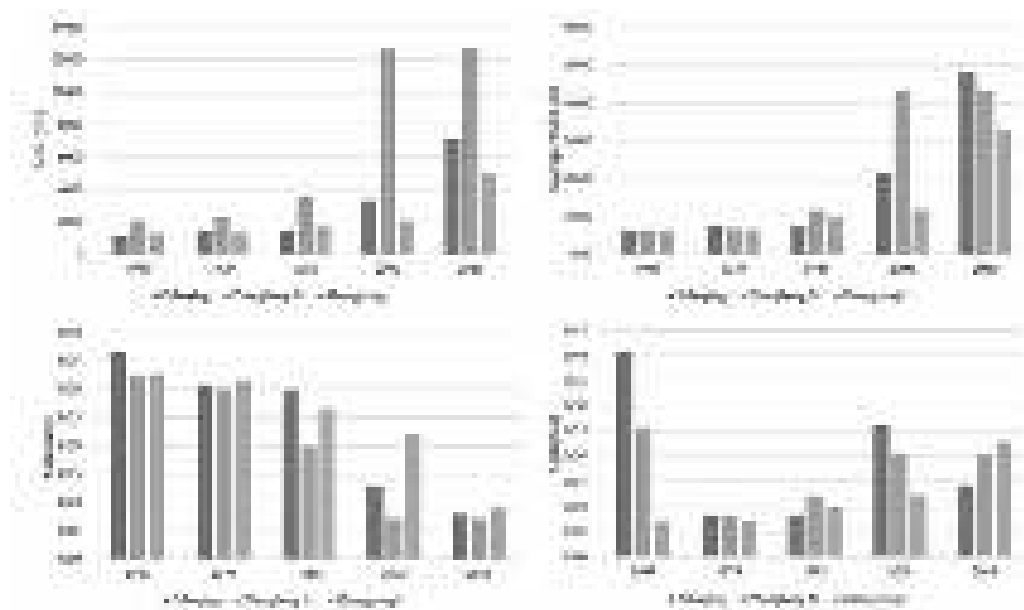
Based on the statistics, we could compare changes in the characteristics of the public space.

1. The three streets are constantly growing in area and have grown significantly from 1988 to 2000, with little or no change before and after. Because in China from 1949 to 1988, the land unit for urban construction was freely allocated land. The process of plot metamorphosis was dominated by the planned economy system and develops through the creation and change of danweis' physical form. When land markets were authorized after 1988, the creation of new danweis gradually ended and the past danweis are gradually relocated and demolished. This block has gradually become a modern business district with multiple commercial complexes and office buildings, so the roads widen and the area of the public space increases.
2. The trend of average street width is similar to that of the area of the street, which shows an overall trend of growth, especially after 1988, which has hardly changed before. This change is particularly evident on Zhenghong Street.
3. The circularity of the three streets is getting smaller and smaller. This means that the shape of the space is becoming more and more spacious. This change is also particularly obvious

Table 1. The statistics and bar chart of four measures of the space.

Streets	Indicators	1949	1979	1988	2000	2019
Pobuying	Area (m ²)	1191	1393	1421	3323	7125
	Average width (m)	6.00	7.40	7.20	21.43	48.57
	Circularity	0.37	0.31	0.30	0.13	0.08
	Openness	0.41	0.08	0.08	0.26	0.14
Zhenghong St	Area (m ²)	2111	2252	3508	12699	12712
	Average width (m)	6.35	6.71	11.67	43.14	43.36
	Circularity	0.32	0.30	0.20	0.07	0.07
	Openness	0.26	0.08	0.12	0.20	0.21
Zhenghongli	Area (m ²)	1263	1306	1716	2089	4960
	Average width (m)	6.30	6.50	9.78	11.80	33.00
	Circularity	0.33	0.32	0.27	0.22	0.09
	Openness	0.07	0.07	0.10	0.12	0.23

a.



b.

on Zhenghong Street. Because the first square appeared in the middle section of Zhenghong Street around 2000, which made the space more spacious.

- However, in terms of the change in openness, the three streets are not consistent. The openness of Zhenghongli is getting bigger and bigger. Because Zhenghongli was surrounded by danweis at the beginning. Then danweis were gradually demolished, and three commercial buildings were built around, which made the space in Zhenghongli more open. The openness of Zhenghong street was the highest in 1949, then shrank rapidly, reaching its minimum in 1979. Since 1979, it has continued to grow. Like Zhenghong Street, Pobuying was the most open in 1949 and then decreased. It increased after 1979 and decreased again after 2000. Because in 1949, the space in the northwest of the block was farmland, which is very open. After that, the land was quickly occupied by danweis (Xinbai Department Store and the Commercial Bureau Staff Dormitory), which made the space feel more closed. After 2000, danweis were demolished and replaced by commercial complexes. The space became open

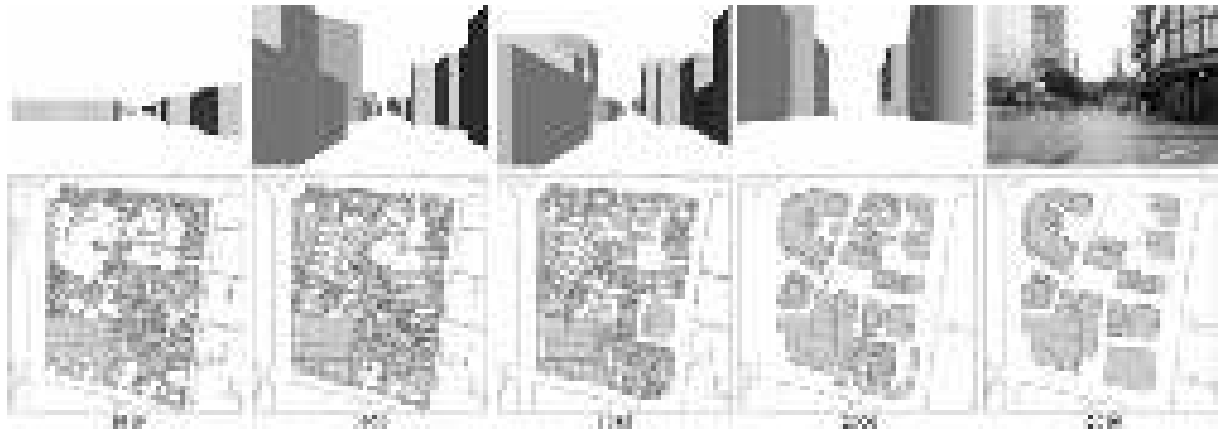


Figure 10. *Perspectives and the photo from the same location in the block from 1949 to 2019.*

again. Due to the demolition of the building on the west side of the road, the openness of Pobuying decreased in 2019.

Quantitative description the change of urban form from the perspective of space coincides with people's perception of space. For example, figure 10 shows the perspective of people from the same location in the block from 1949 to 2019. From these photos, we can intuitively feel the space of this place from empty in 1949 to narrow in 1979 and 1988, then to high and spacious in 2000 and 2019, which are consistent with the statistics of above measures of the space.

6. Conclusion

This study shows that it is feasible to use spatial change to express urban morphological change. The steps are as follows.

- 1. Select the study area and get maps of the area containing buildings, walls, and building functions. The materials can be found in the local urban construction institutions, such as Urban Construction Archives in Nanjing.
- 2. Through the on-site investigation, get the location of the public space in the block at present. Then, combined with historical information and interviews with local residents, the location of public space at various stages in the past is deduced.
- 3. Select the public space that has existed from the beginning to the present and calculate the spatial characteristic indicators: area, average width, circularity and openness.
- 4. Analyze the above indicators and get the changes of the public space.

Taking the block of Xinjiekou central area in Nanjing as an example, this paper studies the change of urban form by quantitatively describing the spatial change. The area and average width of the streets are getting bigger and bigger, while the circularity is getting smaller and smaller. The change of openness is not absolute, but it tends to become bigger in the end. The area of traditional public space is usually about 2000 square meters, while that of modern space is often more than 4000 square meters. Traditional streets are 6.5 meters wide and modern streets are 40 meters wide. The circularity of traditional public space is usually about 0.32, while that of modern space is about 0.08. The minimum openness of the public space is 0.07, when the

surrounding buildings are danweis; the maximum openness is 0.41, when the space is surrounded by the farmland. The openness of modern public space is about 0.2.

The advantage of this method is that it combines with people's perception of space and can tell people where the public space has changed. It also provides a numerical reference for urban designers and architects who want to restore the traditional image of urban public space. However, the disadvantage of this method is that it does not describe the three-dimensional information of the space, which needs further study.

7. Acknowledgement

This study was financially supported by National Science Foundation of China (No. 51538005).

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Beyond Building Envelop: Urban Form of Cultural Public Space

by Melody Hoi-Lam YIU
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Keywords: Public Space, Cultural Buildings, Figure-Ground, West Kowloon Cultural District.

Abstract: Cultural buildings are the key-pieces that gives character to urban form, yet it is more often perceived as the iconic landmark, an isolated object that is devoid of context. The significance of cultural buildings should be more than its visual impact, but to play a greater part in the making of urban form. This paper explores the role of cultural buildings in the city beyond the nominal aesthetic or functional view. The architecture is then read as the container of social space, contributing to the public realm at a spatial and experiential dimension. Grounded in the approach of Nolli map and figure-ground drawings, cases of contemporary cultural buildings are examined in plan through multiple scale from building to site and districts, to review how they respond to the urban context. The review of two international cases of cultural architecture sets the tone of this approach, followed by a detail analysis of the recently complete theatre at the West Kowloon Cultural District in Hong Kong. The result of this study presents a renewed perspective on cultural buildings in the city, and their contribution to the creation of public space and urban form.

1. Introduction

The new cultural architecture in a city are always at the center of attention, and these theaters or museums are playing an important role in the making of the city. In a formal sense they are often the landmark that marks the city's skyline or represented as urban icon, in the same time they are also frequently regarded as key urban strategies in revitalization or new district development. Literature on urban morphology has different terms to describe these special element, from the "set-piece" in *Collage City* to the "monument" in *Architecture of the City*, which all pointed at same special quality of this type of public building that stands out in the urban fabric. While in ancient time the churches (and its plaza) are the center of urban public life, nowadays the cultural institutions would take a similar position where people gather and where public culture is formed. Especially in the current context of neoliberal society, the public role of cultural buildings (and the institution it represents) are ever more important to balance the sometimes manipulated public realm occurring under market influence.

Furthermore, the cultural building has become *the* strategic move in urban development over the past decades. Since the post-war period the cultural building was utilized to rebuild civil life, such as the case the Centre Pompidou in the 1960s, to the post-industrial urban regeneration schemes through cultural development, with the prime case of the Guggenheim Bilbao in the late 1990s. The more recent cultural landmark of the Elbphilharmonie in Hafencity, Hamburg, is another keystone urban project in spite of its continuing criticism in multiple fronts. The cultural building has become the remedy to urban issues and the trophy of successful urban development, with the effort and resources input comparable to that of the ancient cathedral-building. These cultural monuments are the churches of our time, where it often carries a greater symbolic value than the building itself. However, the question to ask is how does it contribute to the making of the city, whether the architecture itself can affect urban form in a positive way?

As *culture* is one of the “most complicated word” in English language (Williams, 1981), “cultural public space” has an equally wide application that can describe any public space where culture happens. It contains the composite notion of “cultural space” and “public space”, in this study the significance of public space in formation of public life is taken, with association to the venues for arts and cultural activities. This could range from the traditional theaters and museums to the contemporary hybrid cultural centers. The focus is not on the specific artistic discipline and function, but the common space such as the plaza, the lobby or foyer that possess certain public space qualities that are important but often overlooked. While they are similarly used and accessed like other public space, the nature of cultural activities and institutional background distinguish the cultural public space from the open public space (e.g. parks and streets) and the commercial public space (e.g. shopping malls).

This paper would look at the cultural building and its associated public space from a formal perspective, through the two-dimensional urban and architectural plan to examine the role it plays within the urban context. The cultural building as an urban strategy and the iconographic interpretation has been a popular topic of discussion, in this study we would stay away from the discourse on appearance and aesthetic, but in a planar approach to read the public-private relationship that occurs within the building and with the urban surrounding.

2. Cultural Space in the Public Space Discourse

The origin of “public space” is often traced back to the Greek definition of *polis*, as a social concept where people gather for certain commonality. Since the Enlightenment, drastic changes in the society were happening as we move into modernity, and the idea of “public” is also being enthusiastically debated and discussed in all disciplines from philosophy to sociology and politics. The notion of “public space” can be interpreted from the conceptual idea and spatial relationship, to the physicality and Cartesian space. In recent decades it is further extended into the in virtual (public) space of the contemporary digital era. As we attempt to map out a brief account of public space discourse to position cultural space within, more relevant are the theories that was developed since the post-war decades in the 20th century, which has affected directly or indirectly the architectural concepts (and design) of contemporary cultural spaces.

While her political theories in labor and action are more famous, Hannah Arendt (1958) has contributed to the public space discourse with the concept of *public realm* that is separated from one’s private domestic life. The public realm holds people together not by nature (family ties) but through the “common” constructed with different positions and perspectives. Here the

notion of public realm is illustrated with the metaphor of an “invisible table”, which keeps people related but at a distance, it is an abstract space that denotes relations but without a physical quality. In response to similar post-war European social context, Jürgen Habermas (1962, 1989) emphasis on the discursive character of the *public sphere*, where people come together to discuss and debate public affairs. The physical places in the city became important venue for such discourse and it is where the public opinion can be formed, this “infrastructure of public life” (Calhoun, 2013) is constituted by public space such as the coffeehouses and other publicly accessible spaces.

Richard Sennett (1976, 1992) reviews the historical development of the concept of public and brought up the issue of the decline of public domain in contemporary society. His writing often references to the urban setting and the physicality of public space, such as the illustration of public life that happens in the theatre foyer, where the physical space is given a meaning and relationship to social life. In a spatial sense, the concept of *collective space* breaks through the dichotomy of private versus public space, and focus on how space is inhabit by the public rather than to define it through property ownership (de Sola-Morales, 1992). While the different concepts of public space described above remain largely in the realm of socio-political discourse, it has influenced their contemporaries and the coming generations of architects and urban designers, many of whom found positive potential of public life and implement through the design of public and private urban projects.

This paper will review the idea of public space grounded in its physicality, and in context of urban form and the city. The public spatial types can be understood in a spectrum from exterior to interior space (fig.1), along which we can find the common categories of the *open public space* (the streets and the parks) and the *commercial/ privately-owned-public-space* (the market or the coffeehouse). While there are abundant discussions on these spatial types, the public space of cultural architecture, such as the museum lobby or the theatre foyer, which the majority are publicly-owned and accessible, are less discussed. As the cultural institutions often operates with a certain public vision/mission, it gives the cultural space a prescriptive character that is different than the open park or the shopping mall. In this study we would focus on this third category – the institutional public space. Each of these spatial types posses distinct formal structure that directly or metaphorically represents an idea of public life. Although it was marginally addressed in the public space discourse, the cultural public space deserves more attention in regard to their formation and effect. How are the cultural public spaces reflecting the intention of its operating institution? Are the public users inhabiting these spaces as intended?

Through the study of cultural buildings, we would unpack the concept of *institutional public space* and its effect to urban form. The initial subjects would be the more established public cultural institutions, exploring how the cultural building and its public space might become the physical embodiment of the institution. The contemporary cultural building has the social significance as the churches in ancient time, it is also the often contested space with a crucial role in urban life. The investigation of the cultural public space will provide an additional layer of understanding to the complex construction of the urban public space.

3. Reading Public Space through Figure-Ground Drawings

As we are constantly exposed to the imagery of cultural buildings, an alternative reading in plans and drawings can save us from the distraction of its appearance, and to examine the formal structure for the intention and value that it carries. Furthermore, to read the cultural

building not as an isolated object, but within the urban fabric enable us to review its contextual relationship and its contribution to the overall urban form. In this study, the figure-ground diagram is utilized as the main analytical tool, where the dichotomy of solid and void, representing building mass and open space, reveals how the cultural building interacts (or not) with the surrounding, and illustrate the formal definition of public space. The investigation of public space is further extended into the interior, in the fashion of the Nolli-Map of Rome, where spatial continuity is mapped out to include the accessible public interior. Here the building threshold became a key element to denote the passing from exterior to interior, while the public flow and activities is maintained. In this approach, emphasis is placed on the experiential and spatial quality of the cultural building at a human scale, instead of the aerial visual and iconography. This morphological analysis of the cultural building is first approached with a descriptive dimension, to understand how it works and the intention that creates it, then further develop to a prescriptive angle to inform design and integration into urban space (Chiaradia, 2019).

Several classic text on urban form is referenced to frame the analytical reading of cultural building through urban and architectural plans. The Italian school of urban morphology has a strong tradition in the study of urban form, through the concept of type corresponding to the idea of the city (Marzot, 2002). Among these Italian architects and scholars active in the mid-20th century, Aldo Rossi and his seminal work *The Architecture of the City* (1966, 1984) is probably the most well-known and influential on the practice of architecture and urban design until today. Among the narrative on urban artifacts and the analogous city, the concept of “primary element” is particularly relevant to our study of cultural buildings, where “they possess a value ‘in themselves,’ but also a value dependent on their place in the city” (p. 87). Developed around the same time in the United States, Colin Rowe and Fred Koetter in *Collage City* (1978) also responded to the modernist architecture and their application in urban planning, raising concerns of the issues on diminishing “public-ness” and “the crisis of the object” (p. 50). Their comparative studies in figure-ground drawings of the traditional and the modernist city center is a clear illustration of how modern architecture often become the “space-occupier” where the solid is read as figure on empty ground. Instead, the cultural building could take the role as “space-definer” where the void (open space) can be read as the figure with clear spatial defi-



Figure 1. *The Spectrum of Public Spatial Types.*

nitition. This would be an important clue as we examine the culture buildings in the following cases, to review and assess their contribution to urban form.

Public space does not limit to the streets and plaza but is extended into the interior of public buildings. This public-private spatial relationship is well-represented through the Nolli-Map of 17th century Rome, where the accessible interior of public buildings is denoted in white, providing a reading of public space that flows beyond the boundary of a building. Within the compact urban fabric of Rome, the solid (building mass) became not objects but the ground, while the void (public space) are read most clearly as figures. This reading is in accord with one's experience of walking through a city in contrast to looking at the photograph or image of the city. In the figure-ground drawing of private and public space, the landmark buildings are not seen as their exterior architectural image but as the void of its accessible interior space, in similar connotation to the open public space that it is connected with. If we look into the building scale and architectural elements, the floor plans can give further information into the reading of the public interior, as architectural scholar Robin Evans stated that the architectural plan can describe "the nature of human relationships" (Evans, 1978, 1997). What he seeks from the plan is the organization of space that reflects design intention and can be read as "a picture of social relationship" (p. 62). He relates the connectivity of rooms with the issue of privacy (domesticity), and how the passage as an architectural element affects the path (and public encounter) through spaces. In similar lens we could read the plan of the cultural buildings to learn about their intention and attitude towards the construction of public-ness.

The Nolli-Map has introduced a way to look at the city that integrates urban form and open space with the architecture plan, which enrich the reading of public space including the accessible public interior. This is particularly useful for our study of the cultural buildings as it represents the *prescriptive* public intention instilled by the cultural institution through its design. The interior space carries equal weight, if not more, as its surrounding exterior to construct the public space that is inhabited and used by the public. In a larger scale, how the cultural building is placed into the urban fabric is also telling about the positioning of the cultural institution and how it imprints into the urban form.

4. The Cultural Building in Response to Urban Form: International Cases

The different attitude of how the cultural architecture is situated within the urban context can be explained through two cases of iconic cultural building, the Center Pompidou in Paris and the Guggenheim Museum in Bilbao. Both of them presents a strong architectural image and is regarded as major urban strategy, yet from the perspective of urban morphology they represent two quite opposite approaches (figure 2). The Center Pompidou is situated within the old urban district of Beaubourg, where the architects Renzo Piano and Richard Rogers decided a site strategy early on at competition stage, to press the building to the edge and fill up half of the plot, to open the other half as the "piazza" (Silver, 1994). Instead of placing the building as an object centered in the square plot, the Pompidou has not only responded to the surrounding context but it has contributed in urban form with a well-defined public space. Provided with a public façade and the extension of plaza space into the open ground level interior, the piazza at the Pompidou sees the most vibrant cultural activities from street performance to public events or festival, in compliment to the organized arts and cultural programs by the cultural institution. On the contrary, the Guggenheim Bilbao is spectacular object that its surrounding waterfront open space has to be surrendered as the backdrop to this jewel-like building (Philip-

pou, 2015). As the visitor approaches the building through the streets of Bilbao, the museum is unmistakably a visual attraction and terminus from several vistas, as the architectural image is already familiar prior to arrival. The vast waterfront park and promenade has only one focal point yet too open to contain any activities, perhaps other than the tourist in search of the best selfie location. The old city fabric stopped abruptly at the edge of the waterfront park and the architectural object sits on its open field alone that could have been anywhere.

In reference to *Collage City's* description regarding the potential of architecture to form urban space, the Pompidou can be understood as a “space-container” while the Bilbao is clearly the “space-occupier”. This illustrates what the cultural building is capable of, either to contribute to the urban context and create meaningful public space, or to consume its surrounding ground with no interaction or contribution. This criticism is also along the line of the urban form debate between traditional ‘townscape’ and modernist planning ideals, which the new towns of towers in (green) field has created a reverse figure-ground diagram with absence of spatial definition.

The question to ask is then, at the level of master planning and urban strategy, will the cultural building remain a symbolic icon, or can it fulfill the public purpose to support and improve local urban form? In many cases, the site selection of key cultural building is an executive-level decision where the expected benefit is usually at a city or regional level, therefore the consideration for the immediate neighborhood and the cultural building's integration to the urban fabric might not be on the agenda. Moreover, with selected sites are usually in vast open area like the waterfront or green park, the reason might be precisely that to prioritize the creation of photogenic image over experience. However, at a site and building level, there are still opportunities for the cultural building to become urban space definer. The case of the Pompidou and the Guggenheim Bilbao has presented two distinct attitudes towards urban form taken up by the cultural building, from integration to isolation. Most cultural projects sit along this spectrum with specific local conditions, there is certainly potentials for them to give more considerations in response to the urban context.



Figure 2. Figure-Ground Plan (at same scale): The Centre Pompidou (left); The Guggenheim, Bilbao (right).

5. The Cultural Building in Creation of Public Space: the case of Hong Kong

With the approach to read cultural buildings in plan and to seek architectural response for positive urban form contribution, the next case study, the Xiqu (Chinese Opera) Center in Hong Kong, will be analyzed at a building scale through its floor plan and at the urban scale to examine the figure ground relationship and master plan potentials. The Xiqu Center theatre is the first building completed in the West Kowloon Cultural District (WKCD) masterplan, followed by the large contemporary arts museum, the M+, under construction and a dozens of other cultural facilities and associated amenities in the coming years. It is also a timely opportunity to review the district-in-making in order to inform the design strategy of the many upcoming projects.

The overall district situation is similar to that of Bilbao and many urban waterfront developments with the character of a “terminus” that discontinues the urban fabric, although the Xiqu Center is located at the eastern end of the district, the “gateway” position that sees the transition from existing urban fabric into the future district urban form. Reviewing the proposed master plan, it has a rather compact urban massing along the strip of land stretching from the current urban edge to the waterfront, with a density that delineates internal “streets” and public plaza. All building mass appears to be built-to-line and with high plot coverage to maintain the dense urban fabric, including that of the Xiqu Center, which occupies almost the full eastern parcel at the intersection of two major roadways that bounded the district.

The program requirement of a 1000-seat grand theatre along with high demand of other functional area has dictated that the building would require almost full site coverage. However, with similar intention as the Pompidou to compress the building massing and release space for plaza, Xiqu Center’s architect, Thom Bing, has given a creative solution to the urban question. His proposal is to elevate the grand theatre auditorium to the 4th floor at 27m, allowing a thoroughly open ground level, as he would call the “public plaza”. The design of this public plaza literally removes the building boundary to become a semi-outdoor public area that is accessible 24/7. With no doors or gates it intends to blend in with the surrounding context, although there is none at the



Figure 3. *Proposed Master Plan for The West Kowloon Cultural District, Hong Kong.*

moment, as the master plan is being completed. It is not only a theatre foyer for the performances but people can pass through and use “the plaza” on a daily basis. The constrain of a compact plot with tight program requirement did not limit the architect’s vision in the making of public space, and it was answered with innovative solution that satisfy both aesthetic and practical needs.

In comparison of the figure-ground plan and Nolli-Map diagram of the Xiqu Center, we can read its intention to incorporate an urbanistic strategy into the design of a cultural monument. Unfortunately, the site condition is not ideal as it is bounded by major roadways and disconnected with the surrounding, also the existing old city fabric has already been replaced by the tower podium typology that gives minimal consideration in urban form. However, the design of the Xiqu Center still attempts to create an internal condition that resembles an urban public space, even with trees planted throughout in the covered plaza. This again exemplify how the cultural building can contribute to urban form and public space in a variety of situation. To continue the urban space sensitivity throughout the new district, the potential lies in the adjacent parcels as they are being developed, whether it would be able to interact and compliment this internal public space. In fact, the super density of Hong Kong has given a good baseline to produce compact urban form with a clear figure of public space void.

Although this paper advocate the approach to read cultural building in urban space through the plan but not the image, this method does encounter some issue at the human scale, where the plan drawing is not able to register the subtle height difference occurring at the ground level. In the case of the Xiqu Center, on plan it appears to be a fully open plaza throughout the ground level, however, in reality the plaza area is fragmented into different zones of varying elevation with steps and ramps to connect. In order to accommodate those height differences with limited space, a rather complicated path is resulted and not as welcoming as the plan or even the original design intention. This leads to the consideration of next scale of public space creation, where details such as height differences and street furniture are also design component that contribute to the success (or failure) of a public space.

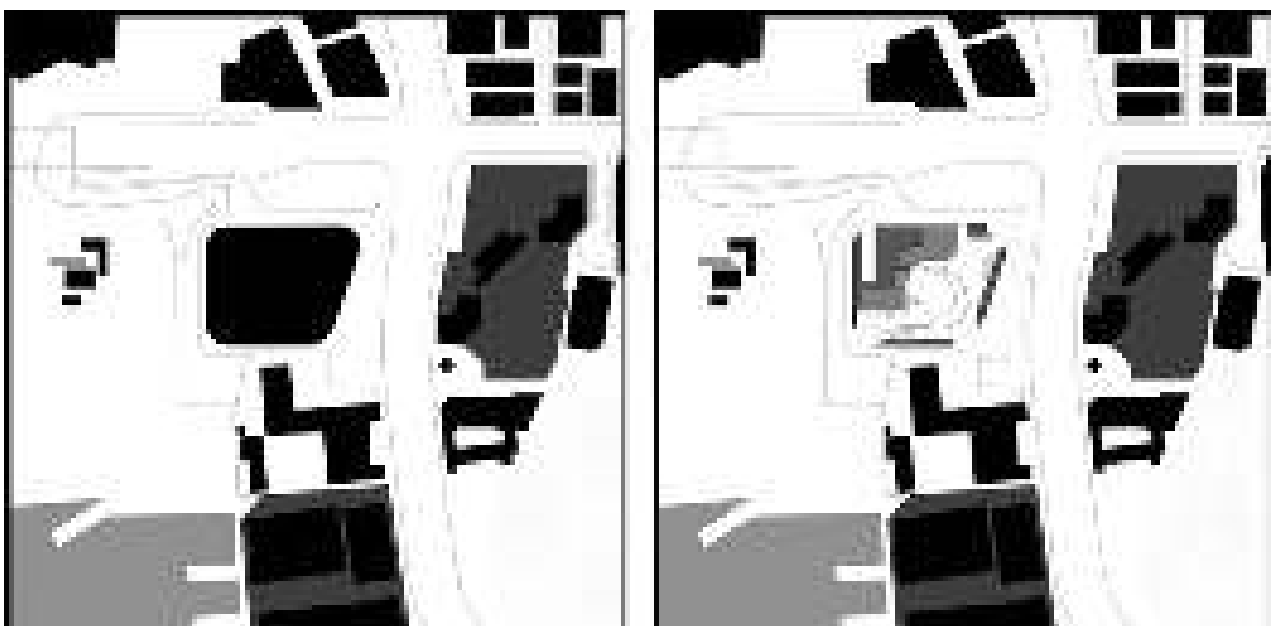


Figure 4. *The Xiqu Center: figure-ground massing (left), Nolli-Map diagram (right).*

6. Conclusion

The cultural building is a crucial part that constitute the urban form and public space, yet sometimes it became a marginal issue that did not receive the attention it deserves. From the study of this paper two reasons could be stipulated, the first being that the public space discourse are more frequently focused on the subject of open public space or to question the privately-owned (commercial) public space, as a result the public space at these essentially public cultural buildings are many times bypassed. On the other hand, the cultural buildings are usually perceived from the exterior with emphasis on its aesthetic architectural image or the social representation and symbolic interpretation, less attention is paid to the formal structure of its interior and how people inhabit it. The approach to read the building in plan and in context is an attempt to bring back the attention to this often overlooked interior/exterior public space at the cultural building. Further investigation on this particular type of public space should be conducted to understand the institutional nature of the cultural space, which they would be intentionally designed to be public. It would also be meaningful to study further how people use and interact with these institutional public space, whether there appears certain behavior or appropriation as it would happen in other urban spaces.

Through the review and comparison in figure-ground plan of the Centre Pompidou and Guggenheim Bilbao, it is shown that the two equally iconic cultural landmarks can have quite different, positive or negative, contribution to the urban form. The detail analysis of the Xiqu Center in massing figure-ground and Nolli-Map diagram explore the relationship of cultural public space and its surrounding through two levels of spatial understanding, in master plan and the public interior. While the massing reading of Xiqu Center tells its position within the cultural district as a solid component to make up the compact district fabric, through the ground-level plan it reveals the idea of an interior public plaza where the cultural building is giving back to the urban context. Although there are other issues that the Xiqu Center has to overcome as a genuinely “space-definer”, it is nonetheless a case with clear and strong urban intention and the potential to develop as the cultural district is being developed.

This paper can be considered as a first step towards this approach for the study of cultural public space. Initial findings could be concluded as proposal of key considerations in four levels to inform the design and planning of cultural buildings in urban context. At an overall planning level, the site selection of cultural building should carefully consider its purpose, whether it is just an object in the open field or can it be located in somewhere that can support and improve local urban form/life? The next level of consideration is at the site plan scale – what would be the design solution in terms of building massing that allows the cultural building to define urban space? The third level focus on the ground floor plan where it should be considered as an extension of the public space, and how it can flow and works with the surrounding exterior space. Finally, at a user level items such as street furniture, accessibility and comfort, as well as management and operation would also be important public space consideration, although this is beyond the scope of the current discussion.

This study has been looking at the cultural building in two perspectives, as a solid mass within the figure-ground urban context, and as the public interior where public space flows beyond the building threshold. These renewed perspectives reiterated emphasis in the void (public space) instead of the solid (building object), and bring the understanding of cultural public space to a more humane and experiential dimension. This approach is not to dismiss the aesthetic or symbolic value of cultural architecture, but to compliment it. With the attention to often overlooked aspects,

it could increase the depth of understanding in cultural architecture and public space, towards an effective contribution to the formal constructions of the urban landscape.

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Social and Environmental Function of Urban Space

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Keywords: Layer, System, Social Urbanism, Urban Morphology, Social Participation.

Abstract: Medellín is a city located at Aburrá Valley, Colombia that had its growth process associated with orographic and hydrographic conditions, where planners and technicians made important plans and projects articulating the environmental and built systems. The valley, despite having a high index of slope and areas of potential risk of landslides, has a high degree of human occupation, represented in different economic strata. In this scenario, planners and municipal administration, associated with academic and civil society, have made important advances in favor of Social Urbanism. *The Plan de Ordenamiento Territorial*¹ – POT (1997) introduced the social and ecological function of property, the public function of urbanism, the equitable distribution of burdens and benefits, with the prevalence of the general interest over the private; the *Plan de Desarrollo de Medellín*² – PDM (2001) introduced elements such as civic culture, which sought to elaborate urban projects that integrated the physical, cultural and social components (2004); the *Proyecto Urbano Integral*³ (PUI), in turn, contributed to the decline of violence and the upgrade of quality of life rates, establishing an important step in the construction of the right to the city. The projects were oriented to active mobility and public transportation, and expanded the provision of collective equipment associated with public space, expanding community outreach and empowerment. Social participation has become a fundamental element for the success of the implementation of the project as well as its maintenance.

1. Introduction

During the 1990's, Medellín was reported by the press as one of the most violent cities in the world. That time, the high number of homicides put the city in the same violent level as other cities that were facing civil wars. It had an average 7 thousand homicides each year.

Over the fifty year guerilla and paramilitary warfare in the biggest cities in the Colombia – especially Bogotá and Medellín – received most of the country's convicts; whole families that were expelled from their lands headed to those cities in search for shelter, work and life opportunities. In the last decade the city was home for over 100 thousand inhabitants in that condition and it is estimated that 20% of its total population have a similar background.

1. Territorial arrangement planning.
2. Medellín Development Plan.
3. Integral Urban Project.

There were several police attempts to end the conflicts, however, the armed group's military power is as strong as the State's. The conflict stretched so much that Medellín, for example, was in a state of emergency.

At the end of the 90's and the rise of the new millennium, public administrators, civil society, business groups and intellectuals joined and engineered a project to Medellín. Once the territory and its social cultural complexities were acknowledged and, guided by the *Social Urbanism* methodology, the city was transformed and consolidated a new city model, emphasizing public space projects and collective equipment in underprivileged areas, looking for diminishing its historical social debt. In 2013 Medellín won the "City of the Year" award, among other 200 cities. The award was organized by the Wall Street Journal and voted by internet, considering the carbon footprint reduction, creation of cultural spaces and criminality reduction.

2. Methodology

This article focuses on deepening the comprehension of Medellín's public spaces and environment contributing to project practicing in the area of architecture and urbanism; promoting a democratic projection and use of this space; and democratic participation, reinforcing the creation of urbanity manners focused on peace and social interaction. This research was made through bibliographic review, data collection and analysis and field registers and observation.

The public spaces issues refer to project elements noticed in the architect and urbanism domain: the spatial form corresponds to a complex materialization of elements and processes. The urban spaces shape analysis – or the singular *public places* – go through the element analysis of its own immediate context and its relation with social and cultural wider contexts. Containment or delimiter elements: buildings; walls; fences; views; geometries; natural elements (topography, hillsides, vegetation); functions (Ferreira, Sá e Leão, 2015).

3. Analysis/Results

3.1. Urban legislation and social participation ratification

Colombia went through a significant institutional crisis during the decades of 1980 and 1990, which revealed a political and social stressful period in the country, widening the debate and the social mobilization that led to a population demand for improvement. The National Constitutional Assembly was the responsible for the society restoration which culminated in the promulgation of the Colombian Political Constitution in 1991, based on the Social Rule of Law and on the participatory democracy.

It can be said that the Colombian Political Constitution arise as a social victory in the popular struggle that demanded recognition and right assurance to the population. Among the proposed changes there were speech development and citizenship practice, as well as political, social and civil rights when enabling social participation as its highest in the national political history, with rules that regulated as fundamental rights and duties in the nations' lives (art. 95); another transcendental change was the political, administrative and tax decentralization in the urban planning, generating appreciation in the local reality such as space management and innovation public policies (Lopera, 2019, p. 22).

The new constitution included tools aiming housing policy, environmental sanitation and



Figure 1.

geological risk, public space, mobility and social participation (Zuquim, Sánchez Mazo, Mautner, 2017, p. 10). It established the public space as the structuring element to the land use having direct influence over the population, leading to creation of laws that set its importance, its determinant, its components, plans, projects and financing and management structures.

Lei de Desarrollo, from 1994, defined basis for the national development based on the equity principles; the urban policy *Ciudad y Ciudadanía*, reaffirmed the city right in 1995; the Plan de Ordenamiento Territorial – POT, in 1997, introduced the social and environmental property function, the urbanism public function, the fair distribution of load and benefits, prevailing the general interest over the private (Zuquim, Sánchez Mazo, Mautner, 2017, p. 11).

Participation was recognized as the main and fundamental supporter of the urban legislation, establishing ties between social organizations and the state hiring in sectorial programs in different orders and it was ratified by the law 134/1994, art. 103, replaced later by the law 1757/2015 (Zuquim, Sánchez Mazo, Mautner, 2017, p. 11).

In 1995, advances in urban policy happened due to the law *Ciudades y Ciudadanía* which enacted the right to the city, valuable asset for collective consumption, public par excellence, and scenery of fundamental rights. Subsequently, in 1997, the law 388 from Desarrollo Territorial changed law 9, from 1989, transcending the illegal view of precarious settlements based on the social and environmental function of property, incorporating international debate concepts such as improvements, relocation and prevention.

After Lei de Desarrollo Territorial, Planes de Ordenamiento Territorial (POT) arose in municipal scale, making it possible the urban policy and regional planning implementation, public services and housing rights (Partial Plans). Such implementation should attend the precarious urban conditions, habitability and land access needs. (Lopera Perez, Gonzáles Avendano, Sánchez Mazo, 2017, p. 19).

Furthermore, the concept “Ecological Structure” was coined and interpreted as a category that has the specific function of keeping biodiversity and the essential ecological processes of the land. The large scale city parks, previously seen as isolated areas in the urban structure, are now seen as essential part in the land use planning, therefore the environmental commitment was validated:

...In order to guarantee principles and law enforcement related to social and ecological property function, the urbanism public role and promote urban development benefits fair sharing (Contreras, 2016, p. 124).

Most of the early territorial framework planning in Colombia was approved between 2000 and 2003, and they are known as POT from “first generation”. It was valid for 12 years (the equivalent to three municipal management periods).

The early POT designs were improvised. Some cities designed them in a hurry, others copied; bottom line is that the early POTs were not of high quality and did not promote the cities’ development according to Diana Muñoz, manager of the Modern POT program, from Planeación Nacional⁴.

The law 1625/2013, which replaced the Organic law 128/1994, conceptualizes the so called Metropolitan Areas as intermediate management territorial entity, constituted by a set of towns surrounding a core city, *bounded by territorial, environmental, economic, social, cultural, technological and demographic dynamics and interrelations*, and it defines its operation, based on issues that affect one or more cities simultaneously. The law 1625 tried to redefine the metropolis concept to beyond urban conurbation, broaden its range to territorial management of systems that extrapolate municipal boundaries, what they called *metropolitan phenomena*.

3.2. Overlapping Layers in the urban area: a collective development

The Integrated Urban Projects held in Medellín, became formulation and analysis methodology with a high potential impact transformation in the areas involved, with the land and its urban fabric cross-sectional reading, rural and semi-urban (borders areas/ *fringe belts*). Knowing Vale do Aburrá’s environmental structure and also its built area, allowed the planners to understand the occupation processes and the development of the projects that guided the city’s growth in the past years.

The land *layers*’ cross-reading was approved by the Decree 1504/1998. This decree regulates the management of the POT’s public spaces, characterizing and structuring the tools needed to develop the plans. The public space is defined as “*coordinating and structuring element fundamental in the city area, it’s also the regulator responsible for the environmental conditions of the city*” (Chapter 2, article 7, Decree Law 1504).

Therefore the Public Area System is the articulator of natural and built spaces in the city, and it is composed of *natural components*, hydric and orographic systems, *artificial components*, human occupation and connectivity system and *complementary components* formed by afforestation and the urban furniture set.

3.3. Metropolitan Comprehension of the Environmental System

Medellín city is in the Antioquia department, in Vale do Aburrá, Central Mountain Range. It is 7 kilometers wide and 30 kilometers long it is border to the north by the city of Bello and to south to the city of Caldas, creating the Vale do Aburrá Metropolitan Area (AMVA), which includes ten cities. Its altitude varies from 1,500 to 2,500 meters in the valley highest point, increasing its inclination and soil vulnerability as it gets closer to ridges and the highland surrounding. It also has three *Cerros Tutelares* in the inner part of the valley – *Nutibara*, *El Volador* and *La Asomadera*.

The city’s area is in Rio Medellín’s basin, which splits Aburrá’s valley, it’s irrigated by roughly 200 direct tributaries, and more than 350 indirect ones and its most important streams are *San-*

4. <http://www.eltiempo.com/archivo/documento/CMS-16643406>. Access 6/4/17.

ta Helena, La Iguaná and La Presidenta. Throughout the years the streams and the river Medellín became an open sewage, and nowadays they are in the process of depollution.

Considering all the natural complexity from the location, in 1980 the Vale do Aburrá Metropolitan Area (AMVA) was created and it started operating in an integrated and inclusive way with all the cities laws in 2000. Currently AMVA is the agency responsible for planning and managing all the valley natural components, such as hydric and orographic systems and environmental public areas. Decentralized, AMVA is constituted by a technical team focused on developing projects and it is managed by the metropolitan area cities mayors, being Medellín's mayor the one with higher decision-making power.

3.3.1. Environmental Public Areas: Linear Parks and the Metropolitan Green Belt

Environmental Public Areas are connected to the ecological land structure, they use natural components such as hydric, orographic or vegetation, to shape public spaces with high environmental value, always considering ecological preservation, already described in the municipal order. Medellín has consolidated metropolitan and municipal projects related to the Medellín River and its tributaries and also related to the high valley, structuring the Metropolitan Green Belt, this project embraces the ten cities part of Metropolitan Area of Medellín.

4. The Metropolitan Green Belt and the Jardín Circunvalar

The Metropolitan Green Belt projects designed by AMVA, attends a series of land structure aspects in relation to its natural elements. It also addresses to the issue of human occupation in slopes near the rural areas (*Corregimientos*) and other cities connected to AMVA. The project's obvious landscape and environmental action towards the land, seeks hydric and vulnerable landslip preservation. These problems are caused by the kind of soils, slope inclination and formal and informal occupation.

The project brings up two belts that present different priorities and need of action due to its characteristics: The *cinturón superior* needs conservation and environmental protection to the land, understanding of its part in Metropolitan Structuring Ecological System, guarantee of its



Figure 2.

environmental functions like hydric fountains, primary woods, etc. The *cinturón inferior* offer strategies to consolidate a transition zone between the urban and rural areas, focusing on the creation of a border park with natural resources, low density maintenance to keep the natural areas, and the support for the population of informal settlements, either improving the belt or removing and relocating people in case of risk.

Jardin Circunvalar of Medellín is a milestone in the Metropolitan Green Belt, and it began with Aníbal Gaviria (2012 – 2015). Expansion areas were established in small urban centers along the valley's longitudinal axis. Two parks were created in the east and west cost of the city and they promoted the longitudinal city growth preventing settlements occupation in slopes and streams benefiting the land ecological structure.

The Garden is part of the Inferior Metropolitan Belt and embraces social, cultural and educational components in its programs. Following the PUI's pattern (Integral Urban Projects) it needs public transportation connection and can be reached by the Metrocable (cable car) stations *13 de Noviembre*, *La Sierra*, *La Cruz*, *Santo Domingo* and *Picacho*.

The Project was divided in steps, starting with *Cerro Pan de Azucar*, eastern side, and by *Cerro El Picacho*, western side, where Landscape Conductor Plans were structured in each hill.

5. Medellín River Parks

Medellín River Parks is supposed to be an urban transformation integrated project that involves intervention in the River's bank with infrastructure, landscape, vegetation quality and readjustment works in order to become the main transport corridor and also enables citizens encounters. It is the city's return to its origin, when the population used to use the river, bringing back life quality and turning the river environmentally friendly.

This Project is being led by EDU – Urban Development Company together in an agreement with AMVA. It consists in a set of parks that together will form a linear ecosystem, that is 28.1 kilometers long, where 19.8 kilometers in the Medium Sector – the correspondent to the city of Medellín – 7.2 kilometers in the South Sector and 1.1 kilometer in the North Sector. The two last sectors correspond to other cities in the metropolitan area. This is the main strategy from the last Medellín POT; it was approved in 2014 and developed with different society areas, public authority, entrepreneurs, social, academic, environmental and cultural organizations through several meetings, workshops and forums. The first stretch was built around the central axis in the International Business and Administrative area, what the supporters claim will benefit everyone.

It started with the downgrade of the expressway in some points, turning it into a tunnel and covering it with a park, creating this way a cultural and recreational activities space. In other areas, empty urban space was used to create green public spaces.

The park will enable connection between the city's protected areas, the three tutelary hills – *Nutibara*, *El Volador* y *La Asomadera*; the *Jardin Circunvalar*, the green belt that intends to contain Medellín's extended growth; besides the rivers territories.

The Medium Sector, which is almost 20 kilometers long and has a 327 hectare area, corresponds to the city of Medellín and that's where the park's construction began. The piece between 33 Street and San Juan Avenue was already finished and other river banks work has already begun. The next parts will be developed by public-private partnerships.

6. Linear Parks in Medellín River's tributaries

Medellín River's linear parks' tributaries are other strategies described in the 2014 POT. The idea is to create an environmental system, integrated to green areas, especially those with higher importance such as stream banks and its ciliary forests, tutelary hills and the Medellín River after the park formation.

The Linear Parks program (Integrated Stream Intervention) started with Sergio Fajardo (2004 – 2007) administration period. In that time, following EDU seven linear parks spread in different communities and in both side of the valley were built: *La Herrera*, *La Bermejala*, *La India*, *La Presidenta*, *La Quintana*, *La Malpaso* and *Ana Díaz*. Some of these projects like *La Herrera*, are part of the PUI strategies and others like *La Presidenta* were environmental interventions between EDU and the Environmental Secretariat when regions were not as complex and didn't need PUI support.

According to Ortiz (2014), the city describes its linear parks strategy as:

The green spaces, around the stream, presenting adequacy as natural public spaces, to connectivity, maintaining biodiversity and ecosystems, decontaminating microbasins and enjoyment of citizenship and passive recreation, outdoor and near nature (...). These are spaces with ecological and environmental functions; furthermore, they are home to many native trees, refuge of birds and a mechanism to protect and recover native ecosystems inside the city and represent an integrative element that allows balance between environmental conservation and space recovery. Open areas that provide outdoor spaces, available for rest and recreation and turn to open permanent environmental education classes for the communities to value and care for water, trees, fauna and to develop friendly actions toward the environment (Ortiz, 2014, p. 1314).

6.1. Territorial articulation and Connectivity System

Natural elements that form the land from the metropolitan perspective comprehension allow more articulation and harmony between the environment and the built area, guiding public policies and management to beyond the political limits that define the cities.

Medellín is the main urban area in AMVA, and it has minor urban centers and expansion areas along the valley. It is composed by layered communes from north to south, being the south area the one with higher income. Transversally to the river it is seen that the higher altitude areas have lower settlement's density presenting low life quality.

The connectivity is organized along the river, where you find most of the arterial routes and public transportation system. The mobility system is directly related to the water system and Medellín River is the main connective channel to the Metropolitan Area, where you can find expressways and subway railway lines. There is however contradiction concerning whether the river must become a mobility system or it should be recovered to become a linear park.

AMVA is the metropolitan transportation authority, designated to manage the transportation systems. In 2005, they launched the *Plan Maestro* of mobility 2005-2030 to all the metropolitan area, guiding the space's development towards a sustainable transportation system, using the *Mtrocable* (cable car), the *Metroplus* (BRT), the *Tranvia* (VLT) and the tram. The responsible for the system's building is the Massive Metropolitan Transportation Company – METRO.

Besides meeting the connectivity need of the city, the *metro system* contributed to success in the urban renovation. It was a milestone in the *Social Urbanism* connecting public spaces and collective equipment net to the mobility system denoted in the POTs and transportation equipment built in Medellín and seek integration with the community offering open spaces for

leisure. A recent example is the *Tranvía de Ayacucho*, which connects the eastern center region to the center and occupied empty spaces along the way with green areas.

The *Metrocable* have also brought relevant contributions to the connectivity, environmental, public and social system's articulation, occupying empty spaces and creating spaces for socializing in the affected areas around the stations. The public space is defined by the transportation line, which is designed by the geographic-morphologic analysis before being consolidated.

7. Comprehensive Urban Projects and the Public Space decentralization

Comprehensive Urban Projects (PUI) developed between 2004 and 2011 had a very participatory process along its steps. During its first period (2004-2007) the local government used the *Metrocable* line K construction to structure their first project, the Northeast PUI, establishing a low impact intervention, based on the POT and PDM principles. The PUI is an integrated urban management program that deals with physical, social and institutional components, acting in areas where the State was not present before and using all the urban planning tools simultaneously. Thus it works with the community through social participation mechanisms like public assemblies, communal councils, etc.

The public space was acknowledged as an ordinary platform in which people live and are developed as individuals and citizens, that's the reason it was created as a social inclusion tool; mobility has acted as a connector system to the urban plot in order to instigate articulation; equipment as reference point associated as complements to collective and individual life; housing and its surrounding as support for the individual and his family (Lopera, 2019, p. 39).

The *physical component* Works with the improvement and building of housing, collective equipment and public spaces development seeking harmony with the environment, creating new parks that plot interventions; the *social component* links civil society in all steps of the process, since the diagnosis and problem identification through field research to proposals formulation through community workshops; the *institutional component* acts in the articulation with community entities, private sector, national and international NGOs and secretariats managing the financial and administrative parts of the projects, and following it up after its implementation.

The social participation was consolidated with each sector's potentials identification, in the citizenship pacts, in the training about use and appropriation of public spaces, in the committee's participation and in the local workforce used to build the projects, raising the belonging feeling in the community. The identification of community leadership and information channels was fundamental for the PUIs' methodology to work, having the community permanently following the projects. The used methodology promoted advances in the Colombian urban policy and allowed the development of new urban forms and functions due to open thinking, turning architecture in engine to the city inhabitants' progress (Lopera, 2019).

8. Oriental North PUI Phases I and II

The Oriental North PUI is located in communes 1 and 2, structuring itself in the influence zone of *Metrocable*, line K from the Metropolitan Transportation Integrated System and it affects directly the neighborhoods *Villa Niza*, *Andalucía*, *La Francia*, *Villa Del Socorro*, *Popular*, *Granizal*, *Santo Domingo Savio 1 and 2*, *La Avanzada* y *La Esperanza 2*, contemplating roughly 230,000 inhabitants.

The project connects Acevedo Station, line A from the subway to its last station, Santo Domingo, where it is possible to connect to the Turistic Metrocable, line L, to Parque Arvi.

The region started to be taken over by informal settlements in the 1950's, the occupation was a result of the armed conflicts happening in the country where people were being expelled from their lands. The first action taken by the public power happened in 1970, when the first formal settlements were built in the region and then later on sidewalks and allotments started to happen, nevertheless, population was still in need of public equipment. Actions were still occasional and were not organized in zone plans or neighborhoods, so the communities kept growing and so did their density.

That was the first PUI developed in the city, simultaneously to the line K construction. This way it was possible to accelerate the project execution, and its best articulation. Around the stations, later on squares, new roads and sidewalks were made coordinated to the local transportation system.

The *Paseo Andalucia* sets the intervention in the urban connection axis in line K turning it in a neighborhood road with a large sidewalk and street furniture; the *Puente Mirador Andalucia* connects the different neighborhoods and creates a pedestrian space that is considered a park by the community; the *Parque Lineal La Herrera* recovers the stream, rebuilds the green system along its banks and offers squares and pools for community joy; the Parque Biblioteca Santo Domingo brings culture and education to the population and is an internationally known landmark – although it had some building problems that compromised its facade; and the housing consolidation in Juan Bobo stream, which restructures the informal land occupation, clearing the steepest slopes, recovering the sewage system and offering social housing to the community.

In 2008 the second phase of Oriental North PUI arose, focusing on La Avanzada, Carpinelo and Aldea Pablo VI neighborhoods. These districts had their consolidation later to the first PUI phase and are facing the search of a proposal of city urban limits affirmation, with border linear park conformation, focusing in the small agriculturists (Circunvalar Garden).



Figure 3.

9. Discussion/Conclusion

Data collection and the recent research analysis intend to show the complete view and the open nature of the Colombian *Social Urbanism* along the last decades, relighting in the city of Medellín. Knowing about the physical and social land aspects enabled the implementation of complex projects that guided a sustainable city growth in harmony to the environment. Urban policies driven to social debt reduction and the search of land equity, raising public spaces offer, collective equipment, housing provision and basic sanitation were successful due to participative methodologies along its implementation.

The urban scenarios developed along the period were consolidated as public space guided by active mobility and public transportation. The *Metrocable* system was the way found to expand the area for the population historically forgotten in valley slopes, and enabling the right to the city. The Integrated Urban Projects are examples, especially the Oriental North PUI that took advantage of the cable car construction to start insertion of equipment and public spaces that were decisive to the project. Territorial connectivity was seen as a fundamental factor to build trust with the community, and it was part of the agreements between both parts.

In relation to environmental public spaces, the city established strategic projects that seek conversion, conservation and preservation to the higher parts of the valley, structuring the *Metropolitan Green Belt*. This belt is a transition area between the rural and urban territories, having public spaces for both demands, support equipment to settlement occupation control and semi-urban community service, with culture and education spaces, subject already discussed in the pilot project *Jardin Circunvalar*.

Environmental public spaces were also constituted through the riparian forest in Medellín River's basin restoration, strengthening the water system and caring holistically about the environment. The *tributary and linear parks* in Medellín River are environmental control areas with solid afforestation and open water rails, preserving the environmental values of these sectors and serving the population as quality public spaces and fauna and flora corridors. Finally, the *Medellín River Parks* offer the population leisure along the river, redefining the population relationship with that place.

A communal public space constitution is only possible when comprehending all the layers that are part of the city. Structuring of different projects associated with programs that meet the connectivity, environmental and public services needs guide towards sustainable city growth and turn public space an articulation element. City's morphology, in its broad sense, maximizes itself as these projects are established, ratifying its fundamental characteristics and balancing the relationships between the natural and the built means.

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Frontage Rules

How Societal Ideas of Legal Regulation Affect Micro-Morphological Solutions at Street-Level

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Keywords: Regulation, micro-morphology, conventional content analysis, assemblage theory.

Abstract: As an element within the urban fabric, the urban frontage reflects and is a result of societal ideas of its time. Rules, codes and regulations are social constructs derived from the dynamic relation between society and built environment forming one of the highest levels of societal consensus in the organization of city society. Embedded in legal framework, they determine the *production of the façade-threshold* (Børrud & Standal, 2019) creating conditions for urban experience.

This paper explores the development of historical regulatory narrative of the façade-threshold and the nature of relation between built-form and regulatory development. This investigation is based on the development of the Norwegian regulatory system the last century, through the Planning and Building Act and related technical regulations. These are analysed using *assemblage theory* and *conventional content analysis*. It explores two dimensions, the *façade-threshold and modality of recommendation* in the legal text (to what degree it is enforced). Chronological development of regulation and the morphology of façade-threshold form a basis for analysis. This reveals an early focus on the urban frontage, as a priority, which reduces over time as both a regulatory and societal concern, and informs on the societal ideas and concerns which determine today's urban form.

1. Introduction

The book *Urban Forms: The Death and Life of the Urban Block* presents a morphological account of the development of relation between the dwelling and the city through the last century. By describing the different steps of this transition process from perimeter block to free-standing slab block it presents a basis to understand how form and structure are vital in framing everyday lives and urban experiences. The book suggests how the thoughts of modernism contributed in dissolving this relation by both abandoning the street grid as well as separating buildings as free-standing objects (Panerai *et al.*, 2004). This typological dilution and interface rupture came as a result of modernist ideas in which planning was split apart from architecture, presenting a focus on *objects* of form and land-use space and neglecting the *relations* that kept these objects together in the building-street relation, as such the spatial aspect of urban knowledge disappeared. Seminal voices such as Jane Jacobs and Christopher Alexander challenged the modernist ideas of functional distinction and suggested different approaches in city building. Alexander

challenged the tree-like structures of hierarchical thinking and suggested an understanding of cities as overlapping semi-lattices where a range of *relations* take place (Alexander, 1964). Jacobs proposed to professionals to engage in the science of complex systems and relations presenting prospects for a better understanding of how cities work (Jacobs, 1961). The founding father of urbanization as a professional field, Ildefonso Cerda, engaged in the capacities of relations in city building, both between domains and as relations between parts. In his theory of urbanisation from 1869 he defined *urbs* and *civitas* respectively comprising the physical city and the city organisation in a dialectic and reciprocal dependent relation. Cerda connected street space as an integral part of the building object highlighting the *relation* between these as forming the *quintessence of urbanization* (Soria y Puig & Serratos, 1999).

The urban form of Oslo presents examples and similar problem of the transition process in the urban housing blocks from the late 19th and early 20th century and up to current examples. Housing demands and provision became the most important societal task as a response to problematic conditions of industrialisation that developed as the urban fabric densified (Ridderstrøm, 2015). This Industrial climate presented the impetus for the first step in a typological dilution and geographical displacement of the urban housing block from the inner original compact city, out to the suburbs and back to the intended compact city (Børrud, 2013). As such, another aspect presents itself, geographical displacement of form though space conditions/constraints. This journey can be illustrated by a morphological *loop* of geographical displacement and typological dilution explaining an interface rupture in the relation between building and street that this paper engages in.

The morphological loop of housing projects in Oslo is presented through six different types. (Figure 1) The first comprised the clearly defined and enclosed urban form of the *perimeter block* (1) closely knit with the street network, exemplified by the private development of Grünerløkka built between 1870 and 1890. The next step includes *the large court block* (2) related to the modified grid, exemplified by the public development of Torshov built between 1915 and 1923. The *street-related slab blocks* (3) exemplified by Ila built between 1935 and 1948 forms the third type. These three first types are built close to work places and within close vicinity of the city centre

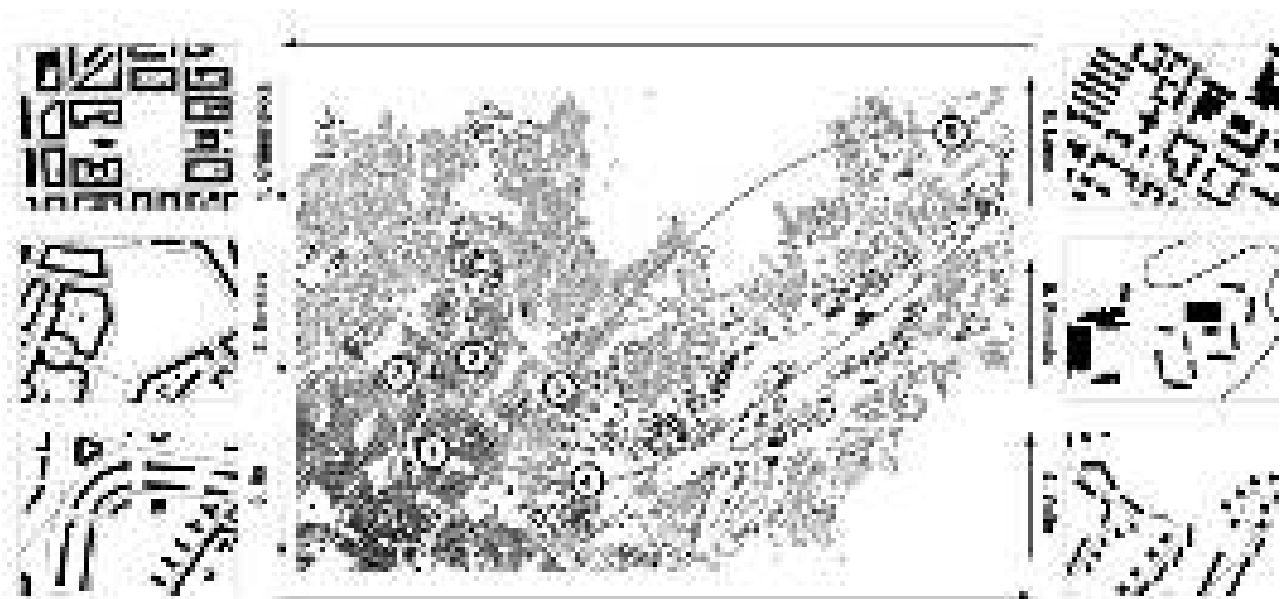


Figure 1. Geographical displacement and typological dilution of urban form – Oslo context.

and are all related to the street. The fourth type comprise the *free-standing lower slab blocks and tower block* (4) exemplified by Valle built between 1953 and 1960, and is presenting a geographical shift moving the house further away from both the street and the city centre. The last type of geographical displacement includes the aggregated slab blocks and tower blocks (5) inside a ring road, exemplified by Romsås built between 1970 and 1974, where the buildings have lost any contact with the street. Finally, the hybrid solution of the “perimeter styled” *slab and tower blocks* on top of a podium forms the last type in this loop, and is exemplified by the development of Løren from the early 2000s presenting a compromised approach to the building-street relation.

This paper address the problem presented in the book about urban form and in the story about housing projects in Oslo, *the interface rupture of the urban block*. It engages in this problem through an investigation of the legislative acts; seeking to understand how this can have happened by researching how this history can be assessed and discussed through the regulations. As an element within the urban fabric, the urban frontage reflects and is a result of societal ideas of its time. Rules, codes and regulations are social constructs derived from the dynamic relation between society and built environment, forming one of the highest levels of societal consensus in the organization of city society (Skatland, 2018). These regulations represent collective societal ideas embodied in a legal framework, which determine the production of the physical public-private interface. The paper presents the impact of legislation both as a *precondition for* and as *a result of* urban form and on the production of the *façade-threshold*, a new concept presented by Børrud & Standal in a parallel conference paper (Standal & Børrud, 2019). This concept presents the relation between building and street, including *façades* of visual and physical permeability as well as *thresholds* of depth and spatial interaction, comprising both *relations and objects*. In this paper I look for explanations about this problem in the legislative development and morphological results of urban form in the last century by asking the following research questions;

- How has the regulatory description addressing the *façade-threshold* developed over the last century?
- What is the impact of legislation both as a *precondition for* and as *a result of* urban form as revealed through the production of the *façade-threshold*?

Seminal thinkers such as Cerda, Jacobs and Alexander form precedents of the understanding that has come to light in the last decades through the work of philosophers Gilles Deleuze, Félix Guattari and Manuel Delanda on assemblage theory (DeLanda, 2019; Deleuze & Guattari, 1988). I suggest that we can read the *façade-threshold* of the Urban Frontage through the lenses of these assemblage perspectives, where complex *relations* between material forms and socio-spatial practices, between human and non-human, between top-down and bottom-up processes forms the basis of the understanding. The unique spaces and places of the *façade-threshold* form complex interrelations between parts; this includes both the urban form and the legislative ideas being able to react to and develop this form.

2. Methodology – Conventional content analysis

I have investigated the research questions through a conventional content analysis of regulatory documents covering the top level of the building codes and related to urban form development in the last century, looking for the effect it plays on and the way it is affected by this urban form. The empirical sources include the Norwegian Building acts with technical regulations,

as well as the 1965 public road act. The legal regulations and planning system are constitutional constructs based on Norwegian history, legal traditions and practices. They provide a two-way perspective on the production of built environment, *the planning system* and *the legal regulations for buildings* (Røsnes 2005). This investigation considers the regulation, and uncovers a “hidden” planning system by which the regulation of details and buildings has a direct effect in determining the urban form. They form site-unspecific regulation at the highest level of Norway’s legally enforceable system, which focuses mainly on *built object* rather than *unbuilt space*, and crucially lacks a focus on the relation between *built and unbuilt*.

The story of the legislation, rules and codes has been reflected on in a range of research addressing *rules* (Talen, 2012), *law and technical* regulations (Skatland & Lohne, 2016) and *planning history* (Grønning, 2017; Ridderstrøm, 2015) while morphological changes of urban form have been investigated through *morphological* (Panerai *et al.*, 2004) (Sonne, 2009), and *Syntactical* (Hanson, 2000) patterns of transformation. Emily Talen combines morphological results and legal ideas, connecting the *effect of rules on urban form* as a type of social history where rules reflect values embedded in legal framework. She highlights that assemblage of rules, modest in their individual capacity, presents physical outcomes affecting patterns and forms in explicit and direct ways.

My method for the investigation includes conventional content analysis and diagrammatic development. Content analysis emphasises how a text makes its descriptions explicit and enables the opportunity to evaluate how building regulations reflect an interaction and relation between built environment and society. The method is used to highlight the features by telling both *what* (about the object) the building code describes and also *how* it describes this object. This type of spatial knowledge production is produced through relational thinking and diagrammatic drawing through lenses of assemblage theory. The method borrows from and develops a recent work from Skatland *et al.* (Skatland & Lohne, 2016).

Investigation of the façade-threshold as an analytical parameter requires a first step of *selective and analytical reading* with three different purposes; *overview of the whole legal framework, analytical assessment and coding*. It includes selecting and analysing data into *macro-, meso- or micro-morphological* aspects. *Macro* includes the urban tissue, the grid and structure of the built form, *meso* comprises the simple tissue/street, the urban block and plot series and *micro* includes materials, structures, spaces and buildings within the individual plot. This classification is a simplification inspired by Kropf’s generic structure diagram (Kropf, 2014; Kropf, 2017) presenting relations consisting of part-to-part, and part-to whole connections. In the second step data is *sorted, refined and visualized* into a 12-field matrix, representing *what* (three categories of morphological scale) and *how* (four categories of modality) it describes. This step of examination reveals the degree of explicitness, of recommendation and/or enforcement, in the description of façade-threshold. Each of the relevant paragraphs selected is analysed by their linguistic modal degree. I am using Skatland’s approach of 4 distinct degrees expressing an interval spanning from vague possibility to unambiguous necessity including *Recommendation, Cohesive recommendation, absolute and quantified regulation*. In the last step the whole process is repeated for the different acts and presented in a *time-series diagram* (figure 1) as a collection of comparable diagrams showing both description and modality of the façade-threshold.

The spatial knowledge production in my research comprise diagrammatic development of timelines produced through relational thinking and drawing. Kim Dovey and Elek Pavka suggest the language of urban thinking includes knowledge embodied in diagrams and central to discourses of spatial knowledge. They emphasise that the development of diagrams are funda-

[illegible]

Figure 2. *From prescriptions to recommendations – regulation of facade-threshold.*

3. Analysis/Results *Description of the façade-threshold in legislation and how enforced through modality*

The first overarching building act for Norwegian cities, the 1924 *building act*, defined corresponding boundaries between street, plot demarcations and building line where all facades face the street, in the frontage. *Relations* between private building and public space were regulated through form-direct and absolute regulations. Forty years later, the 1965 *building act* changed the law significantly, presenting an antithesis of the previous one. The new law defined an offset between street, plot and building line in which buildings were defined as free-standing *objects* on a plot of land with defined land-use. Detailed focus on the relation between building and street disappeared as the act shifted the focus to size regulations and the individual built objects instead. This radical change in legislation reflects changes in societal ideas at that time in which the original compact city form of work/dwelling/leisure transformed into functional and geographical displacement of form. It also reflects the transition from a relational to an object-based understanding of city building (Figure 2). This chapter links the morphological development of the urban block with the legislation of the building acts, through description of their character and modality.

This first type (1) comprised the clearly defined and enclosed urban form of the *perimeter block* (example of *Grünerløkka* built between 1870-1890), closely knit with the street network. A regular street grid structure defined areas for development in which plots were regulated, sold and speculatively built as individual units next to each other. The urban block comprised multiple buildings facing the street with a defined space inside and outside. Outward facing functions such as shops had direct entrances facing the street while residential units were accessed through a gate with a communal closed entrance room (courtyard). Parks were developed in “empty” areas within the street grid, and parking made use of this grid. The façade-threshold included stairs projected out into the pavement. 25 year after the *large court block* (example Torshov built 1915-1923) with enlarged green courtyard emerged as the next type (2). A key difference with type 1 is that these took the form of publicly governed housing provision developed on a plot. A modified grid-structure included curves responding to landscape elements, which defined parks, views and squares within a hierarchy, whilst parking utilized the existing street network. The urban block was connected to and defined by the street with open communal entrance rooms, facades and similar entrances to residential flats from both street and the yard. With this change in the development of similar facades, it also presented the first step in a movement defining either space/relations or buildings/objects.

The year after Torshov was build, the 1924 act represented a breakthrough for modern city-planning in Norway. It included rules and regulations about street patterns, façade lines, building lines and plot division as in previous city-specific regulations, and introduced economic, functional, social and aesthetic characteristics. It set stronger quantified and absolute regulations directly affecting the micro-morphology of the urban frontage, including setbacks and projections from the building line, as well as windows and doors which were defined by intervals, minimums or maximums. Examples of rules producing the façade-threshold at meso-level included the location of the building in relation to the street, where building lines must coincide with street line. In the 1924 Act knowledge about city building, buildings and their relations was clearly embedded in regulations and rules.

The *street-related slab blocks* (exempla Ila built between 1935 and 1948), comprising one plot and set in the landscape, form the third type (3) of the morphological chronology, built under the regulations of the 1924 Act. A differentiated street network was placed into the existing

landscape, not as an equal part of the urban structure but as an imposed pattern. Building and streets were still connected, however the façade-threshold removed itself slightly from the street. The road law regulated a minimum distance from the street edge to the building, with a minimum of 5 metres, and provided space for communal entrances as setbacks and/or sub-accesses facing the street. The facades of the street- and park-side were equal, and buildings rather than forming a defined yard or communal garden were instead related to an open space or park. Parking was provided in the related street network.

The three initial urban blocks and their façade-thresholds all relate to street, even though the form, plot division and street network changed. Post-war developments from the early 50s onwards saw a shift from focus on *relations to the street* to focus on the buildings as *objects*. This happened at the same time as car use increased, and functional distinctions developed. While the three first types were built within close vicinity of the city centre and work places, the free-standing *lower slab blocks and tower block type (4)* (example Valle built between 1953 and 1960) removed the housing further away from the city. These blocks were built as housing estates and placed more freely in the landscape. The road networks included cul-de-sacs and hierarchical systems, from pedestrian routes to major arteries which served principally as functional connections alongside which parking was provided in separate areas or garages. The road law regulated a minimum distance from the street edge to the building of a minimum of 7.5 metres which impacted the relationship with façade-threshold by removing it from the street. As a result of this the building *lost its relation* to street, causing a *rupture* of the *Façade-threshold*.

This shift in focus from street relation to built-object within land-use zones reflects a wider change from prescription and regulation to discretion and recommendation in the 1965 Act, which was also significant as the first building act to cover the whole country. This *act* provided a change where legislation of *city building* transformed into legislation about *city planning*. With the 1965 Act, the precedent set by the morphological shift seen in type 4 was implemented into legally enforceable regulation. Following which technical demands and knowledge shifted toward processual knowledge of planning process. While the 1924 Act focused on regulating detailed technical solutions within an urban context, the 1965 law shifted focus to the use of planning types, such as general and regulation plans for the whole country. The prescriptive demands of the 1924 act transformed into discretionary demands, but which included the option to include prescriptive zoning and land-use plans.

The manner in which the regulation of urban frontage transformed into recommendations corresponds with Skatlands' conclusion that the main tendency in regulations develops from high to lower specificity as an interaction between a society and its built environment (Skatland & Lohne 2016). As such, the 1965 Act included to a lesser extent regulation that affected the micro-morphology of urban frontage. Knowledge about the micro-morphological frontage element decreased in the building act, both through the implementation of ideas from changes already built in the urban block and societal ideas of good housing provision through zoning and size regulations. This happened within corresponding timeframes as the buildings lost their connection to the street in urban form. Within this, some absolute regulations prevailed or were added, with examples concerning location of the buildings on the plot. These included demands to build fences between streets and buildings in urban areas and saw increases in minimum distances to neighbouring plots etc. Indirect recommendations concerned the provision of daylight and places for outdoor recreation, such as play-areas for kids and parking were implemented in legislation. Parallel to this a radical shift to requirements for building lines took place in the 1964 Road Act, where the minimum distance from mid street-line to building line

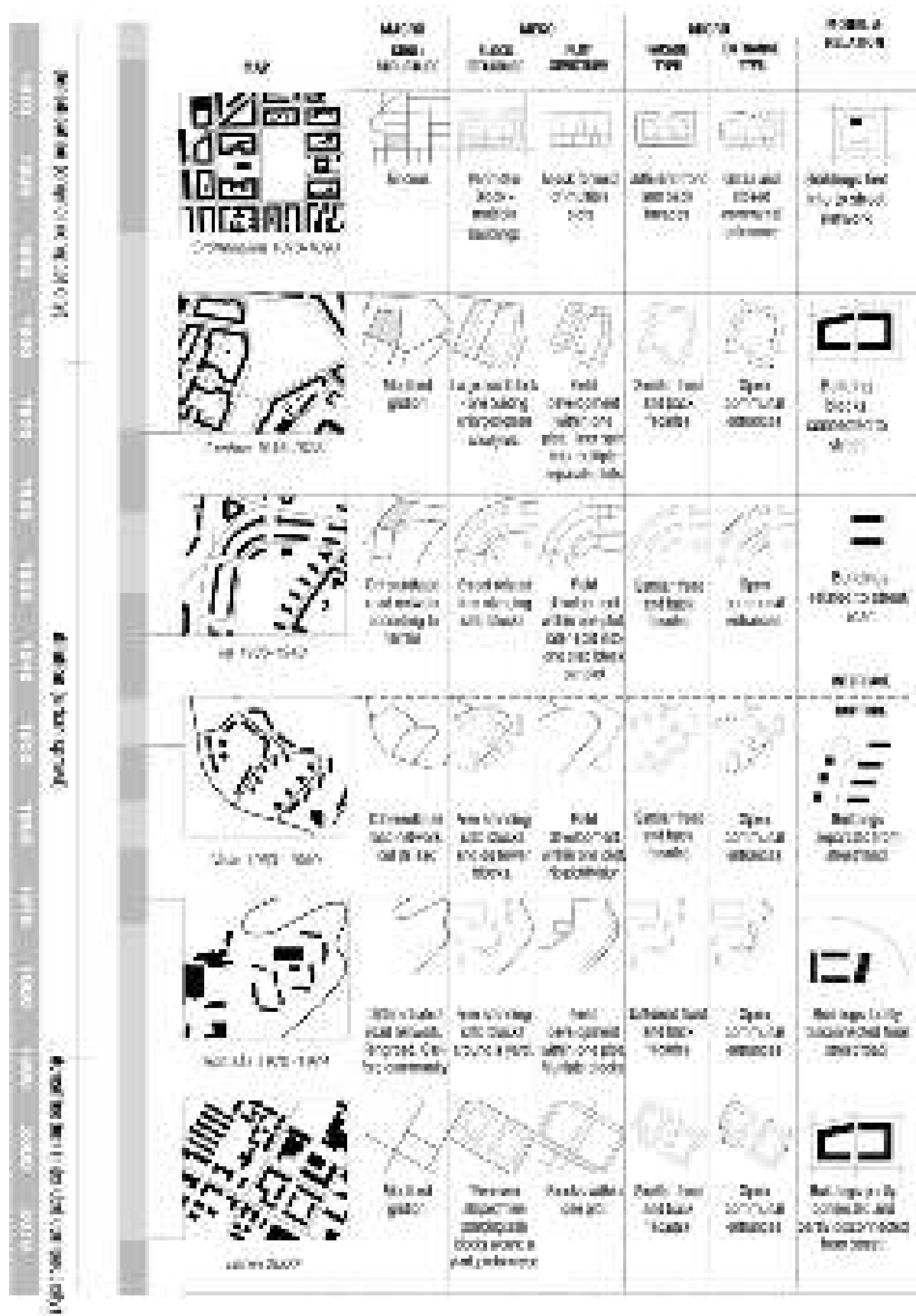


Figure 3. Typological dilution of urban form.

was 12.5 metres for communal and county roads and 30 meters for state roads. This presented another size-increase regulation affecting the façade-threshold.

It was in this new legislative climate the aggregated *slab blocks and tower blocks* around a range of yards on a single (big) plot/field (example Romsås built between 1970 and 1974) were built type (5). This type forms the last phase of geographical displacement of urban form, from city-centre to suburb. They were typically built for planned communities responding to professional critique of earlier morphological types which emerged post-war (i.e. Jacobs, Alexander etc.) Access was provided by a differentiated road network including a ring-road for cars outside the development, with parking in separate garages, and a car-free pedestrian structure inside the residential development. Both smaller units and tower blocks were mixed to form sequences of yards in a natural landscape, whilst these outlying developments typically formed complete satellites of the city. Positioning of roads and buildings was typically determined by the existing landscape. Facades were similar with communal entrances facing the different yards. The Façade-threshold is lost in this case as buildings and streets completely disconnect.

The beginning of the '80s saw a redirection of geographical focus moving back towards the city centre. A range of smaller privately owned plots and potential large transformation areas within the city centre opened up for development as factories closed, and piecemeal and project-based development started. (Børrud, 2005) When the knowledge of the suburban form of slab blocks and towers was reintegrated into the compact urban tissue, new hybrid solutions developed. A major contributor to these new morphological forms was the car, and its integration *within* the building. While cars had plenty of space for parking houses or garages in the suburban context, the compact urban tissue had space restrictions requiring the car to be housed within the residential block.

At the same time the *planning and building Act from 1985* captured a focus on knowledge about and protection of existing environment. Local democracy was strengthened with the municipality operating as land-use government. Private developers could now initiate detailed plans for approval by politicians in the municipality. The law introduced planning on state, regional and local level, where state government could deliver formal opposition to locally decided plans, requiring negotiations to take place. Socio-economic and physical planning were integrated and renewed every four years. Significant changes from the 1965 Act were largely processual, whilst the knowledge of the building-street relation from the former act hardly changed. The small number of paragraphs regulating micro-morphology and the location of a building in relation to its plot became a processual responsibility, leaving the decision to the municipality to accept or decline.

The road law regulated a minimum distance from the street edge to the building, increasing to a minimum 15 metres for communal and county roads, and more than 50 for state roads in cases where no other regulations decide. Within these conditions a new urban block, the podium type (6) arose, taking inspiration from the perimeter blocks in the traditional compact city, whilst creating completely new relational structures (Zurovac, 2019). The free standing *slab blocks and tower block on top of a podium* (example Løren built in the 2000) around a yard and on a single plot formed this hybrid urban block. The modified grid structure supports building types of "perimeter"-style, whilst also creates *islands of slabs* (Berghauser Pont & Haupt, 2009) separated from the grid. Whilst the earlier perimeter block was constructed over a system of speculative buildings on a range of plots, this new hybrid podium block is built as one form and one development on a single large plot. Buildings are *partly connected and partly separated from the street*. Parking is provided as a podium on the lowest floor and can be positioned in different ways; above street level or entirely or partly underground (Zurovac 2019). The type of

podium and the connection to the grid define the façade-threshold of the block, and has a hybrid nature. Sometimes residential or commercial units “wraps” the parking, thereby creating conditions for relations through visual and permeable façade-thresholds, other times parking fills the whole ground floor of the plot with the consequence of a direct blank frontage.

The planning and building act, 2008 forms the current act of the Norwegian planning system. It introduces a range of new topics, including universal design, sustainability, public health and human rights. While the 1985 Act presented regulation plans which regulate utilization and protection of land, water, sea, settlements and the outdoor environment, the 2008 law defines regulation plans as indicating use, protection and *design of land and physical surroundings*. Additionally, the mission statement for the Act has a strong focus on *universal design and aesthetic design* of the environment. What becomes clear through this investigation is that the law is mainly concerned with the regulation of *objects*. The façade-threshold as a relation is hardly addressed by the current legislation, with the exception of the focus on universal design. Regulation of universal design and *accessibility* includes the relation of moving from one place to another, and represent the main area affecting the production of the façade-threshold in current regulation. Elsewhere regulations indirectly affecting the facade-threshold typically relate to an activity, for example *fire prevention* dependent on relations such as: *access road, entrances and movement, emergency access (windows and doors)*.

Other legislation that affect the production of the façade-threshold is the road act. It regulates a minimum distance from mid street-line to building with a minimum of 15 metres for communal and 50 metres for county and state roads, where no other regulations decide.

4. Discussion/Conclusion

In this paper I have presented a story about rules that define and is defined by urban forms, about societal ideas of legislation gradually transforming the historic city into urban sprawl by *geographical displacement* and *typological dilution* resulting in an *interface rupture*. I have used the cases of Oslo to reflect these legislative changes along a diagrammatic timeline, a knowledge producer equipped to reveal relations embedded in form.

My analysis and synthesis of the regulatory description addressing frontage rules reveal that the body and scope of legislation increases in size and content, it changes focus from form to process (Figure 2) Legislation transforms from a focus on *form-direct* regulation to *form-indirect recommendations*. This indicates that the clear early focus on the urban frontage reduces over time both as a regulatory and societal concern. Absolute and/or quantifiable regulations directly addressing components and spaces of the façade-threshold developed into vague recommendations, requiring discretionary interpretation and adjudication. Loss of the capacity for prescription based on technical knowledge in the 1924 act, was gradually replaced by the opportunity to prescribe by zoning-plan, based on processual knowledge from the 1965 Act onward. Within these zoning plans, size requirements for objects such as land, buildings or street were given focus at the expense of the relation between these objects. With the 1965 Act, the main form of current planning legislation for development emerged, whose regulations survive today through subsequent revisions as persistent legal structures. These revisions have added new paragraphs and new topics (such as accessibility) whilst very few earlier aspects have been removed. This revelation supports Talen's view that rules once put into law, are not easily gotten rid of, even were policies change and new development paradigms appear. Within this, the

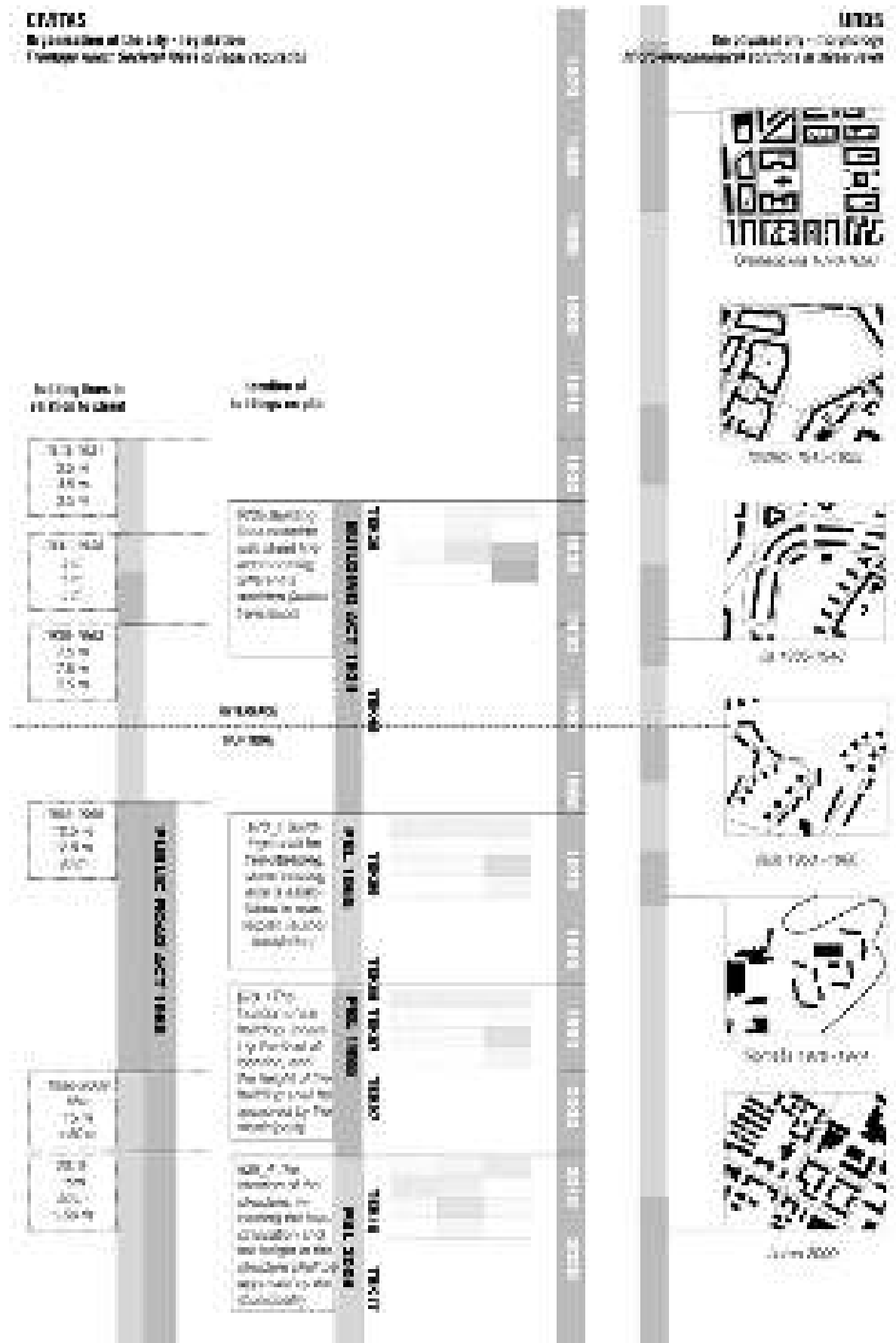


Figure 4. *Synthesis – morphological form seen in relation to legislation in road act and building act.*

façade-threshold is one of those relations, quintessential for urbanisation, which have lost their place and terminology within current legal framework.

Oslo's housing development moved from the city centre to the suburbs and back again. (Figure 1) With this *geographical displacement* the knowledge about house-building increased and knowledge of *city* building decreased. When housing moved back into the city centre in the early 80s, this brought with it new challenges. The *good dwelling*, regulated within the demands of open-space and light, parking and recreation, met the dense city, with a morphology that was unsuited to the density of the compact city. From generosity of space to restricted space, this new habitation created new morphological forms with challenging relationships through their disconnection between dwelling and city.

Typological dilution of the urban block changed a spatial pattern based on continuity of solids to a pattern based on continuity of voids, in which the constructed elements dispersed (Figure 3). This typological dilution presents the preconditions of the *façade-threshold rupture* that occurred between building and street. As buildings became larger, free-standing objects and streets became wider and increasingly car-based, this relationship was compromised. The road act and its changing building line requirements play a vital role in this, increasing from a demand for 3.5 metres for all roads in 1917-1931 to a current demand of 15 meters for communal roads and 50+ metres for county and national roads. The aggregation of these increasing size requirements can be perceived as modest in individual cases but present physical outcomes with significantly impact in determining urban patterns and form cumulatively. The Type 6 podiums represent suburban typologies brought back into the urban tissue but with little or no relation to that context. Whilst critique of these forms has started to emerge in recent years resulting in policies of compact, active cities, different solutions are developing which have a higher emphasis on the relationship of the façade-threshold. These include efforts to redress the vague and problematic popular concept of active facades, which rely heavily on commercial use at ground-floor.

This paper has highlighted a relational approach to an important aspect of city-building, the production of the façade-threshold. It has shown that current production of urban form remains governed by ideas implemented by legislation decades ago, with ever increasing size requirements which work in direct opposition to the aspirations of the compact-city. (Figure 4) At the same time current projects presents a renewed focus and intention to *connect* house and city. As the research through history tells us, legislation responds to morphological results and societal ideas already present, moving slower than ideas and policies. As such, legislation is both affected by and affecting urban form, it is both a *result of* and *providing prerequisites* for development of form. The aspirations presented by current building projects has potential to inform the next revisions of legal constructs.

The authors of the book of the Urban Block, introducing this paper, suggest that only by investigating the urban tissue it is possible to understand the complex relation between plot and built form, between streets and buildings, and *between these forms and design practice*. In this paper I investigate this complex relation between form and society, read through legislation. I suggest that the patterns revealed and knowledge produced through this chronological journey can, in addition to the typology and terminology developed in a parallel paper (Standal & Børrud, 2019), contribute to the revision of legal framework and thereby ensuring better future city-building. I also suggest that the current technical regulations for buildings should be supplemented by a technical regulation for *city* building, which is able to address relations that govern urban experience. *The future of the façade-threshold in legislation* has a potential to implement and precisely regulate in a way that supports Cerda's idea of the quintessence of

urbanization. The first Norwegian building act of 1924 presents important regulations and recommendation that can inspire such a revision. So let's get started!

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Urban Morphological Changes in Hangzhou from the 1950s to the 1990s

An Approach Integrating Oral History

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Keywords: Hangzhou, Urban Form, Oral History.

Abstract: Systematic interviews to compile an oral history of urban planning since the 1950s were first carried out and led by the China Academy of Urban Planning and Design (Li, 2017), as an extension of research into industrial city planning and construction during the first five-year plan (Li, 2016). Although most current statements about Chinese cities in the 1950s have highlighted prominent socialist features such as studying the Soviet Union, prioritizing industrial development, and solving workers' housing problems (WU, 2015. DING, 2018. HOU, 2018), the oral interviews showed more diverse development and localized paths, including urban planning for non-industrial purposes, non-planned construction by local groups, etc. The city of Hangzhou, which was one of the first cities to receive urban planning direction from Soviet experts and had no national industrial projects constructed during the 1950s, was mentioned repeatedly during the interviews.

However, Hangzhou has not yet been studied for its potential in clarifying the overall nature and development path of China's urban planning since the 1950s. Even though, as interviews show, Hangzhou was chosen to represent urban construction achievements in New China at the UIA congress in Moscow (1958), but its pioneering role in China's urban planning efforts in each period since then was ignored. Based on this new understanding and new materials provided by studying oral history, this paper re-examines the process of morphological changes in Hangzhou from the 1950s to the 1990s, in order to make a case for a better and more complete understanding of the overall characteristics of China's urban modernization transformation, and also to verify the possibility and feasibility of an approach combining oral history with urban morphology studies.

1. Introduction

This study explores the developing path and features of Hangzhou's urban form from the 1950s to the 1990s and proposes a new method to understand the reasons behind the urban form changes. Recently, the research methods applied in urban morphology are mainly the ISUF (International Seminar on Urban Form) traditional methods based on the Conzenian and Muratorian traditions (Pinho and Oliveira, 2009, p. 103). In the study of medieval towns, Conzen explained a method to trace the development of a place by analysing the landscape, including street systems, partition patterns and building types. Urban plans and historical archives that

carry the 'material information' of cities are essential materials in research. However, little work has been done towards an empirical approach to validate archival data in this field (Sanders, 2014, p. 189). Most historical records also only cover significant events or official announcements, excluding those details that affect the urban form indirectly. Therefore, the introduction of new methods may help solve these problems.

In 2012, China Urban Planning and Design Institute approved the establishment of Zou Deci studio, which clearly took urban planning history and theory as the main research direction. One year later, the research of the academician studio turned to the in-depth study of urban planning history during the 'one five-year plan' period. Li Hao, who is a member of the studio, conducted interviews with the administrative cadres, professional technicians and full-time translators who participated in the planning work in the early years and published 'Cities, Planning Activities and Witnesses' series. In the practice of interviews, he realised that interviews with veteran experts and oral history are indispensable works for determining the history of China's urban planning (Li, 2017, p. 5). The study partly included important events and institutional changes in Hangzhou urban planning in the interviews of veteran experts, such as Li Zisong, Bao Haihan, Sun Dongjia and Wang Youzhi, who participated in Hangzhou planning in the last century.

Focus on Hangzhou's urban form appeared mostly within planning academics in the past 5 years. The fourth and fifth chapters of 'The Formation History of Hangzhou Scenic City', which was written by Fu Shulan (2015), mainly collated the previous master plans from 1949 to 2007, analysed the spatial transformation of the lakefront districts on the basis of old maps and interpreted the emerging process to confirm the 'City and Lake integrated' urban form in Hangzhou. Feng Jian (2013) used the theory of fractals when he studied the industrial suburbanisation of Hangzhou from 1949 to 1996. Zhu Qian (2015) used the local history and archives of Hangzhou to examine the urban transformation from the founding of China to the pre-reform period and analysed the reasons for spatial change through the perspectives of urban economy, population and urban planning. Li Yutian (2017) used a combination of graphical comparison and data analysis in his doctoral thesis to study the external contours and internalities of Hangzhou since the reform and opening up. However, Hangzhou still lacks the systematic research of morphological change and the exploration of the causes of morphological changes in the period from the 1950s to the 1990s.

Therefore, this study aims to systematically sort out the urban form changes of Hangzhou from the 1950s to the 1990s and apply a new method, namely, oral history, to explore the causes of morphological characteristics of Hangzhou. With this objective, this study started by collating historical maps, plans and data on road construction, large-scale construction projects from the literature and archives, such as Hangzhou City Yearbook, Hangzhou Urban and Rural Construction Journal. In addition, as the Five-year plan is an integral part of China's national economic policy and is a plan for major national construction projects, productivity distribution and essential proportions of the national economy, this study divided the period from the 1950s to the 1990s into nine periods according to the five-year plan and drew maps for every period. On the basis of these data and charts, this study summarised the urban form characteristics of each stage of Hangzhou and divided the whole process into four stages according to the different morphological features. After determining all the uncertainty issues or contradictory expression, this study then introduced interview method and conducted two interviews with Mr. Bao Haihan to seek the support or correct ideas for the research.

Apart from seeking to define different stages of Hangzhou's urban form development, this study also attempted to combine oral history with the traditional morphological method for an improved and in-depth understanding of the overall characteristics of Hangzhou's urban modernisation transformation and the impetus for the transformation.

Table 1. Construction statistics of Hangzhou from the 1950s to 1990s. Source: Data from Hangzhou Municipal Chronicle.

	Built-up area (km ²)	The length of the road (km)	The number of large-scale construction projects
1949	13.09	307.88	/
1958	/	372.68	27
1965	/	328.96	3
1970	/	351.20	2
1975	/	390.49	0
1980	53	431.33	5
1985	60.7	507.60	8
1990	69.2	571	7
1995	102.2	626	15
2000	177.18	1020	2

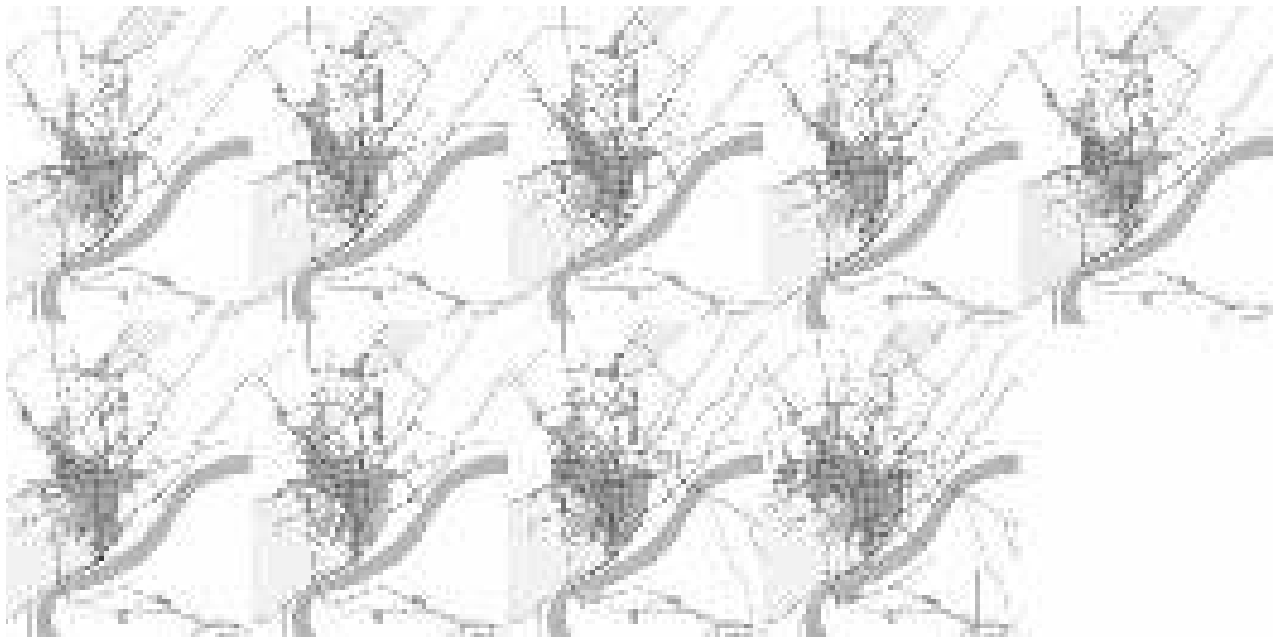


Figure 1. Construction and Urbanisation in Hangzhou (1958–2000). Source: Author's own based on the data from Hangzhou Municipal Chronicle and official maps of Hangzhou City Yearbook.

2. Urban Morphological Changes in Hangzhou from the 1950s to the 1990s

Hangzhou showed different morphological features in different periods from the 1950s to the 1990s. The results show that 1) Hangzhou's spatial form is a circle of expansion with the old city as the core for a long time, and the inner circle is Shangcheng District, Xiacheng District and the western part of Jianggan District, which is mainly dominated by business, administrative and residential functions. The middle circle includes Gongshu District, the northeast of Xihu District, Binjiang District, Jiangnan District and the surrounding areas of Yuhang District, which has comprehensive functions. The outer ring is the industrial zone, which includes Xiaoshan, Yuhang, Linping, Tangqi, Liangzhu, Pingyao and other towns. 2). From 1949 to 1958, the construction and development of Hangzhou developed rapidly and broke the 'east city-west lake' urban structure of Hangzhou, which is a continuation of ancient time and jumping out of the old city that has not changed considerably in a thousand years. In the nearly 20 years since 1959, planning work in Hangzhou stagnated in an all-around way, and the speed of urban morphological change slowed down. Urban construction mainly relied on the inertia of former plans. Construction of public buildings were carried out in the surrounding area of Wulin Square and Zhejiang Exhibition Hall, such as Hangzhou theatre and telecommunications and department store buildings. After 1980, the transformation speed of urban form in Hangzhou accelerated again but was still a horizontal expansion mode. Decentralised clusters appeared in the 1990s. The representative groups were the Xiasha and Yuhang development zones in the east and the sub-centre group in the south with Xiaoshan development zone and Binjiang District as the core.

3. Structure Remodelling Period (1949–1958)

After the foundation of the People's Republic of China in 1949, Hangzhou experienced a rapid remodelling period of urban form. The demolition of the city walls and the construction of the roads around the city have extended Hangzhou's urban development beyond the boundary of Wushan in the south, Wulin in the north, Qiantang River in the east and West Lake in the west. The most apparent change in the map is a leaping growth of the industrial park in the north of the old city. Banshan heavy industrial area, which was dominated by metallurgy and machinery manufacturing industries, formed along the Shanghai–Hangzhou Railway. Oxygen plant group, iron and steel plant, bearing factory, steam turbine plant, textile machinery plant, heavy machinery factory and boiler factory were built in this area in Hangzhou. Along Hangning Road, a Gongchengqiao light industrial area, which was mainly composed of the textile and light industries, was established. On both sides of the canal, Zhejiang hemp textile factory, Hangzhou No. 1 woolen mill and Hangzhou No. 1 silk printing and dyeing plant emerged. Overall, the layout of the industrial zone is in line with the design of the Master Plan completed in 1951.

In terms of road construction, a pattern of ring roads in the old city started forming. In 1951, a separate provincial and municipal traffic administrative agency was established for the first time (China. Hangzhou Traffic Records Editorial Committee, 2003). From 1956 to 1959, Hangzhou successively demolished the east, west and north city walls and built Huancheng East Road, West Road and North Road, which were connected to Hubin Road, Nanshan Road, Wansongling Road and Jiangcheng Road. Thus, the freight from the south bank of Qiantang River can detour past the West Lake scenic area and the old city. As a result, the traffic volume in the central area of the city was decreased. In the inner part of the old city, the renovation of

street pavement and drainage facilities was the main construction work. After reorganisation in early June 1949, the Municipal Works Bureau (renamed as the Construction Bureau in the same year) began to do the road condition survey and formulate plans to transform urban roads and streets. Extensive renovation work was carried out on the road for historical relics, bumpy roads and muddy conditions in rainy days (China, Hangzhou Municipal Government, 1994). In Yan'an Road, a new section from Kaiyuan Street to Jiefang Road was built. Baochu Road, Wulin Road, Jiefang Road, Lingyin Road, Nanshan Road, Kaixuan Road and Shuguang Road were all repaired and hardened. As shown in the picture, the renovated roads of this period were mainly concentrated in the west of the old city. This situation is in line with the main construction layout outside the old city.

Comparing the 1958 map of Hangzhou and two plans, namely, the 1951 Master Plan drafted by the Hangzhou Municipal Construction Bureau and the 1953 Master Plan guided by the Soviet expert A. S. Mochin (A.C.MYЦИИ), shows a large deviation between the actual construction and the two plans. This deviation is caused by the incompatibility between the master plan dominated by Soviet values, methodology and the real situation of Hangzhou.

4. Development without Master Plans (1959–1980)

In 1958, Hangzhou drastically modified its master plan, which was completed in 1953, in accordance with the requirements of Great Leap Forward to reflect the new ultra-Leftism. During this period, the primary purpose of development was industrialisation, whereas other urban functions were belittled. The development of Hangzhou's external traffic centred on industrial construction. Hangning Road, which connected with the old city with light industrial factories, such as Huadong and Minsheng pharmaceutical factories, was widened and rebuilt. Moganshan Road was widened and renamed. As a result, the traffic from Wulin gate was alleviated to the northern part of the city. In the north of the old city, Shixiang Road appeared, which linked Qiutao Road, Dongxin Road and Beijing–Hangzhou Grand Canal. The bus terminal, which was located initially in Hubing District, also moved to Wulin gate during this period to avoid external traffic through the old city. The inner road structure of the old city was further improved. This improvement is mainly reflected in the widening and extension of two east-to-west roads. Jiefang Road was widened in the section from Huixing Road to Changmingsi Lane and extended eastward to Huancheng East Road. Tiychang Road was expanded, and the gravel pavement from Huancheng West Road to Yan'an Road was rebuilt into asphalt pavement.

However, the industrial Great Leap Forward led to the unsustainable and unnecessary expansion of urban industries, a waste of land, shortage of housing and basic public services and environmental deterioration. (Zhu, 2014:575). The government ascribed these problems to urban planning. The incorrect directive of 'three years without urban planning' was announced in 1960. In 1968, Hangzhou was caught up in the wave of cultural revolution. The planning bureau was closed down. The implementation of Hangzhou's urban planning fell into a standstill. The main constructions also were to meet the needs of the political movement. The government started the construction of 'Exhibition Hall of Longlive Mao Zedong Thought' (later renamed as 'Zhejiang Exhibition Hall') on a vegetable field in the north of old city to welcome the 20th anniversary of the founding of the People's Republic of China and display the unpublished photos of Mao. The construction of the square, namely, 'Red Sun Square' (later called 'Wulin Square'), started near the exhibition hall. A section of Tiychang Road, which ended at Huancheng North Road, was converted into the square due to the two aforementioned pro-

jects. The original traffic function was diverted to Exhibition east and west roads. Moreover, Baochu Road was widened and rebuilt in the west of the old city owing to the development of culture and education area. Another important construction was civil defence projects. The defensive counter-attack on Zhenbao Island was launched in 1969, and the combat readiness became increasingly severe. The central government issued a remarkable document entitled 'Report on Strengthening the Work of National Civil Air Defence'. A climax of mass digging holes to prepare for war, which was a response to Chairman Mao Zedong's call, was observed in the whole city. The city construction gradually turned to the permanent and semi-permanent civil air defence projects. A total of 44 connected tunnels were built in the city. Amongst them, Shangcheng District built tunnels under 11 roads, such as Jiefang Road, Yan'an Road, Ding'an Road, Guohuo Road, Renhe Road, Xiaoying Lane, Laodong Road and Huansha North Road. Xiacheng District constructed tunnels under five roads: Tiuyuchang Road, Xiaofeng Road, Haier Lane, Chaoming area and Genshan port channel. Gongshu District constructed tunnels under three roads: Changzhen Road, Gongchenqiao Road and Xixi Road. Jianggan District built four tunnels in Fuxing Road and Wangjiang, Ziyang and Tongjiang areas. Xihu District constructed two tunnels in Baochu Road. The Huansha River was cut off, drained to clean up the silt in the riverbed and filled up to form Huansha Road, which is a main secondary road in Hubin area.

At the same time, Hangzhou became a popular political event venue for foreign guests and an attractive destination for international visitors. The Jianqiao airport expansion project and a high-standard theatre, namely, Hangzhou theatre, were completed at an incredibly fast pace to accommodate US President Richard Nixon's visit to Hangzhou in 1972.

From 1959 to 1980, the chaotic constructions were mainly politically oriented. The urban form has not broken through the pattern of waist drum. However, these constructions have also improved the living environment unintentionally and slowly in infrastructure and residential area constructions.

5. Spreading-type Urban Spatial Expansion (1981–1990)

In 1980, the Hangzhou government established a 16-member urban planning advisory group. The group completed a new round of master plan in November, which was the first state council-approved Master Plan of Hangzhou. In accordance with the principles 'protect the West Lake scenery, create Qianjiang new city, gradually transform the old city, form a complete set of living facilities, adjust the industrial structure and develop satellite towns', this Master Plan focused on urban scale, protecting the West Lake scenic area, controlling the old city and reforming and adjusting the industrial land (Fu, 2015, p. 151). Hangzhou experienced a horizontal expansion period from 1981 to 1990.

The construction activities in this period were mainly the expansion of urban boundaries caused by the construction of residential areas. The new residential area appeared mostly in the edge area of the built-up and the open space in the built-up area. The residential area construction in the north of the old city was all built in the existing road frame. The undeveloped land in the north of Huancheng North Road and the south of Banshan industrial zone built Desheng and Hemu residential areas. The Qingtai overpass located in the middle section of Qingjiang Road appeared to the east of the old city and ended the division between the old city and the eastern part of the city, which was caused by railway and the Tiesha River in the past. The residential area construction in the west of the old city is an extension of the cultural and educational district. Gudang, Cuiyuan, Huayuan, Jiulian and Tianmushan residential areas

were built along Wenyi West Road and Jiaogong Road. Hanghui Road, which was from Lin'an City, was widened and renamed as Xixi Road. The road construction lagged behind the real estate development because the west of the city was a residential area developed by real-estate developers.

The speed of regional development to the east of the old city increased significantly during this period. The construction of Xiasha Highway and Qianjiang Second Bridge and the widening of Genshan Road and Qiutao Road provided favourable conditions for the eastward development of the city. Residential areas, such as Xinglong, Tangmiao, Xizhao and Zhanongkou, were built on undeveloped urban plots that lie between Huancheng East Road and Qiutao North Road. The urban pattern has changed from the development of 'back the Qiantang River' to the development 'along the Qiantang River'. However, the speed of growth slowed down for the west of the old city, and the north-south roads, such as Jiaogong Road and Baochu Road, were rebuilt. Wenyi Road was broadened and extended to Nongguanhe Bridge in the west. Hangzhou middle ring road also began to form. The newly widened Qiutao Road, along with the newly built Daguan Road and the existing Jiaogong Road, allowed transit vehicles to bypass the city. In the north of the old city, new Shixiang Road and Daguan Road got connected to Shiqiao Road, Shenban Road and Moganshan Road in the north of the city.

Construction of large-scale infrastructures drove the change in urban interior form. The Zhongdong River Renovation Project appeared on the map. The project started from Zhonghe road overpass in the north and reached Fengshan Road in the south and had a total length of 5.3 km. The Provincial Merchant Training Centre, the business office of the Provincial Construction Bank, the service centre of the Forest Department, the Commercial Building, the Textile Exhibition and Sales Centre, the Supply and Marketing Trade Building, the building of the Provincial People's Bank, the Power Building, the business building of the Provincial Industrial and Commercial Bank and the cinema and theatre were arranged along the street, which made Zhonghe Road the main north-south traffic artery in the old city.

During this period, urban construction developed rapidly, the old developing pattern of urban around West Lake was shaken and the city began to turn to develop along the Qiantang River.

6. Multi-cluster Development (1991–2000)

In 1992, the group completed the supplemental draft of the city planning on May 13 and reported to the provincial government. This revision proposed five 'optimisations' about the urban system, the layout of industrial and residential areas, land use structure and urban ecological environment and infrastructure.

In this period, the most apparent change in urban form was the emergence of multi-cluster developing mode. In the east of the city, Binjiang high-tech industrial development zone and Qianjiang investment zone appeared on the map. In 1996, Xixing, Changhe and Puyan towns of Xiaoshan were included into Hangzhou City, which is called Binjiang District. Hangzhou carried out several road constructions in the east of the city, including the widening of Zhijiang Road (1996), reconstruction of Fuxing Road (1996), broadening of Qingtai Street (1996), construction of Qianjiang Third Bridge (1996), Qianjiang Road Phase I (1998) and Qianjiang Sixth Bridge (1999). Accompanied by road construction, residential areas in the east side of the city, such as the Jingfang, Caihe and Shuangling residential areas, began to take shape. The west part of the city still held a horizontal expansion mode. On the basis of the original grid road of the cultural and educational district, the city's west side extended to the west and north. Wenyi

Road, Wen'er Road and Wensan Road extended west to Hangsan Road. Tianmushan Road was hardened and widened from Jiaosi Road to the west, extending through Gudang Bay to Liuxia Town. These four roads formed the main east–west roads in the west of the city. In terms of the south to north direction, Hangsan Road, Gudun Road, Fengtan Road and Jiaosi Road appeared, constituting the main south–north roads in the west of the city, which had the existing Xueyuan Road and Jiaogong Road. Farmland, surrounded by the four main traffic arteries, namely, Wenyi Road, Tianmushan Road, Hangsan Road and Jiaosi Road, was rapidly filled up. The residential areas of Gudang, Cuiyuan, Huayuan and others appeared, thereby forming a cluster of residential areas to the west of the original parish.

The construction of external roads developed rapidly during this period. In terms of railway, the Anhui–Hangzhou line was completed in 1991, and the Hangzhou–Shanghai railway was completed in 1992. The Hangzhou East railway station also appeared in the east of Jianggan District. In terms of highways, the construction of the Hangzhou Ring Expressway and the Hangzhou–Ningbo Expressway and the reconstruction of the Lin'an section of the Hangyu Expressway were completed in 1992. The Xiaoshan section of Hangjin Highway was rebuilt in the same year.

The map shows that the city of Hangzhou developed rapidly in the east and west directions from 1991 to 2000. At the same time, the construction in the north of the city slowed down. This event was contrary to the construction policy of strictly controlling the city's development to the west. Nevertheless, the development changed Hangzhou from being long in the north–south direction and narrow in the east–west direction to being narrow in the north–south direction and long in the east–west direction.

7. Interviews and Intercession

In the preparation phase of the study, the first-generation planners who participated in the planning work of Hangzhou in the last century were contacted to find potential interviewees. Mr. Bao belonged to the first batches of students who participated in the professional planning courses in China. After graduating from Tsinghua University in August 1953, he was assigned to the military construction department in Beijing. In 1956, he transferred to Qinghai. After two years of working as a planner in the provincial urban construction bureau, he came to Zhejiang in 1958 and then entered the planning institute of Hangzhou in 1964. After his retirement in 1996, he was re-employed by the government as a consultant for Hangzhou's planning and worked until 2007. During his 43-year career in Hangzhou, he participated in the compilation of the 1983 master plan, the 1996 master plan, the 2001 master plan and the revision of the master plans in 1964 and 1985. He also played a leading role in the planning of the functional layout and development direction of Hangzhou. His familiarity with Hangzhou for the period of 1949–2000, which is the scope of the current study, is rare. Taking all these factors into account, we believe that Mr. Bao is an ideal interviewee.

In the current work, two interviews were conducted. In the preparation stage, a list of questions was formulated on the basis of a literature review and historical map drawing. The questions centred on the construction of the industrial city in the 1950s, the road construction after the 1960s, the formation of the cultural and educational area and residential areas in the 1970s and the large-scale projects of Hangzhou. However, the first interview had limited effect on the lack of continuous guidance in interviews and the ambiguity of the questions. After the adjustment of the questioning method and the preparation of a relatively detailed list of questions,



a Construction and Urbanisation in Hangzhou (1949-1958)



b Construction and Urbanisation in Hangzhou (1959-1980)



c Construction and Urbanisation in Hangzhou (1981-1990)



d Construction and Urbanisation in Hangzhou (1991-2000)

Figure 2. Construction and Urbanisation in Hangzhou (2000). Source: Author's own illustration based on official maps of Hangzhou City.

the second interview was held a month, focusing on impressive and detailed historical events or the events in which Mr. Bao was involved. In this way, Mr. Bao could easily recall his experience and find inspiration for his narrative. The recording of the interviews and Mr. Bao's notes were later arranged into a manuscript. Literature materials were searched for verification of the content proposed by Mr. Bao. After these steps, the historical maps were proofread.

8. Supplement and revision of research viewpoints based on the interviews

The oral history method was helpful in advancing the research results. Primarily, it supplemented the unwritten and unrecorded knowledge. In the interview, Mr. Bao expounded the reasons for the failure of the Soviet expert-led plan. In 1953, Hangzhou's first city master plan was led by Soviet urban planner A. S. Mochin (A.C. MYШИН). However, its implementation was somewhat anticlimactic. In the interview, Mr. Bao also talked about this problem.

Mr. Bao: The plan led by the Soviet expert in 1953 put some sanitariums in Hangzhou. However, not much sanatoriums were built as planned, and nothing else was built in the city according to his plan. The plan stalled due to the lack of funding. At that time, Hangzhou was at the front line of the war. The national government did not invest much in Hangzhou. Thus, no matter how beautiful the Soviet expert's plan was, Hangzhou could not afford to implement it.

After the interview, other research was reviewed. Another expert, Zhang Youliang, who participated in Xi 'an, Luoyang, and other cities' urban planning and design work in the first five-year period mentioned:

They established their country earlier than us, and they have more mature experience than us in terms of disciplined construction and practice. But they have their specific conditions. The ring network plus the radiation mode did not necessarily work in China.



Figure 3. Outline of the First and Second Interviews. Source: Author's own. The handwriting is that of Mr. Bao.

Therefore, even though the 1953 plan had its special status in the history of Hangzhou, the specific construction content was not implemented actively because of two factors: the significant difference between the plan and reality and the lack of funds.

The interviews also shed light on the concept of Hangzhou's political and cultural centre layout, which differed from the form in the plan. The 1980 map shows the new political and cultural centre of the city in the area of the Zhejiang Exhibition Hall which lies south of Huancheng North Road; this location is different from those specified in the 1951, 1964 and 1973 master plans. In the 1951 plan, the political and cultural centre is situated in the north of Huangcheng North Road. In the 1964 and 1973 plans, it is along the West Lake. In the interview, Mr. Bao described the changes in the plan of the political and cultural centre.

Mr. Bao: At that time, deciding how to locate the exhibition hall became problematic. In addition to the exhibition hall itself, we had to consider the flow of the procession. The parade was expected to pass through the exhibition hall, where a reviewing stand would be available. Later on, we decided to locate it in the north to south direction. In front of the hall was the square which had a channel on both sides. There was also a Red Sun Square for the annual National Day and Labour Day Parade.

Given its special political role in history, together with the consideration of people's parade route, the political and cultural centre of Hangzhou was established in the inner part of the old city instead of in the north part of the old city as planned. The interviews enabled us to verify and correct the previous research results. In the previous literature review, we speculated that the decision to control the development to the west in the 1990s was related to the plan for Hangzhou to become an essential central city in the Yangtze River Delta and develop along the Yangtze River. In the interview, Mr. Bao addressed the speculation.

Mr. Bao: When we were preparing the 1993 master plan and the 1996 master plan, we submitted a report to the municipal government: the city should strictly control the development to the west. There were two main places for strict control. One was west of the Gudang area. Why? Mainly because of traffic problems. Mountains dominated the west of the city. The traffic all relied on Wenyi Road, Wen'er Road and Wensan Road. At that time, the three roads were set to be the secondary road measuring 30m wide. Thus, developing to the west was tough. Another reason was the position of the West Lake. If the western part of the city developed, the West Lake could not be called the West Lake anymore for it would be surrounded by built-up areas. The original feature of Hangzhou of being a half-city and half-lake would be destroyed. Hence, in our report, we stated, 'strictly control the development to the west'.

As for the reason why Hangzhou still underwent development to the west, Mr. Bao offered the following explanation:

Mr. Bao: After the reform and opening-up, the Yuhang government had already sold land to real estate developers. Many places in the Jiangcun area had already been sold. These places were included in the scope of Hangzhou. The merchants had built many houses in these areas with nearly no infrastructure construction and with little road construction. Thus, after the Hangzhou government took over these areas, they had to extend and renovate roads and pay for infrastructure construction.

As indicated in the interview, the recommended strict control of the city's development to the west was the result of the government's comprehensive consideration of urban development conditions, such as transportation and urban infrastructure construction. The rapid growth of the west later was because the county government still having the right to sell land. Under market

conditions, real estate developers purchased property for the county-level government. Therefore, the residential areas were built earlier than roads in the west. From this point of view, we can say that the urban form is not strictly determined by planning activities. In the context of the reform and opening-up, market-oriented behaviour is also regarded as a critical factor affecting urban form. The interviews provided mutual evidence of existing views. In the interview, Mr. Bao did not explicitly propose the stage of the urban form change, but he indeed described 1958 and 1980 as two critical nodes in the shift of Hangzhou's form.

Mr. Bao: I was in the city construction office in June 1958. At that time, the 'Great Leap Forward' did not provide any help for the city. The department did not directly engage in planning, and the personnel was gradually transferred... The formal planning after the Cultural Revolution began in 1980. Back then, the Planning Bureau was directly under the Municipal Construction Committee, and the overall planning work was instantly arrested by Wu Chengyu, the deputy director of the Municipal Construction Committee.

To some extent, Mr. Bao's remarks can prove the accuracy of the stage division of the morphological changes in Hangzhou in the former research. The political movements that began in 1958, such as the Great Leap Forward and the Cultural Revolution, lasted for nearly 20 years. In addition, 'three years of no planning' was proposed in 1960. Therefore, on the basis of the literature and interviews, we can regard 1958 as a turning point in the change of the urban form of Hangzhou. However, many scholars believe that the second turning point of urban form change was in 1978 because this period marked the end of the Cultural Revolution. In the interview, Mr. Bao chose the year 1980 as the juncture because it marked the official resumption of the planning works after the Cultural Revolution in Hangzhou. Such description is consistent with the conclusions of the previous literature.

The interviews also brought new inspiration for research. When talking about the construction of the line comprising Tianmushan Road–Huancheng North Road–Dazhai Road (later named as Genshan West Road), Mr. Bao shared a story of public participation.

Mr. Bao: Dazhai Road was originally a temporary road for construction. At that time, there was a vast farmland in the east. Every day at four o'clock in the morning, the peasants from the Pengyu and Jianqiao areas would pull vegetables into the city in wire carts through Dazhai Road. After the construction was completed, Dazhai road was left unattended. When it rained, this road became muddy, and the peasants could not easily pull the carts. Later on, the people in the peasants' commune asked me for help because I was in the construction bureau at that time. I reported their concern to the government which then subsidised 100,000 yuan to repair the road.

This action can be regarded as an early attempt on public participation in urban planning.

9. Four stages of Hangzhou's urban form development based on literature research and oral history method

By integrating the results of the literature research and interviews, we divide the urban form development of Hangzhou from the 1950s to the 1990s into four stages.

The period of 1949–1958 involved the structural remodelling of urban space after the founding of Hangzhou. The main reason for the evolution of Hangzhou's form during this decade was the development of social economy and the advancement of technology that led to new functions in the city. This situation caused conflicts between urban form and urban

function, thus promoting the evolution of urban form. As the plan emphasised the positioning of industrial cities in Hangzhou, industrial expansion was the most crucial cause of urban form change. Consequently, a leap-forward industrial zone emerged in the north of the city, thereby driving the city's north-south road development. The construction of the cultural and educational districts in the city's western area and the construction of rest and recuperation facilities were another two important reasons for the change of urban form during this period. The development of cultural and educational districts broke the historical urban structure of Hangzhou as the 'City in the East, Lake in the West'. Modern grid-like roads appeared in the west of the city. The construction of the rest and recuperation facilities was the only part of the 1953 plan formulated by the Soviet experts to be actually implemented. Resort areas were built in the mountainous areas of the west bank of the West Lake and in the Fenghuang Mountain and Yuhuang Mountain areas.

Between 1959 and 1980, the main change in urban form was reflected in the improvement of the facilities in existing structures. The political movements were the most important reason behind the change in urban form. During this period, the speed of urban construction in Hangzhou slowed down. The most apparent change was the construction of critical public buildings in the Wulin area which gradually developed into an important cultural and commercial centre within the urban area of Hangzhou. The outline of the city had not been further expanded, and the construction of the residential regions brought about by population pressure was arranged in the open space within and along the edges of the old city.

After 1980, under the background of rapid economic development and the formal restoration of planning works, the reconstruction of the urban form was accelerated. The adjustment of the administrative districts and the expansion of the residential areas became two carriages that drove the rapid development of the contours of Hangzhou. In the north and west directions of the existing urban built-up area, a circle-level expansion was initiated, and the east of the city showed a leap-forward development. In the late 1980s, the speed of residential construction began to accelerate. The construction of large-scale residential areas, such as Jiulian, Gudang and Cuiyuan in the west of the city; the Chaohui area along the canal block; and the Caihe area in the east of the city further expanded the urban built-up area. The construction of the residential area in the northern part of the city filled the open space between the Chengbei Industrial Zone and the old city. The development of the west of the city extended the outline of the urban built-up area to the west and close to the Yuhang County area.

After 1990, group developments were scattered outside the old city of Hangzhou. The three districts of Xiaoshan were integrated with Hangzhou, and the Binjiang District was established in the south of the Qiantang River. The focus of urban development shifted from the West Lake to the Qiantang River. In the old city, rapid modernisation and construction began. The old city reconstruction project rebuilt the internal roads of the city. The consciously centralised arrangement of public buildings and critical commercial facilities led to the emergence of two notable business districts, namely, Wulin Square and Wushan Square. Functional structure differentiation began to appear within the old city.

10. Conclusion

The study systematically investigates the development of Hangzhou's urban form from the 1950s to the 1990s and explores the causes of the morphological changes through a wide range of doc-

umentation, such as the Hangzhou City Yearbook, Hangzhou Urban and Rural Construction Journal and Hangzhou Municipal Chronicle, together with the oral history method.

Overall, the development of Hangzhou's urban form from the 1950s to the 1990s can be divided into four stages. From 1949 to 1958, Hangzhou experienced a magnificent industrial construction period, and the urban form broke through the original city's boundary as a result of the urgent need to develop the industry and restore the economy. From 1959 to the Cultural Revolution, the construction slowed down because of the political movements and stagnation of planning works. Important public service facilities appeared on maps for political need. In the 1980s, after the recovery of the planning works, Hangzhou restarted its repaid transformation of its urban form through a spreading-type expansion with the help of the reform and opening-up and the market economy. In the last decade of the 20th century, the urban form evolution accelerated with an adjustment of administrative divisions to include Xiaoshan District and Yuhang District into Hangzhou. The multi-cluster development mode arose in this period.

The attempt to introduce oral history to the research reveals that the oral history method can overcome the limitation of traditional historical records and supplement case records in addition to the statistical data. Oral history can also be mutually verified and supplemented with existing historical data to improve the comprehensiveness and accuracy of the research. As for the methodology, the following aspects deserve special attention. 1) In the selection of interviewees, the purpose of the study and the candidates' experiences and memory ability should be taken into consideration. 2) The pre-interview preparations are of great significance. Before the interview, the interrogative points should be listed after the elaboration of a wide range of documentation and historical maps. We should emphasise that inadequate literature may result in limited inspirations for interviewees. 3) During the interview, guidance for the interviewees is necessary. However, the content should not be framed strictly. 4) Timely supplementary interviews with an adjusted interview outline should be conducted if the former one fails to achieve the desired results.

11. Acknowledgements

We thank Mr. Bao Haihan for providing a valuable interview. This work was supported by the National Key R & D Program of China (Grant No. 2017YFC0702504).

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Urban Design: Urban Morphology, Building Typology and Design

Research on Typology of Traditional Chinese Gated Community Sharing Space in Urban Design

Taking Beijing HUIZHONGLI Community Spatial Redesign as Example

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Keywords: gated community, shared space, urban design, typology, Beijing.

Abstract: The traditional Chinese urban form tends to take big as principle of design, and the traditional urban planning model pursues a grand scale and exhibits dense spatial characteristics. Under the influence of modernism, urban forms are distorted and urban spatial scales are unbalanced. Under the influence of Chinese traditional urban spatial planning concept, many gated communities were built, and they were self-sufficient and formed a closed operating system. With the development of social economy, this closed system is gradually unable to adapt to the new urban spatial form. This paper conducts a typological analysis of traditional Chinese closed communities. Under the background of shared architecture and urban morphology, it analyzes two types of gated community space to urban sharing: one is the internal space of the community to the city, and the other is the community's external space is shared with the city. Moreover, the article takes the shared concept design of the marginal space of HUIZHONGLI community in Beijing as an example, and provides a reference for the open transformation design of traditional Chinese gated communities. It is proposed that it is possible to share the space of traditional gated community space with the city.

1. Introduction: from gated communities to open communities

The gated residential model has been in China for a long time. From the *Lüli community* in Han dynasty to *concession area* in Shanghai, from the *unit compound* to the *gated community* of the market economy, gated residence has developed multiple forms in history. American sociologists Blakely and Snyder define the gated community as 'a residential area surrounded by walls or fences that privatizes space and restricts access to others. In the urban communities of China, it is a closed type that is widely found in Chinese cities. Most of these gated communities have the characteristics of large area, self-sufficiency and privatization of public space.

Large-scale urban blocks have eliminated urban slip roads, leading to a growing problem of urban road congestion with the rapid development of private transportation. In 2016, the "Public Central and State Council's Several Opinions on Further Strengthening the Management of Urban Planning and Construction" proposed that "the gated residential community will no longer be built in principle", and the positive significance of opening the community

to the city began to be valued. “Small space, dense road network”, the urban design approach began to be widely used in the construction of new districts.

Open communities can help to alleviate urban traffic pressure to a certain extent, but this is only the result, not the purpose. Urban construction should be appropriate to people’s behavioral. Space should be created “people-oriented” rather than “car-oriented”. Establishing an urban space with appropriate scale and walking friendly space is the core value of the open community. The spatial layout of transforming traditional gated communities into “small blocks and dense road networks” narrows the spatial scale of urban neighborhoods. It is suitable for walking while also facilitating the development of commercial service functions, effectively improving the vitality of urban streets and the functional complex of neighborhoods.

For the gated community renovation that has already been built, opening is not exactly equal to the wall-breaking movement. The existence of fences and walls can still bring a certain sense of psychological security to the community residents. The resistance to transforming traditional closed communities into open communities in a short period of time is relatively large.

2. Exploring the typologies of how gated community space is shared to the city

Openness and sharing are the essence of a healthy and well-developing city. An important meaning of China’s social transformation is the transformation of social closure to openness, but the construction of gated communities runs counter to this characteristic. It takes time to transform closed space to opening space or shared space. Achieving social sharing and urban multi-inclusive development is a gradual process. The process of opening a traditional closed community space to the city cannot be rushed.

At present, there are many excellent cases in which closed communities’ space are shared with cities at home and abroad. There are mainly two typologies of sharing, according to the direction in which the space is shared. In one type, space is shared from inside the community to the city, while in the other, space is shared from outside the community to the city.

2.1. *Inside space shared with the city*

The gated community is extremely introverted. The more mature the closed community, the more complete its supporting facilities and self-service functions. Such communities are often equipped with a complete set of commercial space and public space for residents in the community. These internal spaces are open and shared to the city, which will effectively alleviate the use of public space in the city, promote the fining of the available public space within the city, and improve the accessibility of the walk.

The Linked Hybrid, which is also called contemporary MoMA, is located in the core hinterland of Beijing’s East Second Ring Road and was designed by Steven Holl. It is a typical case of this type of sharing.

The entire building consists of eight high-rise residences surrounding a common courtyard. The main entrance is located on the north side of Xiangheyuan North Street. The wall is still existing, but the interior is open to the public. It has a wealth of functional space inside, such as Broadway Film Center, Kubrick Book Bar, Hill Art Center, boutique supermarket and other high-end art and living facilities. Today’s MoMA has created an example of infiltration and sharing in the privatization of gated communities and built a new lifestyle.

The sharing of the internal space of the community to the city has brought a new way of life to the residents – living, working, entertainment, leisure, and transportation are intertwined, strengthening the connection and communication between the neighbors. In this way, it effectively shares urban public intelligence and promotes open interaction between communities and cities. Both the shared ring in the air and on the ground can continue to stimulate different kinds of social relationships, thus providing a continuous vitality to the city like a melting pot.

2.2 .Outside space shared with the city

The case of external space sharing to the city is relatively common, and it is often expressed as a layer of space outside the community that is open to the city. This sharing model has penetrated into every corner of the city.

There is a typical community of this type near Songhe Park in Yangpu District, Shanghai. It consists of only five traditional residential buildings, but on the first floor facing the Tieling Road, the space is open to the city, creating a continuous active market space.

The residential building itself is affected by the orientation and forms a certain angle with the street, thereby further forming a jagged flat space. On the one hand, this spatial form effectively increases the usable street surface of the market commerce, on the other hand, the space is naturally divided into multiple levels, which are suitable for different passing speeds and functional purposes.

In addition, the market function of this area has also derived different types of time-sharing features:

- Sharing of different stalls throughout the street: During the day, the main business stalls from early morning to morning are foodstuffs, especially fresh fruits and vegetables;
- Different type of business in the same stall during different times of the day: The same stall sells healthy tea during the day and becomes a barbecue stall at night.

This type of opening not only meets the needs of the community residents themselves, but also facilitates the daily procurement of other citizens around. This time-sharing property also maximizes the efficiency of space usage here.

3. Shared space concept design of Huizhongli community in Beijing

The Huizhongli Community is located in the northeast of the Bird's Nest National Stadium in Chaoyang District, Beijing. It starts from Datun Road in the north, Huizhong Road in the south, Anli Road in the east, and Beichen Road in the west. It was built in the 1990s for the Asian Games. In the post-Olympic era, with the increase in the proportion of internal floating population, problems gradually showed in the community such as poor infrastructure and inconvenient use of public space. In the future, in order to make full use of the sports facility's resources of the Bird's Nest National Stadium to improve the quality of community public activities, the open transformation of the community may become an effective method.

3.1. *Background of design*

Considering the spatial position relationship between the community and the stadium, the linear space on the southwest edge of the stadium is chosen as a design node, trying to explore how to open the marginal space of the community through appropriate opening, and stimulate the community vitality by sharing the space with the city. Community and urban space are interpenetrating after the design.

Based on the analysis mentioned above, the location of the Huizhongli community belongs to the second type, but it not an ordinary type of sharing space. The plot is currently surrounded by a fence, and there is a gap between the fence and the building. The scale of the space is keep changing. This design is mainly for the shared transformation and design of this part of the space.

3.2. *Design techniques*

According to the spatial scale, the four spatial types can be divided into one large and one small groups. Different spatial design strategies are adopted: Type I, Type III, and Type IV have large spatial scales, and space placement methods are introduced. Type II has a small spatial scale, and the main method is to increase the space for staying.

The questionnaire was applied to the research. The survey is divided into two parts, one for the residents' committee interview and the other for the residents.

Here is the information got from neighborhood committee:

- Community population: the proportion of the elderly in the community is more than 50%, the floating population is relatively large. Additionally, the community is close to several schools so there are more renters. Small-sized houses are selling well.
- Cultural life: the majority of the elderly are involved in the cultural life of the community. There are photography teams and square dance teams in the community. There are flea markets in the garden, and the cultural and sports activities are mainly based on spontaneous organization of residents.
- Infrastructure construction: the community has a residential activity room, a table tennis room, an electronic reading room, etc., which are set up centered on the community center garden, and the utilization rate on a daily basis is basically 100%.
- The impact of the construction of the Bird's Nest National Stadium on the community: The stadium becomes a new venue for activities, and the community would organize walking activities around the stadium.

The information provided by the neighborhood committee reflects that although the Huizhongli community is a traditional gated community, its cultural life is extremely rich, and the infrastructure of service and cultural life is close to saturation to some extent.

Through interviews with residents of different genders and different ages, we can learn:

- 1Activity venues: The places with the highest frequency of daily activities of residents are the streets within the community. Due to the small space, the community center gardens often cannot meet the daily activities;
- 2Activities Type: Casual chat becomes the main type of activity, followed by special activities such as chess or square dance.

The information provided by the residents reflects the saturation of the public space within the community.

Therefore, in this particular case, it can be seen that opening a traditional closed community cannot only share the private public activity space of the community to the city, but also further share the urban space to the community residents by improving accessibility. Urban public spaces and community public spaces are gradually achieving a sustainable balance.

3.3. Design contents

In the design, the original railing is softened and the whole space is divided into different nodes according to the section type. Throughout the design, urban space and community space penetrate each other.

Through the interviews of previous surveys, the types of functional activities that may occur are summarized. Type morphological analysis is carried out for different kinds of spaces, and different spatial forms suitable for different functional spaces are obtained, and are inserted into six different sectional spaces by certain logic.

3.4. Design Summary

From the closure of the community to the opening up, the sharing of space has become one of the core elements of the design. On the one hand, the edge space of the Huizhongli community is shared with the city, which can greatly enrich the original single urban interface,

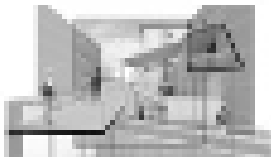
	Inside perspective	Design element
Section I		① Extension: Soften the original space and soften the space level. ② Level: The existing platform extends from the community to the city and overlaps the Huizhongli Station. ③ Vertical: The space is layered and divided, and the level of sight permeates each other. ④ Function: Use the public level up as a small library to further enrich the cultural life of the community.
Section II		① Function: The leisure space originally formed by the closed building is supported. In the old leisure building, the original temporary store is transformed into a shared indoor space. ② Space vertical structure: the canopy on the ground floor, the upper level of tea and leisure.
Section Y		① Extension: The indoor space is transformed and opened to the city. ② Function: use the public level up as the "book cafe", the upper half indoor reading space, the lower step type reading space.
Section III		① Function: Set up a public service hall to provide library services to citizens and communities. ② Space: The ground floor space is given to the children's play area and planting area, and the original required space is reserved.

Figure 1. Four typical section space.

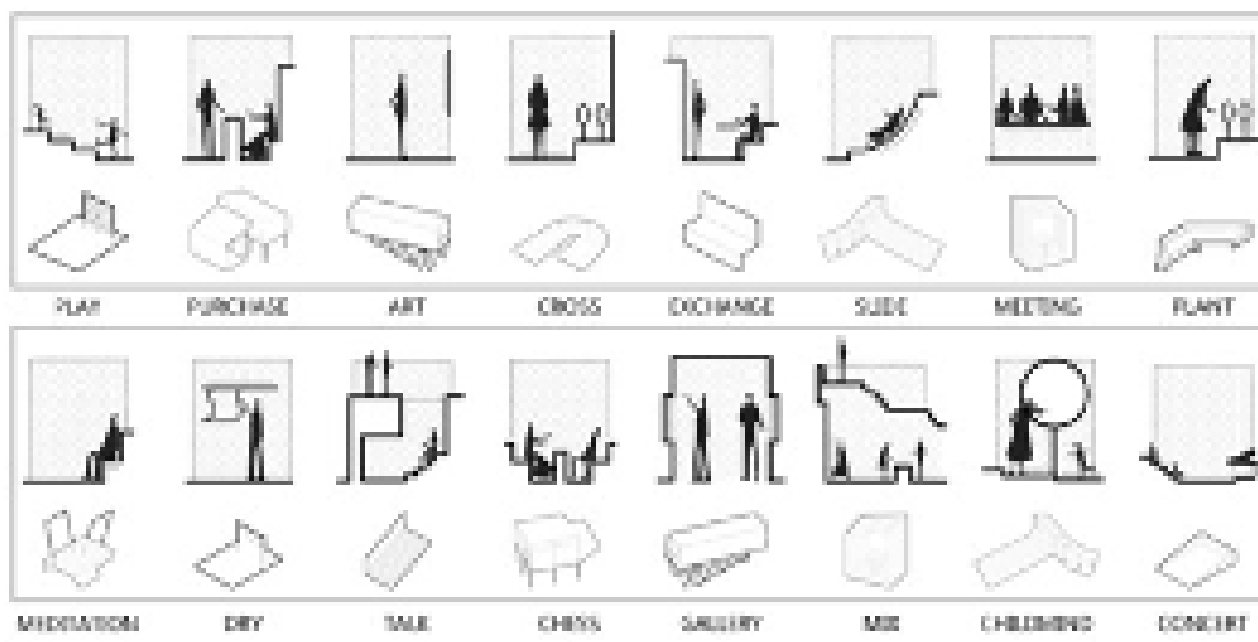


Figure 2. *Different spatial forms.*

and look at the community from the bird's nest to form a harmonious and vibrant city image; on the other hand, urban sports resources and public space are also shared. Residents of the Huizhongli community will solve the problem of old community infrastructure and insufficient public space.

The community functional space types derived from field research are translated into spatial forms to form a heterogeneous community functional space to meet the needs of different types of activities.

4. Conclusion

The transformation of the traditional community from the closure to the opening is becoming a trend of social development, but it does not mean that the open community will completely replace the closed community, both of which have their own advantages and disadvantages. Open communities in some European countries are also taking gated measures to ensure the quality of functional space within the community.

The purpose of an open community should be to create a shared space that is suitable for walking and people-oriented, rather than simply relieving urban traffic pressure. This paper explores the types of open communities shared by two closed communities. Taking the Huizhongli community in Beijing as an example, this paper studies the design method of space-sharing types of export-oriented cities, aiming to provide reference for the shared open-type transformation of traditional closed communities.

As the society progresses, the proportion of open and closed communities may be in a state of dynamic balance. People-oriented urban space sharing is becoming one of the indispensable design elements in this dynamic balance.

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Use and Appropriation of Open Urban Environments: a Brazilian Case Study

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Keywords: open urban environments, post occupancy evaluation, use and appropriation.

Abstract: In the field of relational theories, social sciences and urban morphology, the post-occupancy evaluation multi-method analysis take place to understand how people use open urban environments and which are the requirements of open urban environments to the use and appropriation of it. So the central aim of this research was to discover and discuss the motivations that make people best use urban open spaces and what are the requirements of urban design that contribute to these motivations of use. The research with qualitative approach which involved documental survey and analysis, non-systematic observations and the application of in deep interviews with open ended questions to fifty subjects were conducted to answer the questions proposed to understand the issue. The research took place in a neighborhood of a medium-sized Brazilian city where a federal university campus (with urban park character) is located. The neighborhood also present eight squares very well distributed within this portion of the urban space. Results shown that the physical qualities of an urban environment, such as the presence of urban facilities and equipment, are more important to the use of the open spaces than the provision of urban open spaces alone in a urban environment. Without adequate facilities which contribute to the use of open urban environments, the city became a mere space of urban displacements. Open urban environments are best used when it is close to home or work. Less mentioned answers by the interviewed that contribute to use and appropriation of urban environments but not less important were safety and also the concentration of people, respectively.

1. Introduction

The municipality of Santa Maria, located in the central region of Rio Grande do Sul, in the very south of Brazil (Figure 1), presents itself as one of the main cities of the state, distant 293 km from the capital Porto Alegre. The Camobi District, which is the object of this study, is located in the eastern portion of the city, distant 15 km from downtown, and it counts with 21,822 inhabitants out of 276,108 of the municipality (IBGE, 2010). The District, shaped by the urban sprawl in Santa Maria (Maciel & Zampieri, 2018), is one of the main developing neighborhoods of the city due to presence of the Federal University and the Military Airport (Comin, 2013) (Figure 2).

Camobi neighborhood initial settlement was made by Polish immigrants within the imperi-

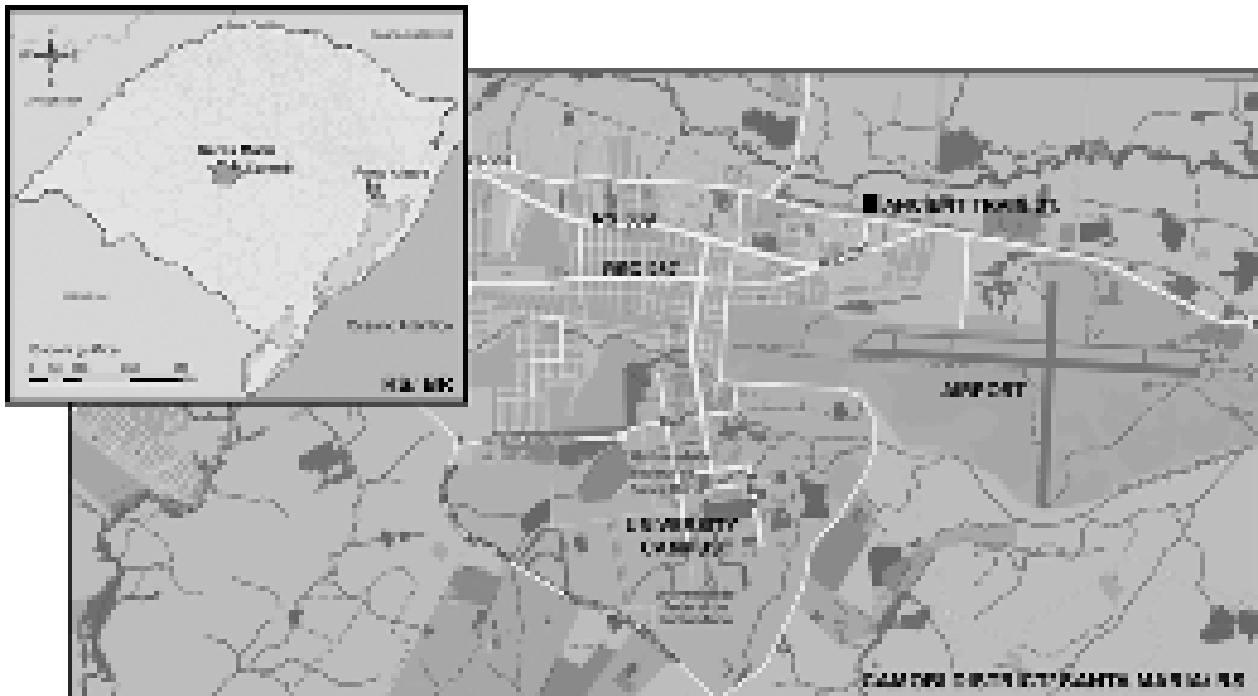


Figure 1. Location of the Camobi neighborhood in the municipality of Santa Maria, state of Rio Grande do Sul in the national context. Source: adapted from Lazarotto, 2015, p.75; EOC Geoservice Maps, 2021.

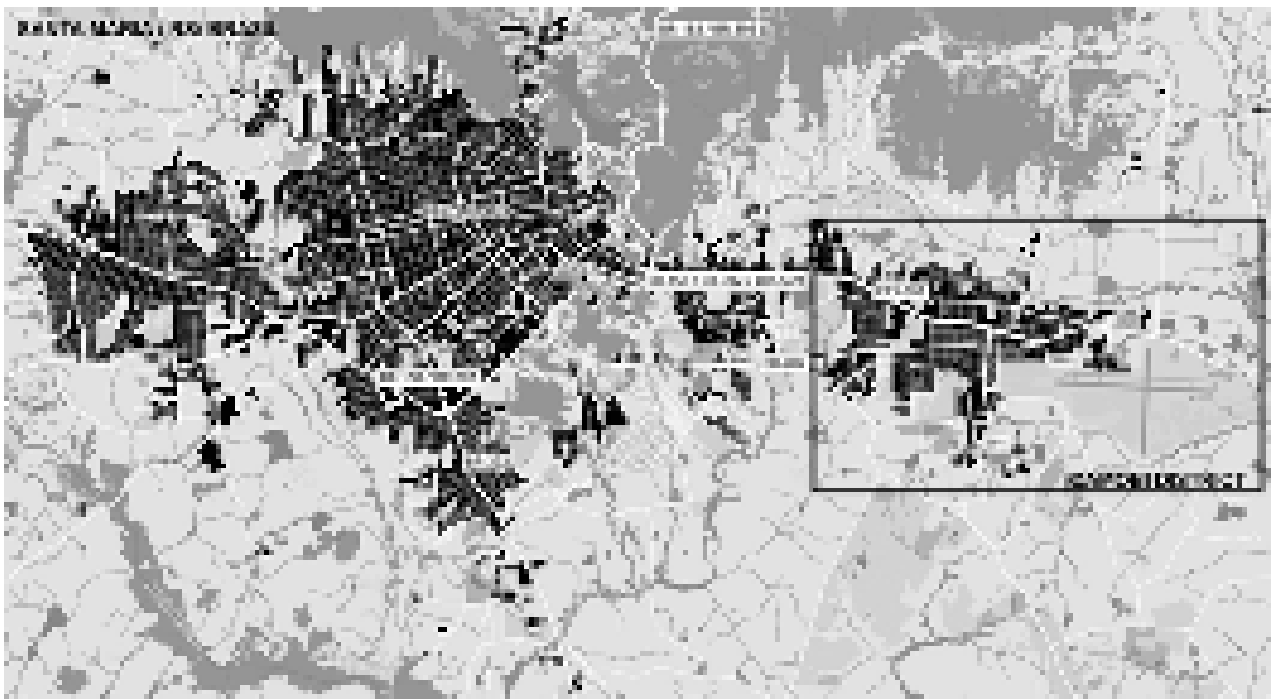


Figure 2. Santa Maria footprint. Camobi district in the east portion. Source: EOC Geoservice Maps – Global Urban Footprint, v1.

al government's immigration plan. These migrants were later replaced by Italian ones from the neighboring municipality of Silveira Martins (Beltrão, 1958).

With the inauguration of the train station in 1885, commercial and social activities took place in the surrounding area, giving rise to the village. The transition from the rural to the urban context took place with the installation of the railway. At that time, João Machado Soares Avenue, located in front of the station, which concentrated the district's economic and social activities, was the only road axis (Comin, 2013).

With the construction of the road RS 509, the creation of the Federal University (1960) and the Military Airport (1970), the activities related to trade and service were gradually moved to the surroundings of RS 509 road, which soon turned into the main centrality of the neighborhood (Comin, 2013).

With the closure of the railway station, in 1996, the area lost its centrality character, configuring a residual space in the neighborhood context (figure 3). The historical, economic or social importance of this place, has weakened with the passage of time. The area today is abandoned due to lack of use and recognition in the urban context of Camobi (Polli, 2018).

Since the implantation of a new road in the southern portion of the district, the RSC 287, the neighborhood had a significant expansion to the south, where new land parcels were located. Today, commercial activities occur along these routes (Comin, 2013), mainly RS 509 which sets up the new centrality of the neighborhood. These transformations of the space configure the current road network of the neighborhood, represented in the figure 1.

The configuration of this new centrality focused on cars, with six automotive tracks and the lack of public space to pedestrians. These situation deconstructed the concept of a center focused on the social practices of the population as well as the recognition of a symbolic place in the district. So the space currently identified as the center of the neighborhood (Figure 4), has a strong conflict of use, as it is configured by one of main road links in the neighborhood. The lack of accessibility, comfort and safety for the pedestrian and cyclist, reinforces the lack of a humanistic character in the place. The absence of a central square that concentrates the social, civic, and cultural activities of the neighborhood may result in a weak relationship between the subject's and the inhabited neighborhood (Polli, 2018).

Together with this main public open spaces mentioned above (the main roads, the university campus which has a character of a park and the open space of the airport), the district has eight



Figure 3. Abandonment of the building and surroundings of the old railway station of Camobi. Source: Paula Polli.



Figure 4. *Center of the Camobi neighborhood.* Source: Paula Polli.

squares very well distributed in the urban tissue and close to residential areas; however, it seems not to be well appropriated by the population.

So this study was designed in order to discover and discuss the motivations that make people best use urban open spaces and what are the requirements of urban design that contribute to these motivations of use. It is also aimed to understand the relationship between the configuration of the urban tissue presented above and the use and appropriation of the public open spaces in the neighborhood.

It is important to mention that the focus of this research is in the public open urban spaces since is there, according to Queiroga (2011), that public life has the physical-material support to happen. Public open spaces, in comparison to private ones, are more accessible, plural and capable to receive diversity, according to the author.

2. Methodology

The research, with qualitative approach, borrowed the procedures from the post-occupancy evaluation studies, which involves observation and in deep interviews applied to 50 subjects in the district – Camobi neighborhood. Interviews were collected in different places of the district in order to be very well distributed along the area.

Two open-ended questions were applied to the subjects:

1. Which are the public open space you best use in the district, with which intention, and why?
2. Where do you usually practice your leisure activities? Why?

The first question had the intention to let people freely speech about which are and in which way they use public space, besides it intended to understand the reasons of their choice for using more intensely some specific places. And the second question focused specifically in the leisure activities.

The responses were coded considering similarities in the content, observing exhaustiveness and mutual excludence.

3. Results and discussion

In the first question asked to the subjects, that let them speak freely about use, intentions and motivations, it was possible to observe that most of the interviewed use the public open spaces for leisure activities. From the 50 subjects, only 6 use the public space exclusively for urban displacements, and for this purpose, they use mainly streets. This can be seen in graphic 1. Since it was found few people using public spaces for displacements, it is believed that it reinforces the character of the neighborhood focused on cars/ car dependents.

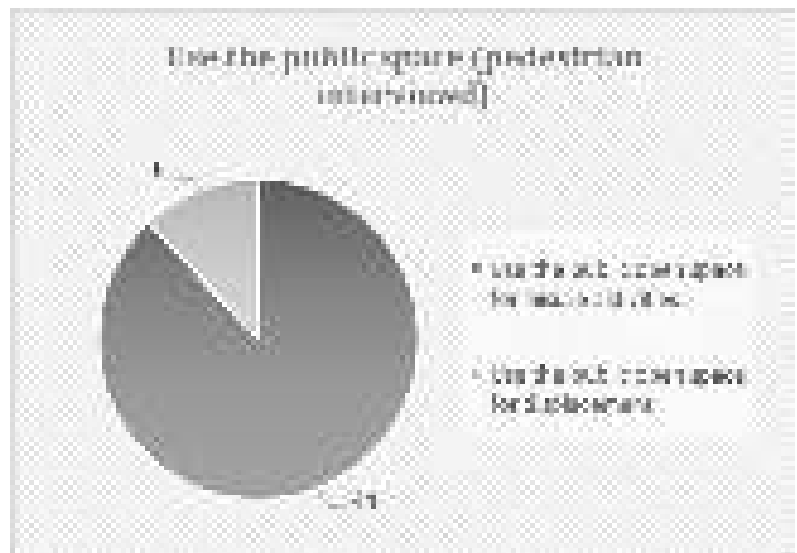
For the majority of respondents that use the public space for leisure, thirty three (33) use the public space into the university campus, ten (10) usually do leisure activities in the streets and four (4) in the neighborhood squares. Elderly generally use streets to walk and none of them (elderly) mentioned to use the university campus for leisure activities. We believe that one of the reasons to this is that elderly usually walk close to their homes due to the loss of mobility that they can develop with aging.

On the second question focused specifically on the leisure activities it was possible to observe that these places mentioned above had an increase in the frequency of mentions, as it can be seen in the graphic 2. On the other hand, seven (7) subjects said that use only private or indoor spaces for leisure activities.

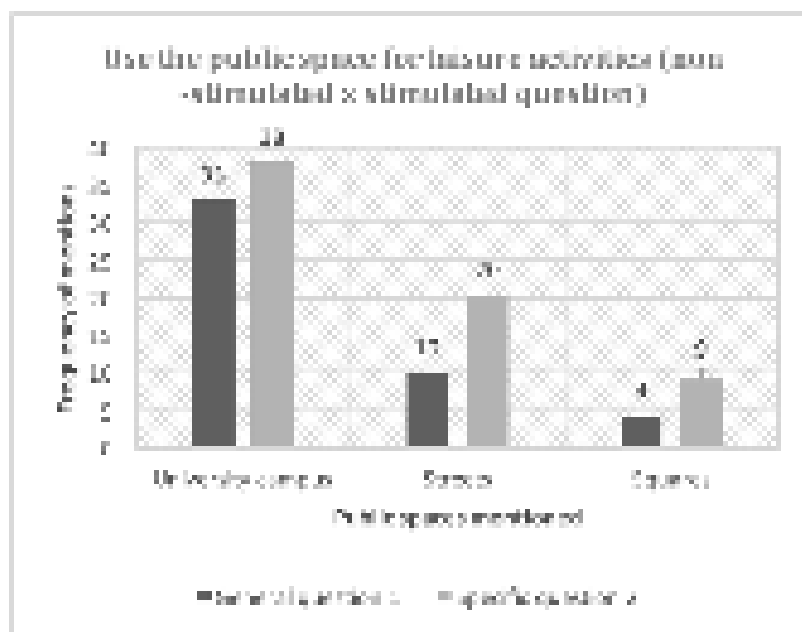
In another research (Pippi *et al.*, 2018), which focus in inquire a sample of 263 subjects from the city as whole, it was also observed the prevalence of the University Campus as being the most used public open space for leisure. In Pippi *et al.* (2018) research, the University Campus had 37 mentions, followed by Itaimbé Park with 13 mentions, and by the main commercial route in the city that is exclusively to pedestrian displacement with 11 mentions. So, this result corroborates the results from the present research that found the University Campus as the most used open space in the neighborhood, result that is extended to the municipality of Santa Maria.

It shows that Santa Maria is a city with a lack in public spaces for leisure, since people has to use motorized transportation (private or public) to reach the university campus that is 15 km away from downtown, to practice leisure activities.

Back to this research, motivations to use these places in Camobi neighborhood for leisure activities, showed in Graphic 2, include thirty (30) mentions which considered accessibility and convenience. It means that the space is close to home or work, or in the way to home and



Graphic 1. Intention of the use in public open spaces in the neighborhood.
Source: Authors.



Graphic 2. Use of the public open spaces for leisure activities in the neighborhood.

Source: Authors.

work, or even easily accessible. Twenty seven subjects (27) mentioned the physical qualities of the space such as infrastructure, facilities provided, such as the recent improvements made in the university campus including the multiuse trail (pedestrians and bicycles), as reasons to use public open spaces in the neighborhood. Five (5) mentions considered the safety of the places as reasons to chosen it to practice activities and two (2) said that the concentration of people in the place is important to them.

Besides the thirty mentions to accessibility and convenience, only 9 people use the squares close to their residences to leisure activities. Most of the people interviewed prefer to do leisure and physical activities close to their work, at university, since the great majority of the interviewed in the neighborhood work or study there. So here it is possible to see the predominance of physical qualities – infrastructure and facilities provided – as motivations to use public open spaces.

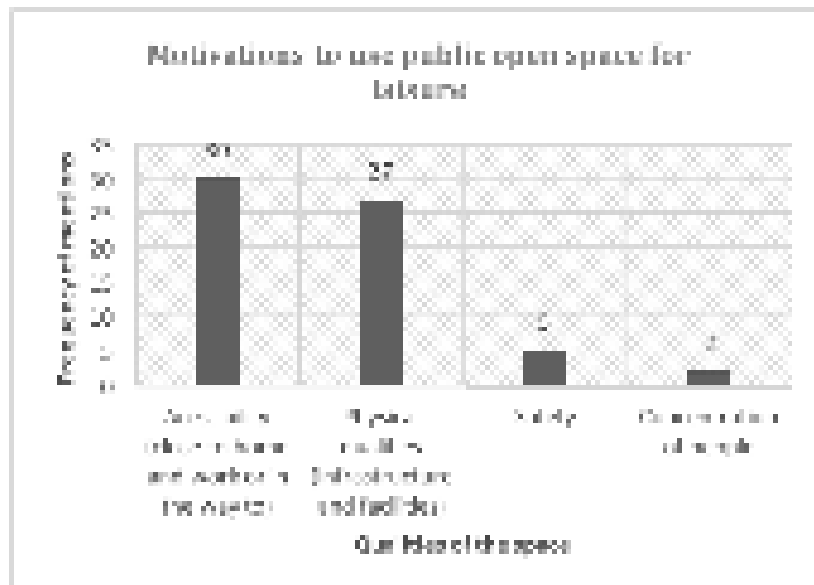
These physical qualities mentioned in the responses are related to the quality and diversity of the facilities offered in the place between other aspects which Nasar (1998) defines as being part of urban likeability, such as natural aspects (presence of vegetation), open view, good maintenance and organization.

It is important to mention that the University Campus, the most used public space in the city and in the neighborhood for leisure activities, is very segregated in the urban tissue, as it can be seen in Maciel & Zampieri (2018) research.

It reinforces the lack of use and the lack of facilities provided observed within the 8 squares of the neighborhood, which are located mainly in residential areas.

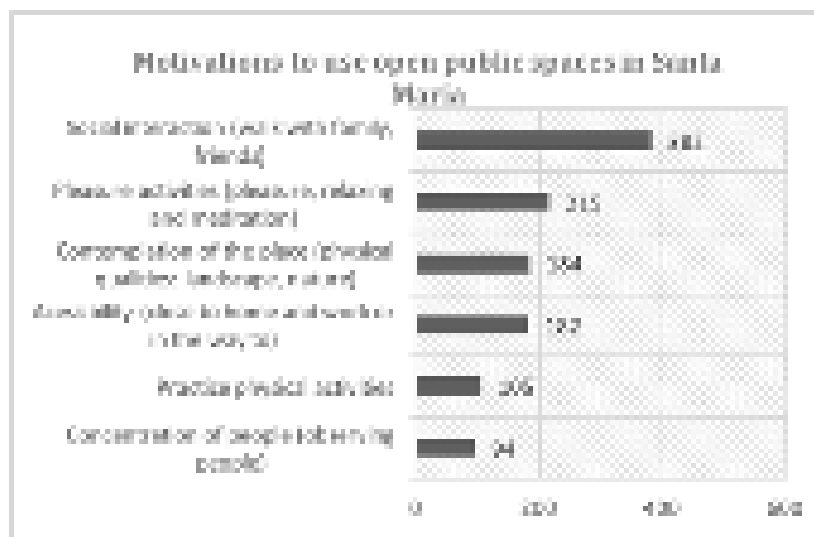
When comparing to Pippi et al (2018) research, previous cited, which involved the municipality as a whole, accessibility took the fourth position concerning motivation to use the public open space, while social interaction (including walk with family or relationship with friends) stayed in the first position, followed by practice pleasant activities and contemplation of the place, as it can be seen in graphic 4. It is also important to mention that in the research conducted by Pippi et al (2018), green spaces were positively evaluated, while facilities in public space had a negative evaluation.

To discuss these results it was considered a recent systematic review of 271 studies in which Carmona (2019) tried to determine which associations between place value and the different



Graphic 3. Motivations to use the public open spaces in the neighborhood of Camobi.

Source: Authors.



Graphic 4. Motivations to use the public open spaces in the municipality of Santa Maria.

Source: adapted from Pippi et al (2018, p. 346).

qualities of place are stronger, weaker and negative. For place value the author consider health, social, economic and environmental value.

In Carmona (2019 p. 33) review the author found very strong positive association between place value (of all types) and six qualities that, according to him, is highly desirable, very tangible and objective and measurable:

- greenness in the built the environment (presence of trees and grass, water, and open space);
- diversity of land uses within a neighborhood;
- low levels of traffic;
- walkability and bikeability of places (related to street connectivity and the quality of the local public realm);
- the use of more compact (less sprawling and fragmented) patterns of development; and
- ready convenient connection to a good public transport network.

pus, but most of the people that reach university, get there with motorized vehicles, particular or collective means of transportation, including people that reach university campus from shorter distances, such as people coming from places inside Camobi neighborhood, where the campus is located.

Besides these high desirable qualities identified in the campus, other aspirational qualities are present there as well and mentioned by the subjects to justify the preference for use of the campus instead of other places in the neighborhood, such as sense of place, natural surveillance, background movement, good street lighting, attractive and adaptable public spaces, integration of natural features, perceived beauty in the built environment. The campus presents also low traffic speeds.

After improvements in the campus, with the installation of the multiuse trail, it became a place even more attractive to people from all over the city to practice their leisure activities, mainly in the weekends, according to Pippi et al (2018).

So the results of this research corroborate the results found by Carmona (2019) and the other studies categorized by him which found similar results.

4. Conclusion

The facilities provided to the urban open spaces demonstrated to have a determinant role in the use, or in the lack of use of the public spaces, in this case.

The equilibrated distribution of the squares in the urban tissue do not guarantee, alone, that these places will be used by the population. In the case of the district analyzed, the distribution is equilibrated but people prefer to use the university campus for leisure to other public squares.

The university campus, which appears as the most appropriated area in the district, recently received federal investments in order to improve open space, while the public squares remain forgotten, without sufficient facilities and likeable environmental features (including the aesthetic ones) that could guarantee the use and appropriation of the place.

Other public open spaces in the neighborhood (the streets) are used mainly with the intention of displacement. However, it is not possible to forget that Camobi is a car dependent district.

This situation has a close relationship with a lack in public/or even private investments to guarantee the quality of urban facilities in public space.

So along with the planning process of a public space, facilities and maintenance should be provided in order to guarantee use and appropriation.

These factors are difficult to analyze only through a morphologic point of view, demanding environmental perception methods and techniques used generally in post occupancy evaluation studies, such as in-deep interviews and observational techniques.

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Form, In-between, City

Analysis of the Urban Street Corner of the Poché-Public Space of the Building Interface: Three Case Studies

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Keywords: Architectural typology, Urban corner, Historical context.

Abstract: urban street corner problem is a complex and social problem, which is mainly affected by two aspects: urban streets form and the architectural form. Architectural corner is not only related to the city, but also based on the single building. The differences between Chinese and Western cultures have led to the opening of street corners to varying degrees. This paper summarizes the characteristics of traditional street corners and individual corners in China and the West. With the re-recognition of urban value, corner is regarded as an important factor of urban continuity environment. The impression of a city often begins in the street, and the impression of the street begins in the corner. Therefore, it is more necessary for corner buildings to consider how to continue the urban context. By takes the way of using negative form of city as the research perspective. Research on the contemporary translation through historical research for the relationship between pattern and type. Focus on “in-between” space generating method optimization. Choose three cases are used to illustrate three kinds of internal and external contradictions. That contradictions correspond to 3 patterns of spatial operations of internal and external differences: nested space, transparency, continuity and uniformity. The construction of a new form of the new mechanism, from the operational value and the creation of modern architecture to provide multiple mind. Inspired by Nolli Map and borrowing the concept of Poché, it is concluded that there should be transitional space between urban form and architectural form.

1. Introduction

At the level of the city, the impression of a city often starts from the street, and the impression of the street starts from the corner; at the level of the building, the image of a building is strengthened at the corner, which can be further expanded to the change of the interface between the interior and the exterior. Therefore, the corner-related issues of cities or buildings are not a new topic. William H. White put forward the important role of urban street corner in the text of “City”, which can be traced back to the square design in ancient Greece. It is pointed out that the corner of urban street is an important place where informal activities take place, and it is also an important node to stimulate the vitality of the city. Since 1980, China has undergone rapid urbanization for 30 years. At this stage, most of the urban road networks and urban forms

have basically taken shape. With the rapid growth of population, solving the problem of high population density has become one of the important problems in urban development. With the current situation of the city and the above viewpoints, this paper enlightens the thinking of the relationship between urban groups and building units at different scales. Firstly, the urban vigor gathering area is focused on the urban corner, and the construction of urban corner space depends on the form of corner building units. Furthermore, the relationship between the building unit and the city is extended to the enclosure feature of the remaining space between the internal space interface and the external contour.

2. The Differences between Chinese and Western Cities

Political and cultural differences have resulted in the sharp differences in street corner morphology between China and the West. From the ancient Greek period, the western urban planning thought was influenced by the separation of political and religious rights, which made the overall urban planning abandon centralized and closed layout. On the contrary, it presents a relatively free and open layout. William H. White once proposed that the city square in ancient Greece should be used as a model for urban design. It advocates communication between people by setting up public urban space. With the continuous development and expansion of cities, the free and irregular urban layout of ancient Greece was gradually replaced by the grid urban layout. Therefore, the western traditional urban layout is extroverted, streets and squares can be used as city living rooms, while corner buildings are the key design objects to pursue their architectural richness in order to stimulate the vitality of the city.

As an example, the Nolli map of Rome drawn by Italian architect in 1748 can be used as a map prototype to express the relationship between western urban architecture and external space¹. The Nolli map (Figure 1, 2) of Rome uses “figure-ground”, to express the urban form, which reflects the understanding of the traditional structure, texture and characteristics of public space in Rome. Among them, the part of Poché represents the building entity, while the blank part is the urban public space. However, as an open space, the white space can be clearly perceived, just like the surrounding buildings that define it. But the basis of space division in the map is not the interior and exterior of the building, but the openness of the space. Through the Nolli map of Rome, we can clearly express a concept that streets and squares are “the interior of the city”. Urban streets are surrounded by buildings on both sides, while squares are surrounded by buildings around them. Continuous building interfaces constitute “enclosure”. According to Graves, “Through the Nolli map treats the relatively private space in the city as urban Poché”. On this basis, Colin Rowe proposed Urban Poché, that is, building as the matrix of the city. Architecture is regarded as an entity, which defines space or space.

However, the layout of Chinese traditional cities is totally opposite to that of the West. Ancient Chinese cities have relatively strict organizational levels and relatively closed layout, which is a whole reflecting hierarchical order (Figure 3). Ancient Chinese cities have relatively strict organizational levels and relatively closed layout, which is a whole reflecting hierarchical order. With the change of Dynasty and system in ancient China, the urban pattern is changing constantly. In the early days, the city was described in Zhou Li Kao Gong Ji as “When architects built (planned) the capital, the city was nine miles long on the plane and three gates (two side gates) large and small. The streets in the city were divided into nine lengths and nine crossings. (Longitudinal) The width of the street was nine carriages at the same time. On the left (east) of the palace was the ancestral temple, and on the right (west)

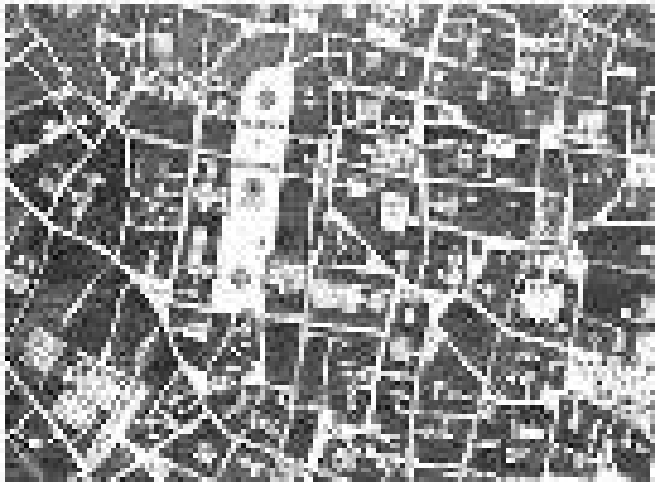


Figure 1. Part of the Nolli Map (Surrounding area of the Navona Square and the Pantheon).

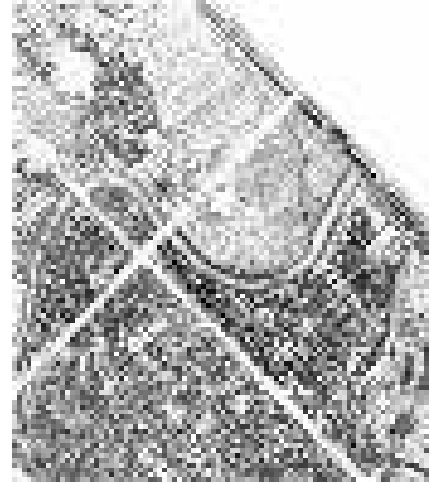


Figure 2. Part of the Nolli Map.

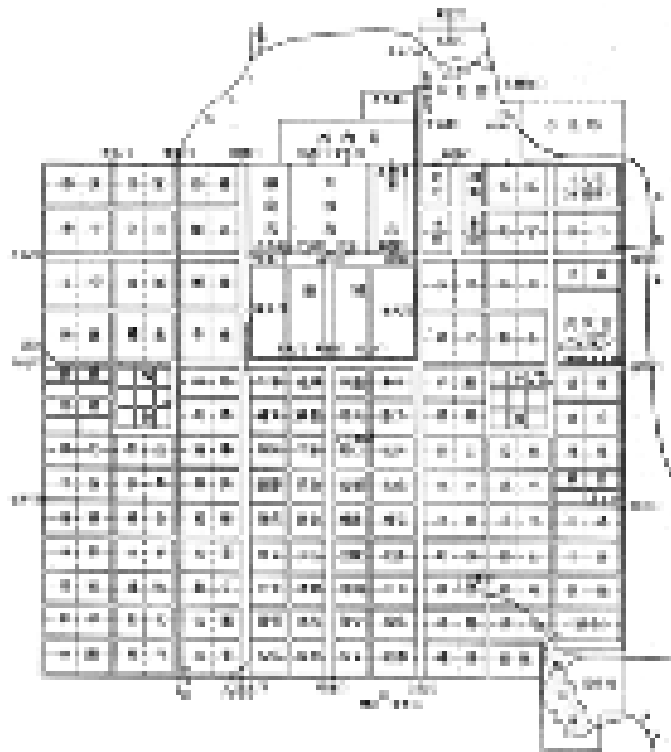
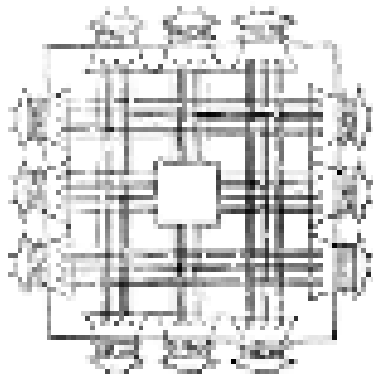
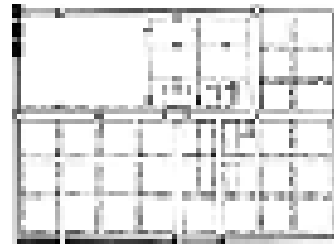


Figure 3. The Li-Fang Unit System City.

was the place where the courtiers worshiped in front of the palace. So, behind it is the market” (Figure 4). This is the city layout centered on the Royal palace, symbolizing the Purple Weidi Palace, as the pole of the four directions, dominating the world. The idea of palace-centered layout has lasted for more than 3,000 years. The Chang’an City of the Tang Dynasty, the capital of the Yuan Dynasty and the Beijing City of the Ming and Qing Dynasties were built according to this idea (Figure 5). The Imperial Palace as the city center, taking Beijing as an example, on the basis of retaining the original axisymmetric and orderly urban texture, presents the trend of outward expansion. The urban form tends to the material image of a system, which represents the absolute centralization of power. On the contrary, urban vitality, public and open space are considered as secondary urban space. On the contrary, urban

Figure 4. *Planning Plan of Capital City.*Figure 5. *Urban Plane of Yecheng.*

vitality, public and open space are considered as secondary urban space. For example, before the Song Dynasty, China's urban planning carried out a well-laid and well-defined urban pattern of Lifang system – “the Li-Fang Unit System City”. Chessboard streets divided cities into different sizes, which was the initial form of Lifang system. The interior and exterior of the square are enclosed by walls. From the street point of view, the enclosed and neat walls are displayed. The square is surrounded by walls, with a cross street in the middle, one on each side, and the gate is closed at night. Walls are also built on all sides of the city. The Chinese – shaped streets are divided into nine parts, and stores are set up on the streets of each city. Compared with the western urban streets, which are public areas for urban communication, the streets of traditional Chinese cities exist more to meet the needs of traffic.

With the development of commercial activities and the opening of policies, there are some positive and active corner forms and spaces in cities. From the Song Dynasty, “the Li-Fang Unit System City” was abandoned, and the development of Commerce led to the transformation of urban street space from closed to open. The form of urban architecture has changed from completely introverted to extroverted. At the same time, street-facing buildings gradually attach importance to the interaction with street space. It can be seen that the Chinese urban form was originally an idealistic urban form, seeking a unified planning and design idea. However, this design idea is not applicable to the needs of modern cities. Therefore, the inherited characteristics of urban concepts conflict with the fundamental transformation of urban functions. Even though we follow the Western planning ideas in China's current urban planning. But we do not attach importance to the building at the corner of the street in the city.

Focusing on the current situation of Chinese cities, it seems that only improving the form of corner buildings can not meet the needs of high-density cities. After a comparative analysis of the traditional urban forms in China and the West, we propose a hypothesis that urban space can be divided into two parts: internal space and external space. What we are concerned about is how to make efficient use of the remaining space between the interior space interface and the external outline of the building, so as to find a closed and open space between private space and public space. Open the balance point, increase the vitality of the city.

3. Current Situation of Urban Development in China

In fact, with the development of urbanization in China, more and more rural people are flooding into the city, which makes the city highly tense in terms of population, transportation, housing and so on. High-density urban environment leads to the lack of public environment, aggravates

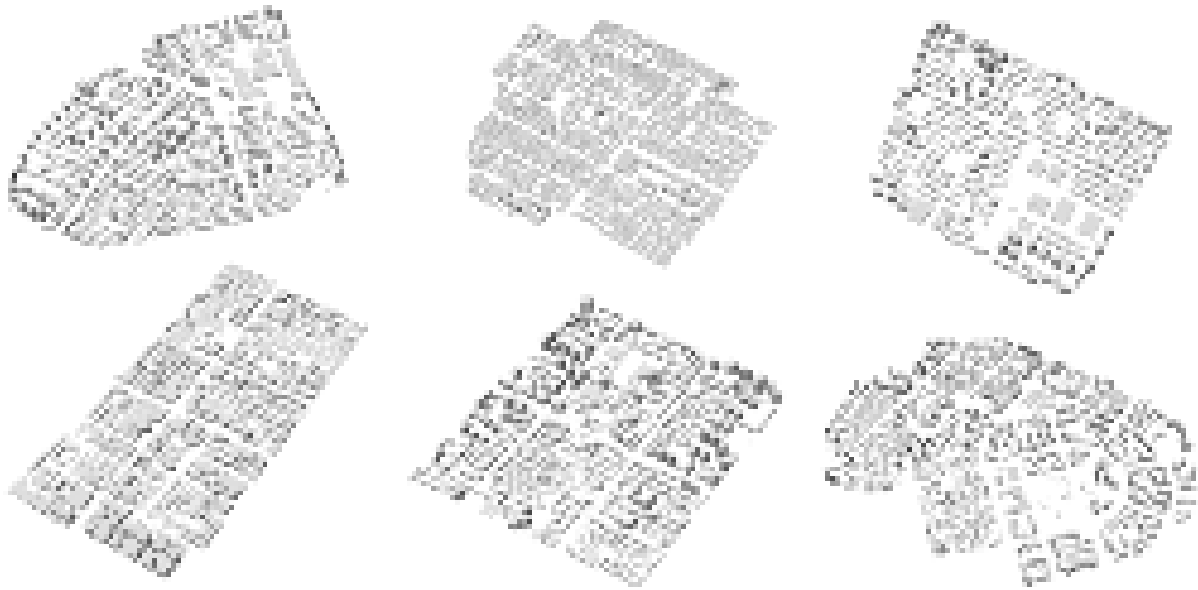


Figure 6. *Six Central Urban Areas of Beijing.*

the contradiction between urban private space and open space, reduces people's quality of life, and hinders the development and progress of the city. Therefore, this paper attempts to propose three design strategies for the architectural interface to respond to the problems that the three designers should solve in the current urban and architectural design. These three problems are: first, how to achieve the balance between private space and public space in new buildings in the face of urban land tension; secondly, in the process of urban construction, many abandoned buildings often occur due to the change of functions, how to make rational use of these existing buildings; lastly, how to achieve the balance between private space and public space? From the perspective of architectural design, it responds to the issue of urban historical inheritance.

3.1. *Present Situation of Urban High Density Environment*

Peter Calthorpe, the founder of the new urbanism theory, believes that density is a key issue in urban development, and urban expansion in China is the spread of density. But the high density does not mean that there is an urban environment. Many large blocks built in Chinese cities are single-purpose and unfriendly to pedestrians and cyclists. This is not really a pleasant environment, but an infinite expansion of high density³.

In his view, urban planning should be guided by public transport for acute development. On the other hand, urban design should be carried out on the scale of human beings, which is in line with the concept of "people-oriented" in China. Take Beijing as an example (fig.6). Modern urban development centers on the ancient urban areas, retains the original urban texture, and gradually expands its marginal growth mode. In fact, the expansion of urban boundaries is carried out on a relatively macro scale. In order to solve the contradiction between high-density cities and the lack of public environment, Manhattan Central Park in New York, as a classic case of centralized layout from a large scale of urban planning, exists. Although it is very classical, it is irreproducible for most existing cities. On the contrary, what we are concerned with is how to solve the same problem from the architectural scale.

3.2. *Existing Buildings of Urban Remains*

With the continuous progress of urbanization in China, the expansion of urban scale has led to a large number of industrial production areas migrating to the outer edge of the city, and the transformation of urban production forms has also produced a large number of industrial buildings left behind and abandoned. However, the problem that these existing buildings are difficult to coordinate with the environment of their times has become more and more prominent. On the one hand, the existing buildings themselves are a major constituent element of the city's characteristics, and their preservation, utilization and renovation are of great significance to the city. On the other hand, resources can be utilized to the fullest extent by means of renovation and reuse of existing buildings. Generally speaking, the long-standing buildings are different from the modern urban development concepts and needs in terms of space scale and architectural texture. The renovation of existing buildings should be based on the original spatial pattern and texture distribution.

3.3. *Homogeneity of urban development*

Compared with the spontaneous development of village and town form, modern cities are facing homogenization crisis in the process of rapid urbanization. The unique cultural and historical accumulation of the city is concealed by the modern commercial buildings, and the unique regional culture gradually disappears in the cultural trend of globalization. The expanding desire for urban development makes more and more cities lose their own characteristics. James Raphael believes that "science and technology change the face of the city, while desire forges the character of the city". Desire has accelerated the pace of urban development, eager to achieve the strategic goal of building a modern international metropolis. More and more cities have gradually lost their own cultural characteristics in the blind expansion, resulting in the phenomenon of one-sided and cultural convergence.

3.4. *Urban Street Corner Form*

It is to analyze the problem of street corner form from two aspects, that is group organization relationship and architectural form (Figure 7). When we organize multiple buildings at street corners as a group, we usually pay attention to the continuity and coordination of their interfaces. This directly determines the spatial form and quality of street corner. Taking the vertical interface corner interface as an example, the proportional change of the length and height of the interface not only affects its restriction on the internal space, but also affects the state of the space enclosed by the interface. As an interactive space between external space and architectural unit, the interface space adjacent to the street in the city determines its spatial value to a great extent. The integrity and continuity of street interface enclosure directly affect people's visual perception and spatial experience (Figure 8). The change of the fracture or smooth connection at the corner of the interface will affect the volume sense, continuity and softness of the building entity to a certain extent (Figure 9). In addition, when two vertically intersecting interfaces rotate along the axis of their intersecting lines or their intersecting lines with the ground, the changes will affect the guidance and direction of the interface to space.

If it is from the perspective of architectural form. When we analyze the relationship between building and urban corner, we pay more attention to the transition space between buildings and cities. At this time, the concrete form of the building becomes unimportant. What matters

is the relationship between the internal space and the external space of the building. That is, operations on in-between spaces.

4. “In-between” -Internal Configuration Logic Strategy of Interface

Architects try to think about space from the perspective of architectural design. Of course, the improvement of building monomer form is only a partial adjustment. This is a kind of architectural design experiment to alleviate the contradiction between building units and urban environment. According to the current situation of urban development in China, this paper tries to put forward three operation methods, namely, layered nesting, inward implantation and structural inversion, from the perspective of the characteristics of the residual space between the interior space interface and the external contour of the building at the level of building monomer, so as to make the redundant space between the interior and the exterior of the building a complex whole. Therefore, the role of solving internal and external contradictions in the building interface.

4.1. Operation method of building unit based on Poché concept

The French word Poché has important theoretical significance in architecture. Venturi uses it to describe the “corners” in architecture. It expresses the space between the inner contour and the outer wall, or the space that becomes an architectural entity because it cannot be used. Colin Rowe extended the meaning of poche and put forward the concept of “urban Poché”, that is, building as the matrix of the city. So it is to find the relationship between city and architecture based on Poché concept, and try to alleviate the contradiction between the private space inside the building and the open public space in the city.

From the perspective of etymology, poche should be used as a verb at the level of architectural space, which can be translated directly into “the state of things in pockets, put in pockets” in French. Colin Rowe’s exposition of “transparency” and Bernard Hoisley’s call it the “joint” between rooms. In recent years, some chinese domestic scholars have translated it and made contemporary thinking. Tong Jun translated it into “fragmentation” of “architectural drawing” by combining the pronunciation of French and the meaning of Chinese words. Ge Ming translated it as “blackening” and Zhou Boyi translated it as “empty space”. Mr. Tong Ming translated it as “porch”. Ruan Xin explained that Poché was a design technique taught by the Academy of Fine Arts in Paris. In the above translation, most of the explanations after being translated into

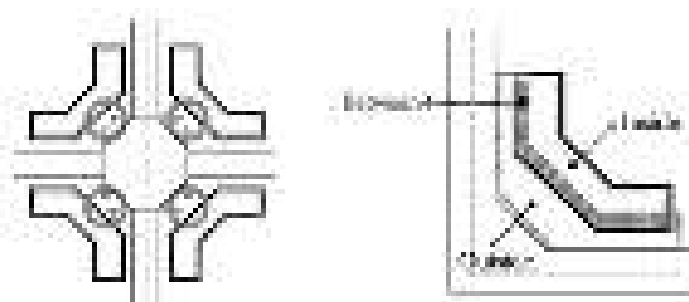


Figure 7. Architectural group combination and architectural form.

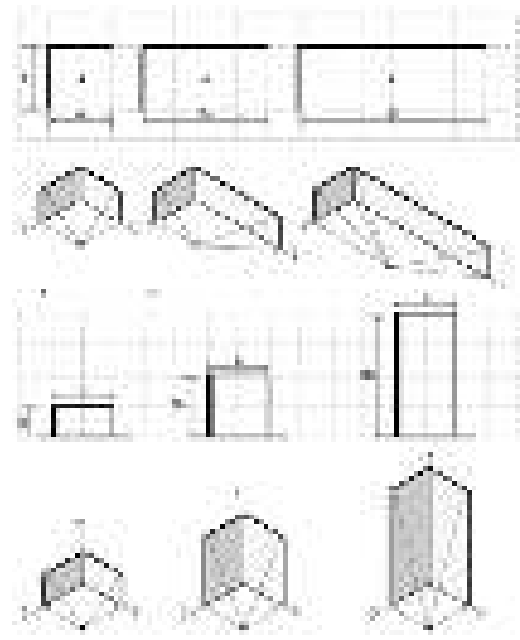


Figure 8. *Proportional change in the length and height of the corner interface.*

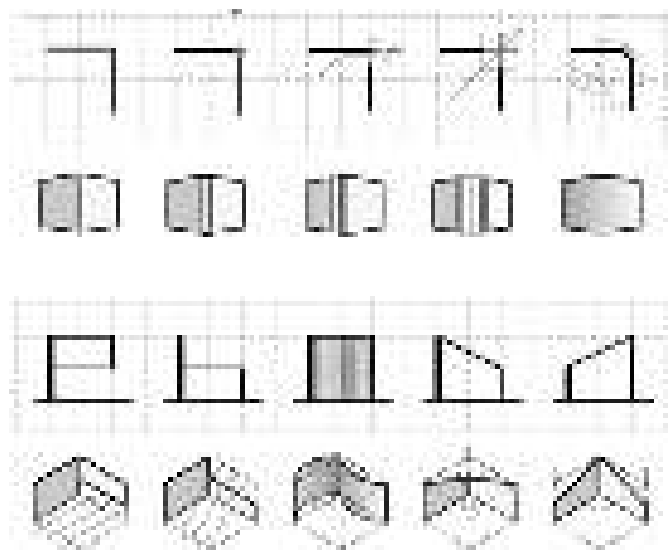


Figure 9. *Change of the vertical corner interface.*

Chinese are to regard it as a method of operation, which is consistent with the part of speech of verbs. Therefore, this paper regards Poché as an intrinsic mechanism of design method.

4.2. Nesting of Layered Space

There are various “gaps” in the urban development space of contemporary China. This kind of gap exists between the huge volumes of a city or in the micro-street volumes of a city. So choose the House N (Figure 10) designed by Fujimoto as a case for analysis. The reason for choosing this case is that in the consciousness of Japanese culture, under the condition of the scarcity of land resources and the high density of urban population, designers have the need to maximize the use of construction land and achieve the mutual penetration of private and public space through the nested operation of structural layers. House N is located in a traditional residential community

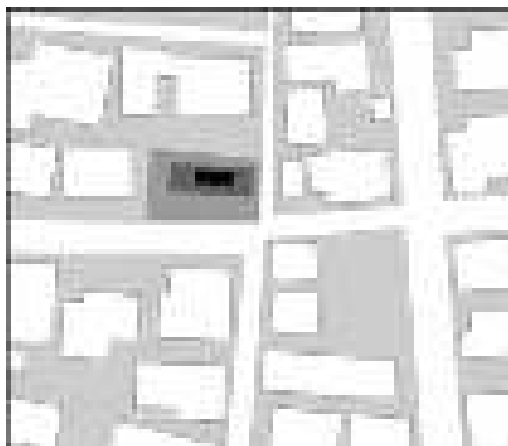
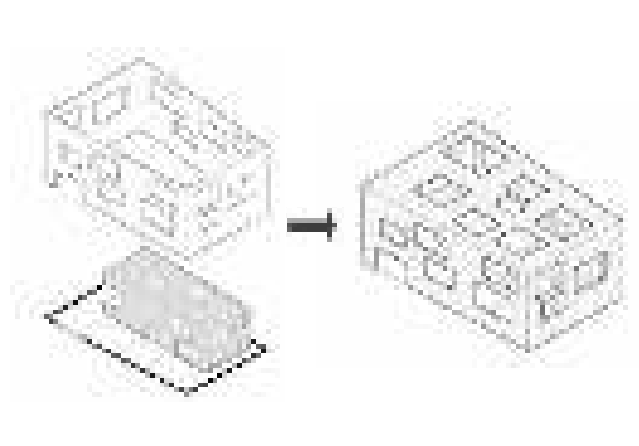
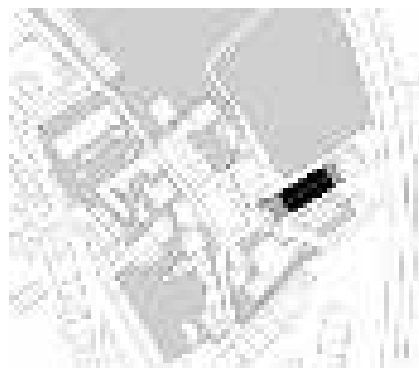
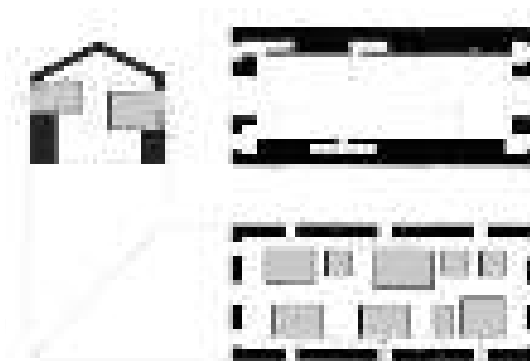
in Oitaken Oitasi, Japan. Its building structure is composed of three-storey building shells nested together (Figure 11). The outermost house N has large windows around and on the top, which not only ensures the daylighting of the garden, but also reduces the noise of daily life outside the street, but also plays a role in isolating the outside noise. As a level connected with the street, it reflects the openness of architectural space; the second floor enclosed space is the interior and exterior transition area, as well as the corridor; the most interior layer is the interior space of various functions, with good privacy, which is of course impossible to touch by pedestrians. In this way, the enclosed space can not only make the owner of the villa get the greatest privacy and security, but also reduce the restrictive effect of the building entity on the external space, so that the indoor and outdoor space can penetrate and blend in the line of sight.

In the project House N, by calculating the area ratio of space and entity in a visual image in a single viewpoint, we can get the value of spatial perception under that viewpoint (Figure 12). Usually, we think that when the proportion of space area is 50%, the sense of enclosure and closure can be reduced, and the larger the value, the corresponding space atmosphere tends to be empty. On the contrary, when the proportion of space area is less than 50%, people can feel obvious enclosure in space. The space generated by the nesting of three-tier structures with different openings is interesting and diverse, and the spatial relationship is ambiguous. It is a design based on human experience. This technique enlarges the meaning of the building itself – the building is not only internal, but also encapsulates the gap between “inside” and “outside” as well as between different boundaries. At the same time, the meaning of the sense of place will be expanded. The formation of the sense of place does not depend only on a kind of spatial cognition, but also on the experience of the gap between different boundaries and the space abstractly defined by the boundaries themselves. House N’s expression of “ambiguous space” directly expresses the concrete elements of the site included courtyard and building, and the concrete elements of the building included wall, door and window, all of which are abstractly expressed as space, a subject closely related to human behavior.

4.3. *Introverted placement*

From the point of view of operation method: Poché can be used as a kind of operation to dig out part of the volume in the entity. Thinking in the opposite direction can also be interpreted as the operation of squeezing large space from outside to inside with small volume. The dislocation, interpenetration and flow of internal space can be constructed, and a positive cavity space can be created in large space.

House N is to find the balance between private space and public space through the stratification of building interface in high density cities. The Azeitao house (Figure 13) designed by Aires Mateus, they take a very different approach to reconstruct the old buildings by grafting new functions into the old structures (Figure 14). Usually this method of operation is suitable for the renewal and utilization of existing buildings. For example, the Azeitao residence designed by Aires Mateus Brothers reflects a new thinking on interior space and lifestyle while responding to the urban context. Aires Mateus Brothers have made new functional rooms into a series of boxes, arranged between the original exterior walls and the main public living areas. In addition, there is a narrow gap between the boxes and the external walls. Stairs and walkways are arranged in the interior of the building interface, forming a circle of traffic space along the periphery, which is in sharp contrast to the thick stone walls of the old buildings and the white walls of the boxes. This mode of operation guarantees the integrity of form and external surface, and expresses the introversion of space.

Figure 10. *The site of House N.*Figure 11. *Structural System Diagram*Figure 12. *"Black" Private Core Space Covered by Outward and Inner Layers.*Figure 13. *The site of Azeitao house.*Figure 14. *Interior Space Implantation Diagram.*

4.4. *Displacement of Inner and Outer Space*

Consideration from the point of view of space nature: Starting from the concept of Poché, the medieval castle plane is analyzed, and the inner and outer space in the form of this package is reversed and replaced. The design of Valerio Olgiati's tourist center (Figure 15) is to separate, separate and merge the middle stairway space. By centralizing the traffic space at the core of the building, the uncertainty of the space is strengthened. If the second mode of operation is interpreted as the mode of operation that surrounds the traffic space inside the existing building interface and embeds the connecting body of the space inside (Figure 16). Then, when Olgiati designed the tourist center project, the traffic space and the open space were reversed inside and outside. It is a kind of layout mode with traffic space as the core of the building. Its plane is intersected by two complete squares, forming a plane outline, showing symmetry. The internal plane division of the building is based on the rigorous geometric and logical relationship, and the resulting building appears as an organic whole, and its space is "anchored". In addition, the visitor center echoes the ancient castle on the other side and stands as a contemporary "castle" in the Swiss National Park.



Figure 15. *The site of visiting center, Swiss national park .*

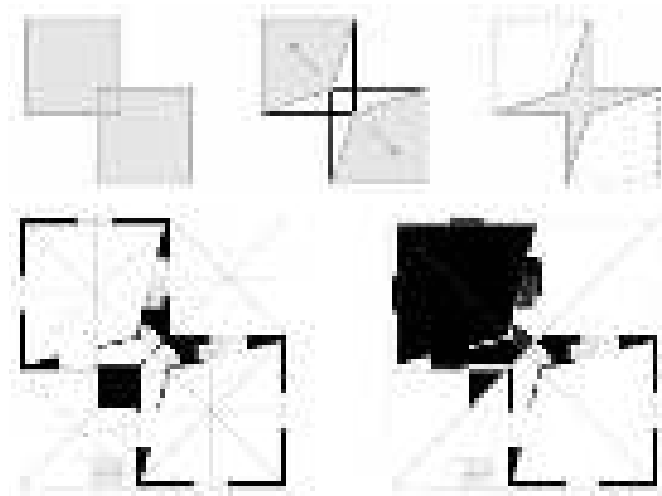


Figure 16. *The diagram of architectural structure turnover.*

5. Conclusion

This research is based on the traditional urban design ideas of China and the West, and finds out the three differences between them: opening and closing, interval and continuity, and introversion and extroversion. Firstly, the factors affecting the vitality of urban development are focused on the corner of urban streets. Secondly, the focus is on the residual space between the interior space interface and the external contour of the building, which serves as a bridge connecting the building space and the urban space. Faced with a series of problems brought about by the growing urbanization, this study attempts to start from the perspective of “in-between” space. From three aspects of relevance elements, operation methods and spatial nature, three operation methods of nesting of layered structure, introverted placement and displacement of Inner and outer space are summarized, which can be used as a design approach to adjust the privacy and openness of space. It is hoped that these three modes of operation can alleviate the three phenomena of urban high density, existing architectural remains and homogenization of urban development.

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Mechanisms for Vitality in Public Spaces

by Juliana de Souza e Silva Arrais, Rômulo José da Costa Ribeiro & Valério Augusto Soares de Medeiros

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Keywords: Public Spaces, Vitality, Urban Configuration, Centre.

Conference topic: Urban Design: urban morphology, building typology and design/planning.

Abstract: The literature has vastly discussed the way central public spaces are configured, with their barriers and accesses, and how they interfere in people's flow (Hillier and Hanson, 1984; Holanda, 2002). However, even if an specific configuration favours this flow (like a grid), proper mechanisms, that encourage and maintain its frequency and diversity are needed, generating vitality. As argued by Holanda (2013), the vitality of public spaces can only be maintained if there is a continuous movement of people, in space and time. In this sense, some urban planners and specialists in urban issues suggest strategies that enable this appropriation. Based on these premises, the article explores the perspective through Jan Gehl's and Frederico de Holanda's approaches and illustrates the factors mentioned by them, with examples of vitality that could be seen in Brasilia, Copenhagen, Paris and London, cities that are traditionally quoted by specialists on the topic. Results allow us to conclude that aspects existing in public places such as a) buildings regarding pedestrian scale; b) promotion of inviting spaces; c) clear buildings visibility; d) rearrangement and integration of the types of traffic on the roads, as well as the accessibility that allows the movement of pedestrians and cyclists without impediment; and e) the presence of mixed use integrating and distributing urban functions and activities are essential to ensure the continuous people's flow in urban space along the day and, therefore, are basic strategies when vitality is intended.

1. Introduction

As Monteiro (2008 *apud* Colchete Filho *et al.*, 2010) defines, the public spaces are areas that grant access to the public, either belonging to private or public properties. The morphological elements that make part of its configuration include the streets, the alleys and squares, delimited by the buildings. The first three elements are open spaces that allow free access, corresponding to the voids (empty spaces) existent in the urban tissue. The last item points to what the Space Syntax calls "fulls", which are the barriers that correspond to places with flow restrictions. Proposed by Bill Hillier and Julienne Hanson around the 1970's, the Syntax addresses a reflection on the group of rules and the guiding principles of the urban spaces, exploring the relations between space and society.

These configuring and structuring elements of the public spaces are usually equipped with a potential that is frequently discarded or scarcely used to the benefit of the community. In the old centres of some cities, for example, the existence of abandoned or poorly maintained public spaces is frequent. Those spaces, destined to the exclusive use of automobiles, are of little use for activities that promote the meeting and the continuous appropriation of the population.

About the issue, Tenório (2012) works on the comprehension of the public space, dividing it in four moments: 1) in the industrial city; 2) in the conceptions of the garden-city; 3) in the modern movement; and 4) in the contemporaneous city. In the first case, the author mentions the public space in the pre-industrial and Industrial Revolution cities:

In the pre-industrial city, public space was a structuring element of urban areas and the place of necessary (economic, political, etc.) and optional (cultural, leisure, etc.) activities. The city of the Industrial Revolution maintained these characteristics, but exacerbated the destination of public space for the necessary activities, and it is described as normally occupied by a crowd of deplorable aspect (Tenório, 2012, p. 38).

The public spaces, in the conceptions of garden-city, developed by Ebenezer Howard (1850-1928), “are presented as a landscape of places. They are all, without exception, configured by buildings, which makes the public/private separation clear. Streets, boulevards and avenues are part of a connected network” (Tenório, 2012, p. 43). According to the author’s own critic, the apparent benefit to public life of a model of this type of configuration, runs into characteristics that have proven to be harmful to the public space, such as: “rigid separation of functions: institutions, commerce, housing, industries and recreation areas have its own place” (Tenório, 2012, p. 47), which result in burdensome displacements, emptying of areas at certain times and over-dimensioning of infrastructure; “transformation of the function of the street: with the functions previously established in specific places, the street becomes a place of passage rather than a destination”; “little variety of housing types” (Tenório, 2012, p. 48): undermines the necessary diversity and vitality of urban spaces.

In the modern movement, “streets and avenues are no longer organized in the form of a connected network and public spaces are not the structuring elements of the place (Tenório, 2012, p. 54). However, other city-garden ideas for public spaces are emphasized and “disseminated by the International Congresses of Modern Architecture/CIAM (1928-1959) in Europe, such as: the extreme separation of functions; public spaces created to house specific practices; complete transformation of the street function as a place of passage; low variety of ways of living; and recreation occurs between walls and turves are destined for free time” (Tenório, 2012, pp. 55-57).

The last item refers to public spaces in the contemporary city. At this moment, the ideas begin to be directed to the configurations opposed to those generated by the principles of garden-city and modern urbanism, which have proved to be damaging to public life. Tenório (2012) mentions important references to the subject such as: Jane Jacobs, Jan Gehl, Christopher Alexander, William Whyte, Bill Hillier, Julianne Hanson and Frederico de Holanda. The authors share the concern to direct the public spaces essentially to people and Tenório summarizes the ideas of these experts well in the following passage:

The so-called specialists of configuration and urbanity comprise, some to a greater extent, others to a lesser extent: the relationship configuration/social expectations, considering architecture as an independent variable; the need to keep distant from the discourses of intention and to use observation as a starting point to know the true functioning of people in public spaces; the importance of designing the city for the human being; and that the public space should be the stage for necessary and optional activities, which should be led by different people and happen continuously over time (Tenório, 2012, p. 61).

Discussions around ideas of this nature have brought interventions in public spaces aimed at people's well-being and urban vitality. In particular, the changes that have taken place in city centres with this focus have played and continue to play a key role in its maintenance (Arrais, 2015).

Holanda (2014) defines the vitality of the centres as the presence of the mixture of circulation and activities, in space and time. In addition, it points to the necessary presence of urbanity, which allows people to meet and reduces dodging. Finally, he ponders that when the centre becomes popular, in fact it does not lose its vitality, but it changes audiences. That is, even when there is a change of social class that starts to use the centre, as a result of urban dynamics, it is still possible to have vitality in these areas if there are incentives for this to happen. The centre often ceases to be principal from an economic point of view and takes on a secondary or sub-centre role, but this change in its importance in the urban system does not mean that its vitality has been reduced.

As for the vitality of public spaces, Tenório (2012) makes the following assumptions: 1) architectural characteristics of the open spaces for collective use of the city correlate with their vitality, in terms of high, varied, continuous presence of people and activities; 2) the city is healthier to the extent of the intense use of central public spaces by people who remain in them or flank through them, not only crossing them towards specific targets inside buildings (Tenório, 2012 *apud* Holanda, 2013, p. 125).

Many studies confirm the influence of the spatial configuration, represented by the relation of the full and empty elements that structure the urban network, in the movement of people in the spaces of the city (Hillier & Hanson, 1984; Holanda, 2002; Arrais, 2015). Thus, these researches are extremely relevant to this work when it is considered that the presence of people in public spaces is related to their vitality. However, the Holanda (2013) emphasizes that the pattern of the urban fabric is not enough to guarantee life in public spaces, because mechanisms are also necessary to stimulate and maintain the continuous movement of people, in space and time.

Based on these premises, the article explores the perspective through Jan Gehl's and Frederico de Holanda's approaches, exemplifying with mechanisms of vitality present in Brasilia, Copenhagen, Paris and London, cities that are traditionally quoted by urban planners and specialists on the subject.

For the organization of information, the article was divided into the following parts: 1) The first part introduces the theme and addresses some definitions of public spaces and urban vitality, particularly in city centres; 2) The second presents the methodology used. 3) And the last part discusses and exposes the findings of the study.

2. Methodology

The research was based on the analysis of the main mechanisms of vitality applied to public spaces exposed by two reference urban planners in the theme, Jan Gehl and Frederico de Holanda. To this end, the following methodological stages were carried out:

- Study on the researchers who discusses life in public spaces. In this item, the main names cited by Tenório (2012) were used as support;
- choice of two names indicated by Tenório (2012) to discuss and illustrate the approaches explored by them, especially those related to public spaces in central areas. To this end, it

- was considered the importance of urban planners as a reference in the addressed theme and the way they detail the strategies they suggest to apply in urban space;
- choice of cities that would illustrate the mechanisms pointed out by experts. The settlements were selected by considering their relevance in the studies on urban life;
- analysis of the approaches and detailing of the vitality strategies through the illustration of the examples listed. The photos result from the observation made *in loco*;
- discussion of the findings, which anticipates the conclusions.

3. Analysis/Results

This item explores the strategies that favor vitality in public spaces according to the specialists of the theme cited by Tenório (2012). For the author, Jane Jacobs, Jan Gehl, Christopher Alexander, William Whyte, Bill Hillier, Julianne Hanson and Frederico de Holanda suggest important points in common to provide life in public places. The main of them considers that public spaces need people in quantity and diversity to ensure their vitality, either circulating or remaining in them.

Regarding the spatial configuration, considering the urban system as a whole, researchers affirm that places of public use need to be established in areas: with diverse uses and functions, combined uses and without concentration of functions, and with integration of means of transportation. (Tenorio, 2012)

At the local level there are several elements pointed out by the authors and cited by Tenório (2012) and that should be present in the public space to provide their vitality, such as: buildings of different types and features; more doors and windows that open to the streets; spatial configuration that favours the passage to other places and at ground level; clear limits and dimensions consistent with their characteristics; accessibility by public and non-motorized transportation; accessible for pedestrians; limits with housing and various activities that work in different periods and outside of business hours; support for the performance of various activities, day and night; thermal, lighting, sound comfort and quality of air. The existing mechanisms should have low implementation and maintenance costs; and the space should have clear aspects, such as identity and orientation, symbolism, awakening positive affections, being beautiful and well cared for. (Tenorio, 2018)

From the cited authors, particularly Gehl (2013) and Holanda (2012) are of special relevance for detailing the strategies that ensure vitality in public spaces. For this reason, this study focuses on the approaches of these two researchers.

For Gehl (2013), the first fact to be considered in the city concerns the human dimension, referring to the scale of pedestrians. Urban planning, especially focused on modernist ideologies, prioritized models and interventions aimed at car traffic, and did little to think about “public space, pedestrian areas and the role of urban space as a meeting place for city residents (Gehl, 2013, p. 3).

The scales of the great centers, with their monumental dimensions and designed to highlight emblematic buildings and not to benefit the pedestrian, were models reproduced in the twentieth century. Cities with their large-scale buildings, huge voids and wide streets for car circulation (Figure 1) were examples of increasingly recurrent urban planning. For Gehl (2013), The “Brasília syndrome” became an expression to refer to the city as a symbol of modernist urbanism and as distant from planning on behalf of people.

With regard to the Brazilian capital, Holanda (2013) discusses the difficulties that pedestrians have to travel in Brasília due to a highly dispersed urban layout, with large urban voids and that prioritizes the circulation of vehicles. In Plano Piloto, this problem is even more evident and the



Figure 1. *Monumental Axis in Brasília with a view of the TV Tower.*
Source: Arrais, 2015

discomfort for people walking is enormous, especially considering that in addition to the long distances to be covered, there is a lack of shaded areas and urban equipment that allow rest.

Gehl (2013) states that the urban space of Brasília is “too big and not welcoming at all (GEHL, 2013, p. 194)”. And he adds that, for people to feel invited to stay in places, it is necessary to insert some elements in the urban space. In this sense, Gehl suggests some necessary mechanisms for vitality in public spaces and that in some points are similar to the ideas disseminated by Holanda, such as:

3.1. *Places to sit*

Primary movable seats with backrests and arms (seats, chairs); and secondary seats (Figure 2), places where people can stand (pedestals, steps, stones, friars, monuments and the floor itself).

Gehl also alerts to the importance of thinking about the location, design and materials of these seats, especially in the case of urban furniture that should aim at the comfort of its user. At this point, it is interesting to discuss the urban equipment and furniture inserted in public spaces that certainly work as attractions for people and invite them to stay. In Copenhagen, at all times, whether on the street or in a square, it is possible to be surprised with creations (Figure 3) that impress by the simple solutions of design and idea, but which reflect care for the spaces and for whoever uses them.

3.2. *Transition spaces*

According to Gehl (2013), these are spaces that are not completely inside buildings and not completely outside them, such as: details of irregular façades; and commercial establishments with open-air care (Figure 4).

These spaces cited by Gehl allow greater visibility of buildings and according to Holanda (2013) is something fundamental for life in public spaces, because depending on how this resource is used, it may encourage the flow and the gathering of people, or on the contrary, cause dodges. The transition spaces or even facades on the ground floor (Figure 5) with doors that open to the streets provide greater flows of movement, because people tend to walk through buildings that maintain this relationship with the street, and prefer them over those where what is to be seen are blinded gables. Buildings with more visibility or more “eyes” and “faces”, terms used by Holanda, convey more security to passers-by than those who only have “shoulders” and “back”.



Figure 2. *Secondary seats in Paris. Fonte: Arrais, 2015.*



Figure 3. *Elements in the public spaces of Copenhagen. Source: Arrais, 2015.*



Figure 4. *Transitional spaces – cafe in Copenhagen with emphasis on heating mechanisms. Source: Arrais, 2015.*

While the openings – the doors – in buildings that lead directly to the street stimulate the movement of people and thus increase the flow of movement, the blind walls do the opposite and worse, create insecure and reduced spaces of vitality, which are likely to suffer degradation. For this reason, underpasses (Figure 6) – elements introduced into Brasília's urban space to separate pedestrian and vehicle circulation – are highly questionable.

3.3. Reorder and integrate

Traffic types: According to Gehl, the model of traffic type segregation – cars and pedestrians – used in the conception of Brasília seems optimal, however, in reality, it does not work very well when the following is not taken into consideration: 1) people choose shorter routes; 2) it is necessary to be concerned with protection mechanisms, because this separation tends to create places with little movement and therefore also unsafe. A pedestrian-only street should have measures to ensure the continuous flow of movement, otherwise they become unsafe places that should be avoided.

Perhaps the most effective solution to ensure safe movement of vehicles and pedestrians while maintaining the vitality of cities through the continuous flow of movement of people is the segregation of traffic types at the same street level. This separation means exclusive lanes for vehicles and pedestrians, but does not mean lack of integration. In fact, it is very important for the proper

Figure 5. Ground floor facades that lead directly to the street in Copenhagen.
Source: Arrais, 2015.



Figure 6. In Brasília, underpasses through Eixão. Fonte: Arrais 2015.



functioning of the transportation system. Jan explains with the example of bicycles in Copenhagen (Figure 7).

The invitation to pedal implies that bicycle traffic is integrated into the overall transportation strategy. It is necessary to create conditions for taking bicycles on trains and subways, and preferably also on urban buses, so that it is possible to travel by combining bicycle and public transit. (...) Another important link in an integrated system is the possibility of parking bicycles safely at stations and terminals. (...) It is also necessary to have good parking options for bicycles along the streets in general (Gehl, 2013, p. 185).

Every year the number of cyclists in the Danish capital is growing, reflecting public policies aimed at reducing the number of cars on the streets and the use of less polluting means of transportation. To achieve this, the public authorities create better and safer conditions for those who ride bicycles. There is an adequate and effective system that supports bicycle paths.

According to Gehl (2013), Copenhagen suffered major problems with car traffic and was one of the first European cities to seek solutions to the problem in the 1960s, beginning to reduce the circulation of cars and parking lots in the city center. The author cites the case of Strøget Street (Figure 8), a traditional Copenhagen street that was transformed into a pedestrian promenade in 1962. Despite many criticisms, the project was implemented and the increase in the number of pedestrians on the site soon became evident. Gehl (2013) also adds that barriers that restrict vehicle traffic, parking fees and reduced speed on the streets discourage car circulation and, combined with measures of accessibility on the streets, favor the displacement of people, especially those with special needs (elderly, wheelchair users, baby strollers, among others).

3.4. Road Accessibility

In cities where urban planning is focused on people, one of the most relevant aspects to observe is the care with accessibility for all, especially for those who have some kind of physical restriction, such as the elderly and wheelchair users. Gehl (2013) shows some solutions that are to some extent simple and that favor pedestrians on the streets, such as: a) widening the sidewalks and free of obstacles; b) using specific signs in pedestrian lanes, carefully designed to provide tranquility and safety for people to walk (Figure 9); c) avoiding the use of fences, islands, which interrupt the continuous traffic flow and prioritise the crossings directly at street level over the use underpassed ones.



Figure 7. Integrated system in Copenhagen. Source: Arrais, 2015.

Holanda's (2013) approach to road accessibility converges with the topics addressed by Gehl and adds the observation of road layout as an essential element, also for providing accessibility and ensuring the flow of people's movement. The author states that an urban network configuration where people have to make countless inflections, to reach certain destinations, has little accessibility. A clear example is the residential superblocs in Plano Piloto in Brasilia: the amount of inflections or corners to be crossed results in a considerable degree of labyrinthineism.



Figure 8. *StrØget Street transformed into a boardwalk.* Source: Arrais, 2015.



Figure 9. *Carefully thought out specific pedestrian crossing signs in London.* Source: Arrais, 2015.

3.5. *Mixture of Uses and Activities*

For Gehl (2013) one of the aspects of extreme relevance for urban planning refers to the way functions are organized in the city. For the urban planner, it is necessary to distribute the functions in order to ensure shorter displacements, and integrate them to allow versatility, social sustainability and safety. Once again, he criticizes the models of cities that are divided into specific zones for each use, i.e. that is, cities which are compartmentalized into residential, commercial and service zones, similar to that of Brasília.

When Jan discusses the importance of integrating urban functions to ensure that the city is sustainable, versatile, and alive, it is nothing more than enabling the uses to be found in the various parts of the urban structure. In the central areas it is essential to mix residential and commercial uses in the same area (Figure 10), allowing that even when there is no movement in business hours, there is the presence of residents continuously, including at different times of the day. The urban planner mentions the case of the centre of Copenhagen: “seven thousand people live in the central area of Copenhagen and, in winter, during the night of a normal week-day, about seven thousand illuminated windows are visible on the streets (Gehl, 2013, p. 98)”.

When it comes to bringing cities to life, Holanda (2002) considers the separation of uses and activities as a big mistake, as it happens in Brasília and in some settlements, where urban planning is based on modern, segregated urbanism, with specific zones for each urban function and with large gaps that highlight buildings and do not favour people. The author believes that the extreme separation of uses is one of the factors that trigger the degradation of some central areas.

4. Discussion/Conclusion

The article explored the approach developed by Jan Gehl and Frederico de Holanda that describes the mechanisms needed to generate and guarantee the vitality of public spaces. In summary, for Jan Gehl, the aspects to be considered are: 1) the pedestrian scale should be prioritized; 2) the spaces should be inviting and elements should be implemented (urban furniture, reordering and integrating traffic, providing accessibility for all, encouraging the mixture of uses and activities, favoring safety, among others) that reinforce the permanence in these places.



Figure 10. *Busy streets in the centre of Paris with mixed uses.* Source: Arrais, 2015.

In the strategies developed by Frederico de Holanda, which are similar in some points of the mechanisms cited by Gehl, three essential factors for urban vitality are discussed: 1) the accessibility of roads: avoiding barriers, levels and obstacles that prevent pedestrians and cyclists from circulating; 2) the mixture of activities: with the integration of functions and activities in different parts of town, avoiding the extreme separation of uses; 3) the visibility of buildings: this means that buildings should have more openings that lead to streets and less blind gables.

The mechanisms described by both are essential elements to ensure the continuous flow of movement of people in urban space, at differing times of the day, and are therefore key strategies when the goal is vitality, especially of the centers. Despite presenting themselves as instruments that are applied at the local level, they end up producing positive implications for the whole system, since the actions are also integrated and reverberate in other parts of the city.

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Compacts Typo-Morphologies by Use of Local Search Methods

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Keywords: compactness, typo-morphologies, housing block, local search.

Abstract: In prospect of sustainable urban densification, a tool aiming to assess and to assist the design of compact housing blocks with a target population density was created and tested in the scope of the CoMod Project. The concept of spatial compactness is here applied, at the architectural scale, on the built environment, the non-built environment and both combined. This approach encourages typo-morphologies which save land and material resources while achieving high energy efficiency. Potential misuse of the concept is prevented by numerous objective criteria notably relative to green areas, projected shadows as well as minimal distances and surfaces to consider.

However, targeting urban compactness faces a difficult conciliation between various quantitative and qualitative parameters. Numerous mathematical tools have already been applied on the problem of urban planning (using optimization methods, multi-criteria decision help, cellular automata, fractal sets, etc.). The study of compact typo-morphologies with the help of graph theory, game theory or local search can help solving the problems that arise when dealing with conflicting criteria. We are currently developing a prototype of software that generates urban blocks using local search algorithms. The generated blocks optimize compactness criteria with respect to a set of comfort, privacy and regulation constraints.

1. Introduction

For decades, architects and urban planners have been interested in density (Clément & Guth, 1995). Densification of territories is the leitmotiv of many urban planners in favour of a *sustainable* development of territories in the face of the peri-urbanization of cities. It is an urban and architectural response envisaged to reduce the increasing use of agricultural and forest land and the sprawl of mobility networks and applicants. Empirical studies (Newman O., 1975; Newman & Hogan, 1981) show that at the scale of a territory, a high density is more favourable for the ecosystem than a low density, which inevitably causes spatial spreading under demographic pressure.

How can we urbanise to satisfy the demand for new housing while reducing peri-urbanization and over-consumption of land, energy and materials? How can the architect contribute to this during the design of projects? Acting on the shapes, both volumes and surfaces, could be a solution. Indeed, reducing the built volume and the area of the outdoor spaces, *in judicious way*, helps to limit expenses.

Nevertheless, as shown by Fouchier (Fouchier, 1997), a same building density can lead to very different shapes. For example, the building density is identical for a set of buildings gathered on 10% of the area of a terrain or if they are spread on it. Similarly, a residential tower can have a building population density barely greater than that of a group of residential dwellings, if the surface area of the land on which it is located is high. We deduce that a value of population density cannot be correlated with a typo-morphology. It is therefore difficult to understand the spatial consequences of densification operations from the design stage of a project. The lack of bijective link between typo-morphology and density can prevent efficient assessment of the impact of typo-morphologies in terms of density on the built *and* non-built environment.

Taking that in account, we developed a tool to assist the design of housing blocks following a targeted population density and considering the concept of compactness. Some authors develop this concept on the city scale as a complement to the density (Bertaud & Malpezzi, 2003; Bonin & Tomasoni, 2013; Dantzig & Saaty, 1973; Frankhauser, Tannier, Vuidel, & Houot, 2008; Halleux, 2012; Jenks, Burton, & Williams, 1996) (Katz, 1993; Kirwan, 1992; Maignant, 2005; Pouyanne, 2004). Others apply it on the building scale for energy and material savings (Arantes, Marry, Baverel, & Quenard, 2016; Grenier, 2007; Marique, 2013). The methods for calculating surface compactness are frequently used on the *macro* scale and the ones for calculating the built volume are used in the tool on the *infra-local* scale. More precisely, they are used to study the block based on three components: the plot, the buildings, and also the non-built land created by the interaction between the plot and the buildings. Well-known for its connection with the shapes, the compactness can reduce the land use and the envelope surface of a building through its volume, surface or porosity indicators while exploiting the spatial qualities of compact spaces. Reducing the different values of compactness while satisfying criteria of spatial compactness is one of the objectives of the tool.

Nonetheless, a particular attention is given to the spatial consequences of a drift in the process. Indeed, a set of spatial and morphological constraints must be taken in account during the design of compact housing blocks. We consider the following constraints, in order to avoid an excessive increase of compactness while favouring the spatial qualities of compacts spaces:

- a minimum volume and area of accommodation by type of housing,
- a rate of green spaces area per block, 50% of which consist of a maximum of two spaces of compact shape,
- sufficient light on facades, outdoor and indoor spaces,
- a minimum distance between facades in terms of promiscuity and accessibility for emergency services,
- a feeling of closure of the whole and its components, enabling some porosity between the inside and the outside of the urban block.

Targeting urban compactness faces a difficult conciliation between various quantitative and qualitative parameters. The tool is currently a *static* tool where dealing with all the parameters requires a “trial and error” approach, made tedious by manual encoding. These parameters must be previously computed by the user at each stage of the conception, because of the iterative

nature of the design process. A considerable ease could result from interfacing the tool with a 3D representation software. This would allow for an *automatic* computation of most of the indicators used, based on a CAD model of the housing block, in all its components. It would then become possible to guide the user more effectively as for the interest of a specific modification based on a given configuration of a project. This approach would require a process to handle the indicators and the constraints. So, the tool should include all the properties to implement a true optimization process, in the mathematical sense of the term.

For this purpose, the CoMod Project (Compactness from the angle of mathematic modelling) led by a multi-disciplinary team was created. This project is supervised by three research departments of the University of Mons (Belgium): the Town and Regional Planning Unit (Faculty of Architecture and Urban Planning) and the Algorithms Lab and Effective Mathematics Team (Faculty of Sciences). We are currently developing a prototype of software that generates urban blocks using *local search algorithms*. The generated blocks optimize compactness criteria with respect to a set of comfort, privacy and regulation constraints. Numerous mathematical tools have already been applied on the problem of urban planning (using optimization methods, multi-criteria decision help, cellular automata, fractal sets, etc.). The study of compact typo-morphologies with the help of graph theory, game theory or local search can help solving the problems that arise when dealing with conflicting criteria.

2. Methodology

The initial reflection of software development follows the methodology of building a catalogue of configurations, resulting from a resolutely theoretical experimentation with the previously developed “static” tool (De Smet, 2018). This catalogue, composed of a total of 1674 cases, results from the systematic variation of key parameters on triangular, rectangular and square *fictitious* urban blocks. The area of the considered blocks varies, as well as the depth of the building (from 10 to 18m, by steps of 2m) and the number of levels (from 1 to 8). Limiting the template to 8 levels allows implementation in many urban contexts.

Regarding the layout of buildings, four families of configurations are considered in the catalogue:

- closed (block’s perimeter totally built),
- pierced (presence of rifts between the outside and the inside of the block),
- increased (addition of built volume inside the block),
- staggered (presence of various heights of buildings).

These configurations result from following hypothesis:

- a high density combined with a restricted template can be only obtained by use of a larger footprint only for higher constructions;
- the lighting requirements, and thus health requirements, limit the depth of the buildings;
- for a given depth of building, the typo-morphology enabling the biggest footprint favours *de facto* the construction on the perimeter of the urban block as a priority;
- such a construction on the perimeter of the urban block is in line with the common will of the governments to favour the establishments in front of roads (or in alignment with existing buildings);

- a partially closed typo-morphology can lead to determination of private or semi-private outdoor spaces.

This catalogue led to a set of observations related to the evolution of population densities and compactness indicators according to the considered variables, to provide useful guidelines in the context of concrete projects. However, the types of configurations are limited and expanding the catalogue with more parameters would require an unrealistic amount of work.

The dynamic tool in development would make it possible to go beyond the limits of both arbitration and encoding and to develop a real typo-morphological optimization of compact urban blocks. It aims to offer urban blocks' layouts that optimize some criterions and constraints. To achieve this, the tool is using *local search algorithms* (El-Ghazali, 2009; De Beukelaer, Davenport, De Meyer, Fack, 2017). In computer science, *local search* is a method for solving *optimization problems*. That kind of problem can be formulated in this way: given a set of possible *solutions* for a problem, we want to find the solutions that minimize or maximize some criterion called *objective function*. To understand how the local search basically works, we need the notion of *neighbourhood*. Given a solution *s*, a neighbourhood of *s* is a set of solutions that can be reached by performing a small transformation to *s*; an element of this set is called a *neighbour* of *s*. The modification applied to *s* to reach its neighbour is called a *move*. For example, let's imagine that we are on a chessboard's square, on the position of our king. A neighbourhood of this square is the set composed by all the adjacent squares to our king's current position.

Once we have defined the solution set, the objective function and the neighbourhood operation, the basic local search algorithm works as follow: we start from a random solution, we compute its neighbourhood, we evaluate each neighbour with our objective function, the best neighbour becomes our current solution if it is better than our current solution and we iterate this procedure. The algorithm stops if it finds a solution that is better than all its neighbours or satisfy some stop criterion (for example, the search can't take more than a given time).

Besides improvement of the objective function, local search can also try to satisfy some constraints. There are two kinds of constraints: mandatory and penalising constraints. To satisfy a mandatory constraint, local search just discards solutions that don't verify some criterion. Let's return to the example of the chessboard with the objective to find the best next position for our king. An example of mandatory constraint can be "the solution must be a black square". So, the search will ignore the white squares. Penalising constraints give a penalty to the evaluation of a solution that doesn't verify some criterion. Penalising constraints modify the objective function. Local search seeks now to find the best solution that isn't penalised by the constraints.

The main weakness of the basic local search is that it doesn't guarantee that we finally get the best solution. Indeed, the returned solution is better than all its neighbours, not necessarily better than all other solution. It is the best one *locally* and not *globally*. This can be explained by the fact that we don't explore all the possible solutions. To visit more solutions, we need other search methods called *metaheuristics*. El-Ghazali (El-Ghazali, 2009) defines metaheuristics like this: "*Metaheuristic search methods can be defined as upper level general methodologies (templates) that can be used as guiding strategies [...] to solve specific optimization problems*". What we called "basic local search" is a metaheuristic, the Hill Climbing. There exist metaheuristics that accept no-improving neighbours. Accepting no-improving move during the search can lead to better solution than the ones returned by the Hill Climbing.

Let's explain now how we use local search to help us fill an urban block, first only with buildings. We insist on the fact that we use the local search on a specific problem. However, local search is very general and can be used on another problem, with another model or other

constraints. In our context, a solution (an urban block) is modelled as a chequered square or rectangle. Each cell of the quartering can have different colours. A white cell is a no build cell. Other colours/patterns are for buildings. A block of cells with the same pattern represents a building. We currently don't worry about the height of buildings but only about their surface on the urban block. The neighbourhood of a given solution is the set of all the solutions that can be obtained by just changing the colour of a given cell. This action can create a new building in our simulation, expand an existing building, remove a building if we change the cell's colour to white or simply change the colour of a building. Just changing the colour of a building can be interesting because two sufficiently close buildings with the same colour can merge to form a bigger one. We first neglect the compactness of the urban block to focus on its *porosity* (ratio between the built area and the total area of the urban block). Our objective is to minimize this *porosity*.

We don't want to limit ourselves to tile an urban block with squares. We want a model that can work with any kind of tiling, made of regular polygons (hexagons or triangles for example). This allows to test buildings with more varied forms and then other properties on their area and perimeter. For this model, we have implemented a specific object to represent a cell. To create an instance of this object we must specify the number of sides of the cell and the maximum number of adjacent cells. For example, a cell with four sides and maximum eight adjacent cells is a square in a square tiling. A cell with six sides and six adjacent cells is a hexagon in a hexagonal tiling. Each cell is connected to its neighbouring cells. A tiling is a list of cells connected together. Figure 1 illustrates tiling that we have already implemented. To determine the effect of changing the colour of a cell, we need to check its adjacent cells. In addition to the information about its form, a cell object contains a number that symbolises its colour. If this number is equals to zero, the cell is coloured in white and is not built. A cell with a positive number is a build cell and a cell with negative number are the other components of the urban block (-1 for the green spaces for example but we will discuss it in the next section). Let's note that the user can specify the length of cells' sides.

As explained before, local search can work with constraints. In our case, the constraints guide the program to obtain more realistic and interesting solutions. Indeed, with the minimal porosity as only objective, the program can return as a solution an urban block filled with only one big building, or hundreds of tiny buildings without gaps between them. These kinds of solutions don't respect our comfort and privacy constraints, so they must be avoided.

The first mandatory constraint that we have implemented ensures a minimal distance between the facades of different buildings. This constraint takes in input the minimal number of no-build cells that must be present between two build cells. Let's recall that the user can specify the size of cell. As an example, if we work on a square tiling and we want a minimal distance

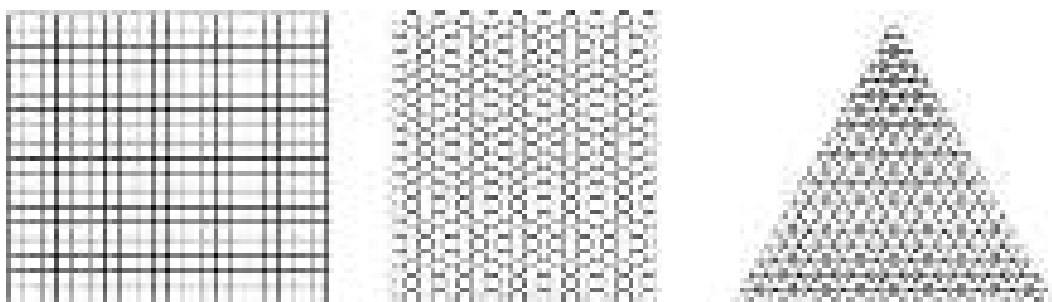


Figure 1.

of four meters, we can work with square of two meters by two meters. So, the constraint must verify that there are two no-built cells between contiguous buildings.

Other constraints are penalising constraints. They penalise solutions if the number of buildings, the total perimeter, the perimeter of each building or the area of each building doesn't belong to a certain range. They take as input the bounds of the range and give as penalty the difference between the observed value and the lower bound if the observed value is lesser than it or the upper bound if the value is greater than it. For example, if we want between six and ten buildings in our urban block, a solution with four buildings will receive a penalty of two. If it has forty-two buildings, it will receive a penalty of thirty-two. Let's just note that the constraint on the perimeter and the area of each building sums the differences between the perimeter or the area of each building and the bounds.

Another feature of our model is the possibility to lock cells. This feature allows us to model the presence of pre-existing buildings or protected green spaces in our urban block. Since those components must be preserved, the neighbourhood operation will not allow changing the colour of a locked cell or expanding a locked building. Locked buildings are coloured with X crosses (see Figures 3 and 4 for examples).

3. Analysis/Results

The implementation methodology of the dynamic tool needs many tests. The observations and analyses of these results guide us in our considerations choices and lead to many possibilities.

Figure 2 illustrates a result obtained by the program on an urban block of 102 meters by 102 meters tiled by squares with sides of 2 meters. The objective is, as explained before, to minimize the porosity of the urban block. Furthermore, we add the following constraints: having between 6 and 10 buildings in our block, the buildings must have a perimeter between 75 and 500 meters and facades must be 4 meters away from each other (or must have two empty squares between them). Each block of cells with the same pattern represents a building.

The constraint on the number of buildings enables to avoid an urban block with numerous small buildings. The constraint on the perimeter enables to avoid results with only one big building and some small ones. As the objective is to minimize the porosity, the tool wants to fill as many cells as possible in the tiling. The results tend thus toward a full urban block. The constraint on the distance between the facades prevents this. As observed on Figure 2, this constraint creates empty spaces that can be interpreted as traffic lanes in our urban block.

Only considering buildings can thus lead to the creation of traffic lanes in our urban block.



Figure 2.

However, we don't have any control on these traffic lanes and their properties. Moreover, we want a minimal rate of green spaces in our solution and there aren't any places left for them. At this point, we need to introduce other components in the urban block, particularly, the green spaces.

As mentioned before, to distinguish green spaces from buildings, the green spaces are assigned the colour -1, represented by the + cross pattern (see Figures 3 and 4). As mentioned in the introduction, we have constraints on green spaces:

- aim for a certain rate of green spaces on the area of the urban block,
- ensure that maximum two green spaces form 50% of the totality of green spaces.

For more flexibility we have implemented the second constraint in a more general way. The user can specify the rate and how much green spaces must fulfil this rate.

We have currently integrated the green spaces in a quite naive way. During the local search, the program has just a new colour to fill a cell: the colour -1. With this approach, we obtain result as in Figure 3.

This solution is returned with similar constraints as for Figure 2. We require just a number of buildings between 6 and 9 instead of 6 and 10. We impose also 20% of green spaces formed by maximum two green spaces.

We observe in Figure 3 that the tool fills the empty lane formed by the distance between fronts with green spaces. Then, the program creates some spread green to tend forward the targeted 20%. This solution is problematic because it leaves us without the possibility of creating potential traffic lanes. This kind of solution appears because minimizing the porosity and aiming a rate of green spaces is a source of conflicts. On the one hand, we want the biggest possible built area; but on the other hand, we want less buildings to create green spaces. To avoid conflicts, the tool puts green spaces in cells that can't be filled by buildings before anything else. Then, it tries to put green spaces where it can to reach the 20%.

To improve the returned solutions with green spaces, we tried to slightly change the neighbourhood operation used by the local search algorithm. Now, the tool cannot put a green space on an empty cell anymore. They must be "inside" the building. An example of returned solution with the modified neighbourhood is illustrated in Figure 4. Let us remark that, even if we observe empty lanes, the green spaces are still very spread. So, we need to improve our model to get green spaces with more compact forms. An idea is to fill block of cells with green spaces instead of filling it one by one. Another idea is to start from an existing green space and then grow it in a way that preserves its compact form.

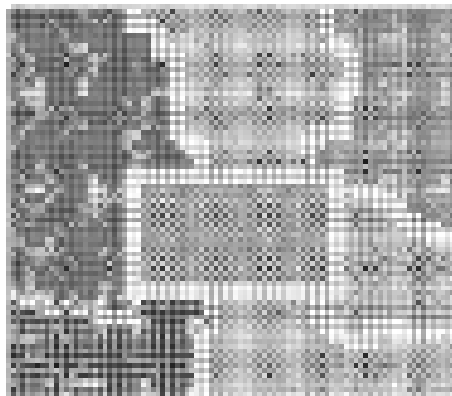


Figure 3.

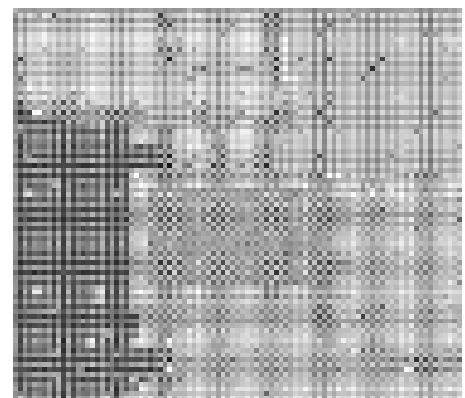


Figure 4.

Moreover, from the firsts tests, the simulations (see Figure 2) show very cut results within the block itself while the outlying bounds of the created buildings always follow the outlying bounds of the block (square here). Enabling the program to return only this kind of solutions risk to standardize shapes outside the block. At this stage of our study, we have decided to neglect this problematic. However, observing the simulations on different scales (on city block scale but also on district and why not on city scale) would allow to solve that problem. The tool could make possible to work on different successive scales. On the district scale, the tool would determine a cut of an area (district) in some urban block with varied forms. On the urban block scale, it would study its content.

4. Discussion/Conclusion

Our tool to assist in the design of compact urban blocks is still in its beginnings. As explained before, it currently aims to minimize the porosity of the urban block with respect to a set of constraints. The obtained results are promising but can be improved, especially the management of green spaces. Although we have neglected the notion of compactness in a first stage, we are aware that compactness is our main objective. The model is frequently enriched with new constraints and objectives to attain the compactness of the urban block.

To achieve compact morphologies, we have to add more constraints on the form of the buildings and the green spaces. Constraint on the perimeter or the area of buildings is a good starting point, but it is not enough. A catalogue of morphologies generated by the tool was sent to the urbanist members of the CoMod project to get remarks and identify the best solutions. These remarks will be used to implement new constraints and refine the model to obtain more realistic results.

Among our future works, we also plan to constraint the depth of building. However, if calculating the depth of a rectangular building is easy, the way to calculate the depth of a more complex polygonal building is not as clear. A first question is thus “how can we formally define the notion of depth for a complex polygonal building?” Our first idea is to define the depth as the diameter of the bigger circumscribed circle in our polygon. To use this definition, we need to find the centre and the radius of this circle, which is not a straightforward problem. In addition to the problem of the definition, comes a problem of computation: “how can we compute *efficiently* the depth?” Indeed, the program is led to know the depth of each building at each step of the search, in order to check if the solution respects the constraints. So, it needs to compute the depth a very high amount of times. This computation may not slow down the search.

As explained before, the program tries to minimize an objective (the porosity of an urban block) and to be penalised the least possible. To achieve this, the program sorts the constraints and the objective. The bigger the penalty, the more “important” the constraint. With this order, a constraint can be totally neglected by the program because its penalty is weaker than another. The program works on this way because it has a very short-term view. Moreover, it is currently difficult to introduce in our model other compactness’ criterions of the type “we want that this value is minimal or maximal”. We would like to set the constraints and the objective on equal footing and have a multi-objective model that doesn’t neglect any criteria or constraints. An idea to do that is to use the mathematical models from the game theory.

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Compact & Collage: a Spatial Morphology Research on Xi'an Old City

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Keywords: Urban Morphology, Street Structure, Xi'an Old City, Inheritance Relationship, Diverse Cultural Heritage.

Abstract: It is profound history background and diverse cultural heritage that make unique charm of cities, which present in urban morphological layers of different historical stages. The spatial morphology of Xi'an Old City today is the result of compression, superposition and collage in various historical periods, which contain logic and dialectics.

The article takes urban morphology of Xi'an Old City as the research object. Xi'an is the starting point of the land-based Silk Road connecting Europe with Asia and the capital of 13 dynasties in Chinese history. The spatial morphology in the Tang Dynasty (唐朝618AD-907AD) was the accumulation and evolution result of former capital cities, which also had a far-reaching influence on contemporary capitals of Japan and Korea. This period laid the cornerstone for today. In the Mongolian Yuan Dynasty (元朝1271AD-1368AD), Hui nationality Islam was an essential factor influencing the city morphology. Then the large-scale expansion and reconstruction in the Ming Dynasty (明朝1368AD-1644AD) and Manchurian Qing Dynasty (清朝1636AD-1912AD) made the city a hub and fortress of central and western China, leaving the most details for today. Since then, Western architectural culture also exerted impact.

The article interprets and reorganizes the compacted and collaged urban morphology of Xi'an Old City through study of historical maps, images, Chinese and foreign literature and critical thinking on existing research. The accurate and comprehensive cognition can offer a case study for East Asian city history; provide basis and guidance for protection, restoration, regeneration of local historical environment and lively inheritance in contemporary urban renewal.

1. Introduction

The street structure and block pattern of the Xi'an old city today are directly inherited from Xi'an-Fu City (西安府城) in Ming (1368-1644AD) & Qing (1616-1912AD) Dynasty and Xi'jing Special City in the Republic of China era (1912-1949AD, 民国西京特别市). Its source is the Imperial City of Daxing in Sui Dynasty (隋朝581-618AD) and Chang'an in Tang Dynasty (唐朝618-907AD), which is also the origin of Xi'an City today. Existing studies have paid much attention to the Sui, Tang, Ming and Qing dynasties. Between them, the Jingzhao-Fu City (京兆

府城) in Northern Song (北宋960-1127AD), Jin (金朝1115-1234AD), Yuan (元朝1271-1368AD) Dynasty acted as a key role in the transition process from the previous Imperial Capital Era to the Regional Center Era. However, the research on the urban structure of this period is insufficient, due to the limited physical remains and the lack of documentary records.

2. Methodology

Based on historical documents and maps, combined with on-the-spot investigation and interviews, and through critical thinking of local consensus and existing research results, this paper studies the street axis structure of Jingzhao-Fu City in Northern Song, Jin and Yuan Dynasty. There are mainly two purposes: the first is to clarify the exact inheritance and evolution relationship of urban structure and pattern between Sui – Tang, Song – Jin – Yuan and Ming – Qing dynasties; the second is to make a preliminary study on the inheritance relationship of important spatial nodes along main street axes from 10th to 14th centuries of Northern Song, Jin and Yuan dynasties.

3. Analysis/Results

3.1. *The 1st South-North Longitudinal Avenue of Imperial City in Sui and Tang Dynasties*

The 1st South-North Longitudinal Avenue (counted from west to east) of Imperial City in Sui and Tang Dynasties, south to the South Wall of Imperial City (皇城南垣), north to the South Wall of Taiji Palace City (太极宫城). On the west side of this avenue, there were Shunyi Gate (顺义门) and Anfu Gate (安福门) of the West Wall of Imperial City. On the east side of this avenue, there were National Sacrifice Department (郊社署), National Horse Administration Department (骅骝马坊), National Supreme Court (大理寺), Royal Procession Department (卫尉寺), Royal Architecture and Jewelry Administration Department (将作监) from south to north.

In Northern Song, Jin and Yuan Dynasties, the south part of this avenue was named Xicheng Lane (西城巷), the north part was named Yeting Street (掖庭街). On the east side of this axis, there were Provincial Granary (千斯仓), Provincial Horse Administration Department (马站), Xiyue Taoist Temple (西岳庙), Yuqing Taoist Temple (玉清宫), Provincial Post Station (秦川驿).

In the early Ming Dynasty, the city wall of Xi'an-Fu was greatly expanded northward and eastward. But the axis did not extend northward. The Qing Dynasty followed the pattern of Ming Dynasty. In the late Qing Dynasty, the southern section of this avenue was called Shuncheng Lane (顺城巷), the northern section was in a semi-abandoned state, which ended at the west-east axis of Xiwutai Buddhist Temple (西五台), the relic of Taiji Palace South Wall.

3.2. *The 2nd South-North Longitudinal Avenue of Imperial City in Sui and Tang Dynasties*

The 2nd South-North Longitudinal Avenue (counted from west to east) of Imperial City in Sui and Tang Dynasties was named the Inner Avenue of Hanguang Gate (含光门内大街), south to the Hanguang Gate (含光门), north to the South Wall of Taiji Palace City. On the west side of this avenue, there were Land God Altar (大社), Royal Chariot Department of Harem (尚辇

局), Royal Storehouse Department of Harem (尚仓局), Royal Architecture and Jewelry Administration Department (将作监) from south to north. On the east side of this avenue, there were National Foreign Affairs Department (鸿胪寺), National Astronomy Department (司天监), National Library (秘书省), National Agriculture Department (司农寺) and Royal Guard Department from south to north.

In Northern Song, Jin and Yuan Dynasties, the south part of this avenue was still called Hanguang Street (含光街), the north part was named Tielu Street (铁炉街). On the west side of this axis, there were Provincial Granary, Provincial Horse Administration Department, Yuqing Taoist Temple, Provincial Post Station from south to north. On the east side of this axis, there were Public Welfare Shelters (养济院), Provincial Supervision Department (廉访司), Ancestral Temple of Fengyuan King (奉元王祠).

This axis was extended northward slightly in the early Ming Dynasty after the city wall of Xi'an-Fu was greatly expanded. The Qing Dynasty followed this pattern. This street was divided into several sections during the Ming and Qing Dynasties, and the old name was given up. The sequence from south to north included Tianshuijing Street (甜水井街), North Tudimiaoshizi Street (南北土地庙什字街), South Qiaozikou Street (南桥梓口街), North Qiaozikou Street (北桥梓口街), Damaikou Street (大麦口街), Sajinqiao Street (洒金桥街) and Laomiao Lane (老庙巷).

3.3. The 3rd South-North Longitudinal Avenue of Imperial City in Sui and Tang Dynasties

The 3rd South-North Longitudinal Avenue (counted from west to east) of Imperial City in Sui and Tang Dynasties was named Chengtian Gate Avenue (承天门大街), south to the Zhuque Gate (朱雀门), north to the Chengtian Gate (承天门), the main entrance on South Wall of Taiji Palace City. This avenue is the South-North Central Axis of Imperial City, which was also called Heaven Avenue (天街). On the west side of this avenue, there were National Foreign Affairs Department, Royal Family Administration Department (宗正寺), Royal Guard Department, National Agriculture Department, National Minorities Administration Department (四方馆) and the Cabinet (中书外省) from south to north. On the east side of this avenue, there were Royal Family Ceremony Department (太常寺), Royal Chariot Department of Emperor (太仆寺), Royal Guard Department, National Council (尚书省), Royal Daily Affair Department (殿中省) and National Censorship Department (门下外省) from south to north.

In Northern Song, Jin and Yuan Dynasties, the south part of this avenue was named Yaoshi Street (药市街), the north part was named Guangji Street (广济街). In this stage, the street was no longer an important axis across the whole city. The south section degenerated into a lane because it was occupied by dwellings and Public Welfare Shelters. On the west side of this axis, there were Provincial Supervision Department and Ancestral Temple of Fengyuan King. On the east side of this axis, there were Yingxiang Taoist Temple (迎祥观) and Horse Market.

This axis didn't extend when the city wall of Xi'an-Fu was expanded in the early Ming Dynasty. The Qing Dynasty followed this pattern. This street was divided into several sections during this period. The sequence from south to north included Dabaoji Lane (大保吉巷), South Guangji Street (南广济街), North Guangji Street (北广济街), Shizimiao Street (狮子庙街).

3.4. The 4th South-North Longitudinal Avenue of Imperial City in Sui and Tang Dynasties

The 4th South-North Longitudinal Avenue (counted from west to east) of Imperial City in Sui and Tang Dynasties was named the Inner Avenue of Anshang Gate (安上门内大街), south to the Anshang Gate (安上门), north to the South Wall of Taiji Palace City. On the west side of this avenue, there were Royal Family Ceremony Department, National Finance Administration Department (太府寺), National Officials Administration Department (吏部选院), National Ceremony Department (礼部南院), National Council and Royal Guard Department from south to north. On the east side of this avenue, there were Royal Family Ancestral Temple (太庙), Ancestral Temple of Emperor Zhongzong (中宗庙), National Handicraft Industry Administration Department (少府监), National Water Administration department (都水监), Royal Catering Department (光禄寺), Royal Chariot Department of Crown Prince (东宫仆寺), Royal Family Order and Punishment Administration Department (率更寺), Private Affair Department of Crown Prince (东宫内坊), Political Affair Department of Crown Prince (右春坊) and Royal Guard Department of Crown Prince (右清道率府) from south to north.

In Northern Song, Jin and Yuan Dynasties, this axis was still named Anshang Street. On the west side of this axis, there were Ancestral Temple of Duqigong (杜祁公庙), Prison, Provincial Medical Service Department (惠民局), Rock of Honest Officials (试官石) and Ancestral Temple of King Wuan (武安王庙) from south to north. On the east side of this axis, there were Provincial Finance Promotion Department (提举司), Kaiyuan Buddhist Temple (开元寺) and Ancestral Temple of Yangwenkang (杨文康祠).

After the city wall of Xi'an-Fu was greatly expanded in the early Ming Dynasty, this axis was extended northward. And a magnificent Bell Tower was set on the middle of this avenue, which divided it into two sections. The Qing Dynasty followed this pattern. As a result, the south part of this axis was named the South Gate Avenue (南门大街), south to the Yongning Gate (the south gate of the city), north to the Bell Tower. The north part and the new extension was named the North Gate Avenue (北门大街), south to the Bell Tower, north to the Anyuan Gate (安远门 the north gate of the city). The south-north central axis got uncertain after the end of Tang Dynasty. More than 460 years later, the South Gate Avenue and North Gate Avenue finally became the south-north central axis of this historical period. The urban structure turned to be clear again.

3.5. The 5th South-North Longitudinal Avenue of Imperial City in Sui and Tang Dynasties

The 5th South-North Longitudinal Avenue (counted from west to east) of Imperial City in Sui and Tang Dynasties, south to the South Wall of Imperial City, north to the South Wall of Taiji Palace City. On the west side of this avenue, there were Royal Family Ancestral Temple Administration Department (太庙署), National Storehouse of Finance Administration Department (左藏外库院), Royal Weapons Administration Department (军器监), Education Service Department of Crown Prince (詹事府), Royal Procession Department of Crown Prince (左司御率府), Political Affair Department of Crown Prince (左春坊), Order and Service Administration Department of Crown Prince (家令寺) from south to north. On the east side of this avenue, there were Jingfeng Gate (景风门) and Yanxi Gate (延喜门) of the East Wall of Imperial City.

In Northern Song, Jin and Yuan Dynasties, this axis was called Dongcheng Lane (东城巷). The neighborhood of this street was a residential area. The south end was at the southeast cor-

ner inside the city, and there was Taibai Taoist Temple (太白庙). The north end was at the northeast corner inside the city, and there was City-God Taoist Temple (城隍庙).

This block went through dramatic changes in the early Ming Dynasty. As a result, most of the axis got vanished since then. Only Tanshi Street (炭市街) and Xinkaidao Lane (新开道巷) in Ming and Qing Dynasty had inherited the middle section of the original Avenue.

3.6. The 1st West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties

The 1st West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties, west to Imperial City West Wall, east to Imperial City East Wall. On the south side of this avenue, there were Hanguang Gate, Zhuque Gate and Anshang Gate of Imperial City South Wall. On the north side of this avenue, from west to east there were National Sacrifice Department, Land God Altar, National Foreign Affairs Department, Royal Family Ceremony Department, Royal Family Ancestral Temple, Ancestral Temple of Emperor Zhongzong, Ancestral Temple of Empress Wenxian (文献皇后庙) and Royal Family Ancestral Temple Administration Department.

In Northern Song, Jin and Yuan Dynasties, this axis was named Nancheng Lane (南城巷). On the north side of this axis, from west to east there were Provincial Granary, Provincial Horse Administration Department, Public Welfare Shelters, Provincial Agriculture Administration Department (屯田府), Ancestral Temple of Duqigong, Provincial Examination Office (贡院), Confucian Temple (宣圣庙), Sanhuang Temple (三皇庙) and Taibai Taoist Temple.

This axis was extended eastward in the early Ming Dynasty. In Ming and Qing Dynasty, this axis was divided it into several sections. From west to east, the sequence included Huoyaoju Lane (火药局巷), West Tianshuijing Street (东西甜水井街), Baoen-Temple Street (报恩寺街), Taiyang-Temple Street (太阳庙门街), Wuyue-Temple Street (五岳庙街), Xiangzi-Temple Street (湘子庙街), Shuyuanmen Street (书院门大街), Sanxue Street (三学街) and Xiamaling Street (下马陵街).

3.7. The 2nd West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties

The 2nd West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties, west to Imperial City West Wall, east to Imperial City East Wall. On the south side of this avenue, from west to east there were National Sacrifice Department, Land God Altar, National Foreign Affairs Department, Royal Family Ceremony Department, Royal Family Ancestral Temple, Ancestral Temple of Emperor Zhongzong, Ancestral Temple of Empress Wenxian and Royal Family Ancestral Temple Administration Department. On the north side of this avenue, from west to east there were National Horse Administration Department, National Astronomy Department, Royal Family Administration Department, Royal Chariot Department of Emperor, National Finance Administration Department, National Handicraft Industry Administration Department and National Storehouse of Finance Administration Department.

In Northern Song, Jin and Yuan Dynasties, the west section of this axis was named Shuichi Street (水池街), the east section was named Caochang Street (草场街). On the south side of this axis, from west to east there were residential houses, Ancestral Temple of Duqigong, Provincial Examination Office, Confucian Temple, Sanhuang Temple and Taibai Taoist Temple. On the north side of this axis, from west to east there were Xiyue Taoist Temple, Ancestral Temple of Duke Zhengguo (秦郑国祠), Provincial Civil Affairs Administration Department

(录事局), Provincial Tax Department (税使司), Prison, Kaiyuan Buddhist Temple (开元寺) and Provincial Handicraft Industry Administration Department (杂造提举司).

This axis extended eastward when the city wall of Xi'an-Fu was significantly expanded in the early Ming Dynasty. In Ming and Qing Dynasty, this axis was divided it into several sections. From west to east, the sequence included Madao Lane (马道巷), You Lane (油巷), Bangzishi Street (梆子市街), East Tudimiaoshizi Street (东西土地庙什字街), Wuweishizi Street (五味什字街), Nanyuanmen Street (南院门大街), West Mutoushi Street (西木头市街), East Mutoushi Street (东木头市街), Sipailou Street (四牌楼街), Dongtingmen Street (东厅门街), Dongxianmen Street (东县门街) and Dongyangshi Street (东羊市街).

3.8. *The 3rd West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The 3rd West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties, didn't go through the entire city, west to National Agriculture Department, east to National Handicraft Industry Administration Department. On the south side of this avenue, from west to east there were National Astronomy Department, Royal Family Administration Department, Royal Chariot Department of Emperor, National Finance Administration Department. On the north side of this avenue, from west to east there were National Library, Royal Guard Department, National Officials Administration Department and National Ceremony Department.

From the end of Tang Dynasty to Ming Dynasty, there were no precise records of this street. In Ming and Qing Dynasties, the axis of West Xiajiashizi Street (东西夏家什字街), Liangjiapailou Street (梁家牌楼街) and Yandian Street (盐店街) was clear, broad and straight, which was basically equidistant between the axis of West Gate Avenue (西门大街) and Nanyuanmen Street. Since most of the residential alleys formed after the Sui and Tang Dynasties were tortuous, it is speculated that this axis may partly inherit the old site of the 3rd West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasty.

3.9. *The west section of the 4th West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The west section of the 4th West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasty was named Shunyi Gate Avenue (顺义门大街), west to Shunyi Gate, east to Chengtian Gate Avenue. This avenue was the West-East Central Axis of Imperial City. On the south side of this avenue, from west to east there were National Horse Administration Department, National Agriculture Department, National Library and Royal Guard Department. On the north side of this avenue, from west to east there were National Supreme Court, Royal Procession Department, Royal Chariot Department of Harem and Royal Storehouse Department of Harem.

In Northern Song, Jin and Yuan Dynasties, the west section of this Avenue was still named Shunyi Street (顺义街), the east section was renamed as West Zhihui Street (指挥西街). On the south side of this axis, from west to east there were Xiyue Taoist Temple and Ancestral Temple of Duke Zhengguo. On the north side of this axis, from west to east there were Yuqing Taoist Temple and Provincial Supervision Department.

This axis was renamed as West Gate Avenue (西门大街) and extended eastward in the early Ming Dynasty. For the West Gate Avenue, the west end is inside the West Gate, the east end is at Xi'an Bell Tower (西安钟楼). This pattern has been followed up to now.

3.10. *The east section of the 4th West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The east section of the 4th West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties was named Jingfeng Gate Avenue (景风门大街), west to Chengtian Gate Avenue, east to Jingfeng Gate. This avenue was the West-East Central Axis of Imperial City. On the south side of this avenue, from east to west there were National Storehouse of Finance Administration Department, National Handicraft Industry Administration Department, National Ceremony Department, National Officials Administration Department and Royal Guard Department. On the north side of this avenue, from east to west there were Royal Weapons Manufacturing Plant, Royal Catering Department, National Water Conservancy Department and National Council.

In Northern Song, Jin and Yuan Dynasties, the east section of this Avenue was still named Jingfeng Street (景风街), the west section was renamed as East Zhihui Street (指挥东街). On the south side of this axis, from east to west there were residential houses, Provincial Handicraft Industry Administration Department, Kaiyuan Buddhist Temple, Provincial Medical Service Department (惠民局) and Provincial Tax Department. On the north side of this axis, from east to west there were residential houses, Xuandu Taoist Temple (玄都观), Ancestral Temple of King Xianning (咸宁王祠), City Government (奉元路门), Jingshi Tower (敬时楼), Ancestral Temple of Duke Chuli (櫟里庙) and Yingxiang Taoist Temple Bell Tower (迎祥观钟楼).

This axis was renamed as East Gate Avenue (东门大街) and extended eastward dramatically in the early Ming Dynasty. In addition, a new Bell Tower was founded on this axis. For the East Gate Avenue, the east end is inside the East Gate, the west end is at Xi'an Bell Tower.

When it came to Qing Dynasty, the Manchu nationality built an inner city which was named Manchu City (满城) inside Xi'an-Fu city. As a result, most of the East Gate Avenue was occupied by the south Manchu City Wall. Only a small lane was left and called Shuncheng Lane (顺城巷). After the Republic of China was founded, Manchu City was demolished completely at once. And the East Gate Avenue was restored and broadened. This pattern has been followed up to now.

3.11. *The 5th West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The 5th West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties, west to Imperial City West Wall, east to Imperial City East Wall. On the south side of this axis, from west to east there were National Supreme Court, Royal Procession Department, Royal Chariot Department of Harem, Royal Storehouse Department of Harem, National Agriculture Department, National Council, National Water Conservancy Department, Royal Catering Department and Royal Weapons Manufacturing Plant. On the north side of this axis, from west to east there were Royal Architecture and Jewelry Administration Department, Royal Guard Department, Royal Chariot Department of Crown Prince, Royal Family Order and Punishment Administration Department, Royal Guard Department of Crown Prince, Royal Procession Department of Crown Prince and Education Service Department of Crown Prince. After the end of Tang Dynasty, the axis annihilated and was difficult to track.

3.12. *The 6th West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The 6th West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties, didn't go through the entire city, west to Royal Architecture and Jewelry Administration Department, east to Imperial City East Wall. On the south side of this axis, from west to east there were Royal Guard Department, Royal Chariot Department of Crown Prince, Royal Family Order and Punishment Administration Department, Royal Guard Department of Crown Prince, Royal Procession Department of Crown Prince and Education Service Department of Crown Prince. On the north side of this axis, from west to east there were Royal Guard Department, National Minorities Administration Department, the Cabinet, National Censorship Department, Royal Daily Affair Department, Royal Guard Department, Private Affair Department of Crown Prince, Political Affair Department of Crown Prince, Royal Guard Department of Crown Prince and Service Administration Department of Crown Prince.

History record of this axis from the end of Tang Dynasty to Ming Dynasty doesn't have many details. We can only figure out some key nodes on both sides of this street in Yuan Dynasty. On the south side of this axis, from west to east there were Yuqing Taoist Temple, Provincial Supervision Department, Yingxiang Taoist Temple Bell Tower, Provincial Cloth Administration Department, Ancestral Temple of Duke Chuli, Jingshi Tower, Provincial Government. On the north side of this axis, from west to east there were Provincial Post Station, Ancestral Temple of King Fengyuan, Horse Market, Sheep Market, Catering Department of Prince (掌膳局), Architecture and Jewelry Administration Department of Prince (左作局), Rock of Honest Officials and Ancestral Temple of Yangwenkang.

Only part of this axis remained in Ming and Qing Dynasties, which was divided it into several sections. From west to east, the sequence included Miaohou Street (庙后街), Yangshi Street (羊市街) and Jingzhao Lane (京兆巷). Today this axis still remains the same.

3.13. *The 7th West-East Horizontal Avenue of Imperial City in Sui and Tang Dynasties*

The 7th West-East Horizontal Avenue (counted from south to north) of Imperial City in Sui and Tang Dynasties was also called the Horizontal Avenue (横街). It located at the south of Taiji Palace. The west end was at Anfu Gate of Imperial City West Wall. The east end was at Yanxi Gate of Imperial City East Wall. This avenue was more than 400 meters in width, the widest avenue in Chang'an City, the national capital of Tang Dynasty. It functioned as a huge square to some degree. Outside Chengtian Gate, the main gate of Taiji Palace, was the Outer Court (外朝), which was exactly in the 7th West-East Horizontal Avenue. Most of important national ceremonies were held here every year, like New Year, Winter Solstice (冬至), change the designation of an imperial reign (改元), Imperial Edict (颁诏), Amnesty and War Triumph.

On the south side of this axis, from west to east there were Royal Architecture and Jewelry Administration Department, Royal Guard Department, National Minorities Administration Department, the Cabinet, National Censorship Department, Royal Daily Affair Department, Royal Guard Department, Private Affair Department of Crown Prince, Political Affair Department of Crown Prince, Royal Guard Department of Crown Prince and Service Administration Department of Crown Prince. On the north side of this axis, from west to east there were Yeting Palace (掖庭宫) which was the service center of royal family, Taiji Palace (太极宫) which was the palace of emperor and empress, East Palace (东宫) which was the palace of crown prince.

In Northern Song, Jin and Yuan Dynasties, this axis was divided into several sections. From west to east, it included Yiting Street (驿亭街), Shibei Street (市北街), Jiuyao Street (九耀街) and Beicheng Lane (北城巷). On the south side of this axis, from west to east there were Provincial Post Station, Ancestral Temple of Fengyuan King, Horse Market, Sheep Market, residential houses, Catering Department of Prince, Architecture and Jewelry Administration Department of Prince, Ancestral Temple of King Wuan, Land Goddess Taoist Temple (后土祠), Provincial Supervisory and Judicial Department (行御史台署) and City God Taoist Temple.

On the south bank of the Lotus Pond in Prince Qin Palace (秦王府) of Ming Dynasty, there is the relic of Chengtian Gate. On the south of the relic, there are west-east Hongbu Street (红埠街) and Erfu Street (二府街). Another west-east axis less than 300 meters south of it consists of Dapiyuan Lane (大皮院巷), Outer Xihua Gate Avenue (西华门外大街) and Inner Xihua Gate Avenue (西华门内大街). Because the 7th Horizontal Avenue was about 400 meters wide, these two axes should be both included in it. And the pattern continues to this day.

4. Discussion/Conclusion

Modern Xi'an is the regional core of central and western China. It used to be the starting point of the land-based Silk Road connecting Europe with Asia and the capital of 13 dynasties, among which the Zhou (1046BC-771BC), Qin (770BC-207BC), Han (202BC- 8AD) and Tang (618AD-907AD) Dynasties are the most prosperous periods in Chinese history.

The spatial morphology in the Imperial Capital Era of Tang Dynasty, which was called Chang'an City at that time, was the accumulation and evolution result of capital cities in the past, and also has far-reaching influence on contemporary capitals of Japan and Korea. Chang'an City of Tang Dynasty was composed of Palace City, Imperial City and Outer City. The Imperial City laid the cornerstone for the spatial morphology today. Four of the five major south-north Vertical Avenues and six of the seven major west-east Horizontal Avenues in the Imperial city can be clearly distinguished in the urban morphology of Xi'an Old City today.

In Northern Song and Jin Dynasties, Xi'an City was repeatedly captured because it located in the border area of the country, which was called Jingzhao-Fu City at that time. City construction and renewal was slow and basically followed the pattern left from Tang Dynasty. In the Mongolian Yuan Dynasty, formation and immigration of Hui nationality Muslim was an important factor influencing the urban morphology, which was called Fengyuan-Lu City at that time. Muslims mainly live in the northwest section of the city and continue to this day.

The large-scale expansion and reconstruction in Ming Dynasty made it the hub and fortress of central and western China, which was called Xi'an-Fu City at that time, leaving the most details for today's urban morphology. In the Manchurian Qing Dynasty, the northeastern section of the city was built as an independent military fortress of Manchu people, which was called Manchu City. During the Republic of China Era, Manchu City was demolished and the pattern of Ming Dynasty was restored. Meanwhile, Western architectural culture also had a profound impact on urban morphology in this period.

Four orthogonal avenues divide the rectangular old city of Xi'an into four parts. The research finds that the southwest section and the western half of southeast section retain the most space structure of Sui and Tang dynasties, the southern half of the northwest section reflects the most space structure of Mongolian Yuan dynasty, the northeast section and the eastern half of southeast section embody urban construction in Qing Dynasty and Republic of China Era. The axes

of main avenues in Xi'an Old City today formed in Sui and Tang Dynasties, while numerous ordinary roads and alleys formed in Ming and Qing Dynasties.

Nowadays, the general public's cognition of Xi'an Old City's identity and value is often vague and biased. This study can provide a comprehensive and accurate reference for the protection, rehabilitation and regeneration of local architectural heritage and historical environment.

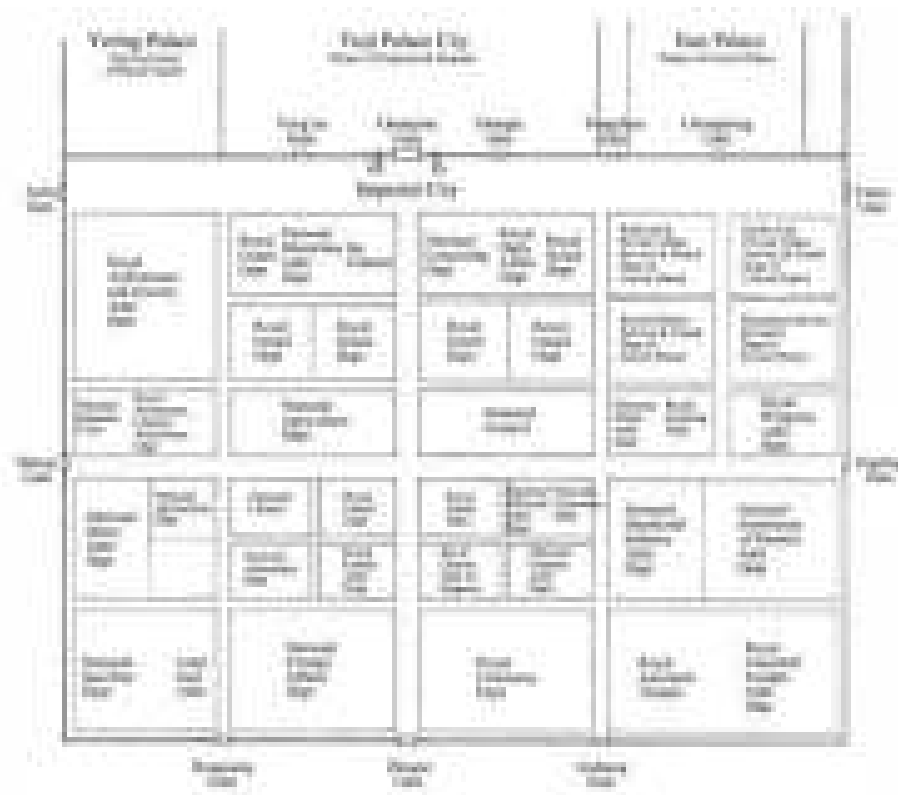


Figure 1. Map of Chang'an Imperial City in Tang Dynasty (618-907AD).

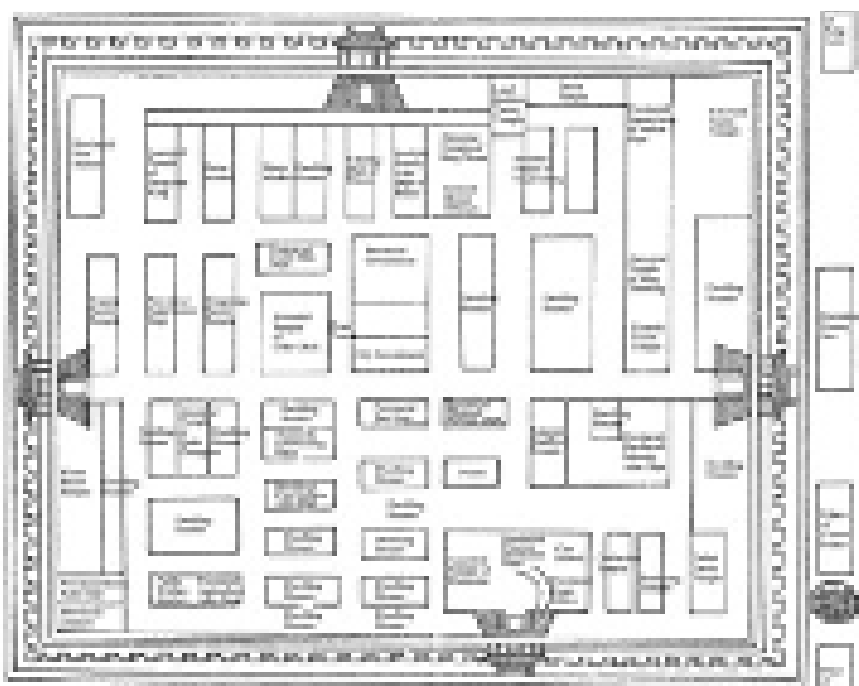


Figure 2. Map of Fengyu-an-Lu City in Yuan Dynasty (1271-1368AD).

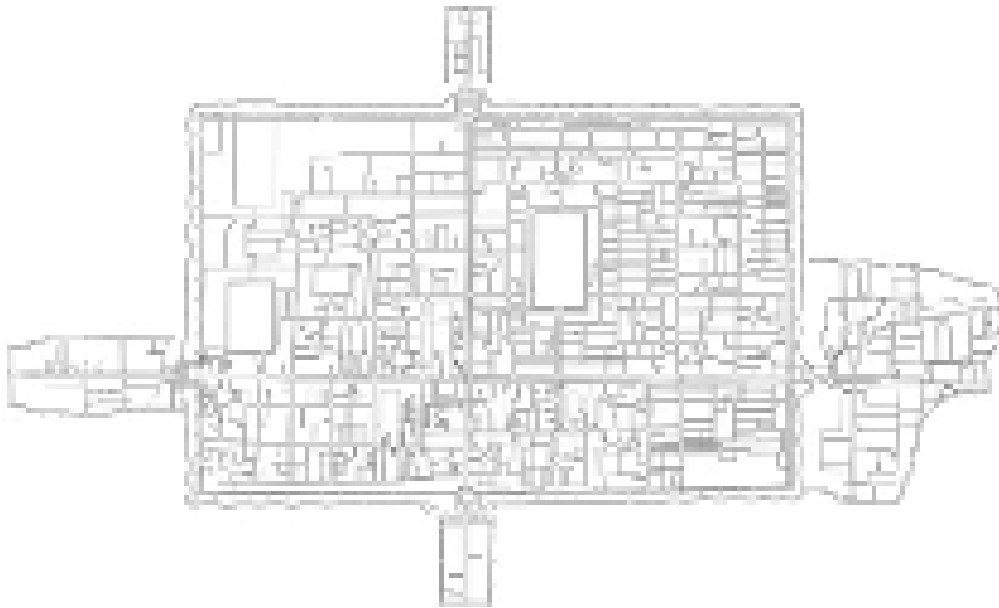


Figure 3. Map of Xi'an-Fu City in Qing Dynasty (1636-1912AD).



Figure 4. Street Structure Comparison of Three Eras.

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Exploring the Morphological Process of New Districts in China: the Case of Nanjing

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Keywords: newly-built district, morphological process, structure, social economic demand.

Abstract: Morphological research enables better understanding of the urban physical form through studying its generating process. In the past 3 decades, urban expansion leads to a rapid construction of new districts recognized by scholars as a “top-down and one-shot” process, which is believed to have caused a high degree of similarity in their structures and fabrics. In fact, in parallel with urban expansion, the market economy has integrated with former planned economy, which means the bottom-up forces have started to play an important role during this period. Thus, it is meaningful by focusing on newly-built districts to investigate two interwoven forces with morphological tools.

Hexi Newly-built District, a new developing zone of Nanjing, used to be farmland before 1992. In 2004, due to the upcoming National Olympic Games, a new developing plan for Hexi was founded and growing. This paper reviews the morphological process of Hexi to analyze the way of its morphological changing, the pattern of the structure and the idea behind. Focusing on the center area of Hexi, the paper carefully draws out the land changing step by step, and the morphological changing process is clearly shown, in terms of cultural intension, social activities and commercial values. Based on various planning indicators, the paper characterized the morphological features of the new zone, including building height, arrangement of buildings and street interface. Result shows social economic demand is the main driving force of the development of the area, rather than a top-down planning, which determines the network structure.

1. Introduction

Urban morphology studies, especially the Conzenian School, has made some achievements in exploring the urban morphology of classical European cities and modern European and American cities. In recent years, some scholars have begun to study urban morphology of Chinese cities, but most of them focus on old cities or historic districts, such as Pingyao (Whitehand and Kai Gu, 2010) and Huangpu Ancient Village in Guangzhou (Zhiliang Wei and Yinsheng Tian, 2016), while little attention has been paid to new developing zones. The wide construction of new developing zones has been playing a significant role in the rapid urbanization during the past 3 decades in China. Foreign scholars tend to simply recognize the construction of new

districts in China as a “top-down and one-shot” process dominated by strong government power, while within the country, existing studies on new districts rarely set foot in their morphological process. However, if we take a deeper insight into the formative process of these new zones, there are some phenomenon hardly to be explained by “one-off planning”. For a more comprehensive understanding of the features of China’s urbanization after the reform and opening up policy, morphological approach can be applied to fully reveal the driving forces behind the formation of new zones.

Referring to plot analysis, as used in the studies on Alnwick (Conzen, 1960) and well-recognized as a fruitful approach to examining the transformation of urban form (Conzen, 1969; Slater, 1990), the research examines the formative process of streets, plots and buildings in the selected new developing zone. Hexi New Developing Zone of Nanjing, a well-developed new zone located in a city with both long history and relatively high urbanization level, is selected as a representative case. Located to the southwest of the old city of Nanjing (Figure 1), Hexi covers a larger area than the old town. After a brief review of the historical background of Hexi, the paper examines the germination of urbanization in the area, which was reflected through initial growth of road network and expansion of built-up areas. Then focusing on the central Hexi, the core study area is explored from the aspects of streets, plots and buildings, shedding light on the role of social-economic demands in the formative process of the new zone.

2. An Overview of the Historical Background of Hexi’s Development

Surrounded by rivers, Hexi takes up an area of 94 square kilometers, of which the land area accounts for 56 square kilometers, while the rest 38 square kilometers is covered by Jiangxin Island, Qianzhou Island and waterbody. It is customary to divide Hexi area into three parts: north, middle and south. In its urban master planning, the middle is considered as the center



Figure 1. Location of Hexi New Developing Zone.

of the new zone; the north part mainly serves as the mid-range residential area; and the leading function of the south part is to upscale community and reserved land for culture and sports facilities.

In the history, Hexi used to be farmland. According to *Thirty Years History of Nanhu New Village*, it can be date back to 1953 when the first residential area appeared in Hexi. A map of land utilization in 1978 (Figure 2) shed light on the low level urbanization in the area at that time, with limited built-up land concentrated in the north and along the eastern border with the old Nanjing city mainly used for industrial purpose.

In 1978, the year witnessed the end of the Cultural Revolution and the start of the reform and opening-up policy, a large number of educated youth and their families returned to the Nanjing city. In order to solve their housing problems, the construction of Nanhu Resettlement House in the early 1980s kicked off the initial development of Hexi area. From the preliminary planning in 1982 to the completion of construction in 1985, the three-year time witnessed Nanhu New Village taking the lead in the urbanization of Hexi. Covering an area of 68.55 square kilometers out of Shuixi Gate, which used to be the most significant gate in the west of the old city of Nanjing, it could accommodate 30,000 people, which means more than 9000 households. In the meanwhile, 114 public and service facilities: large to comprehensive shopping malls and hostitals, small to public toilets and bus stops, were built upcorrespondingly. Due to its incomparable scale at the time, Nanhu New Vilage was tagged as the “first district in Jiangsu Province” by the media. Built under the unified management of the headquarters set up by Nanjing government, this huge modernist residential area can be regarded as a product left by the planned economy.

Following the completion of Nanhu New Village, theconstruction of residential areas in Hexi spread quickly towards west, in order to make full use of the existing neighbourhood fa-

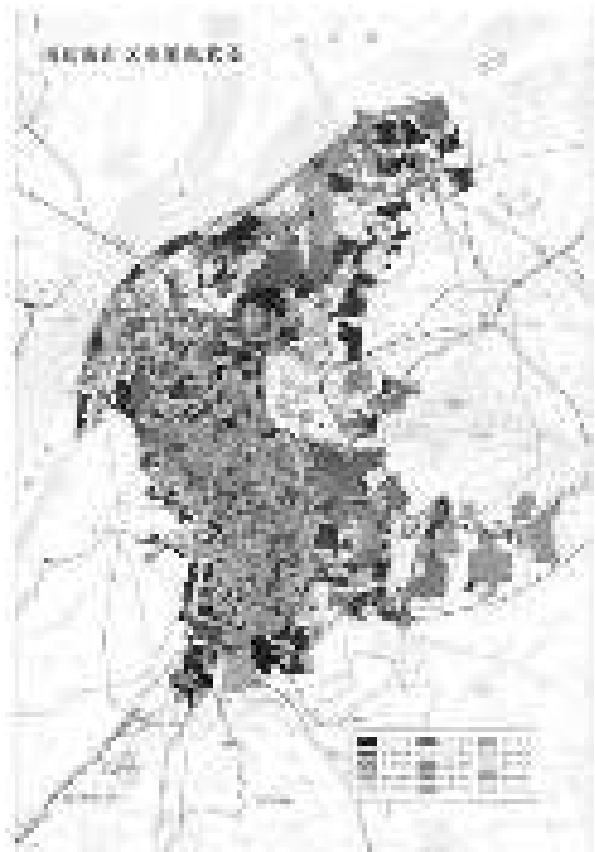


Figure 2. Land utilization status in Nanjing, 1978.
(Source: <http://js.xhby.net/>)

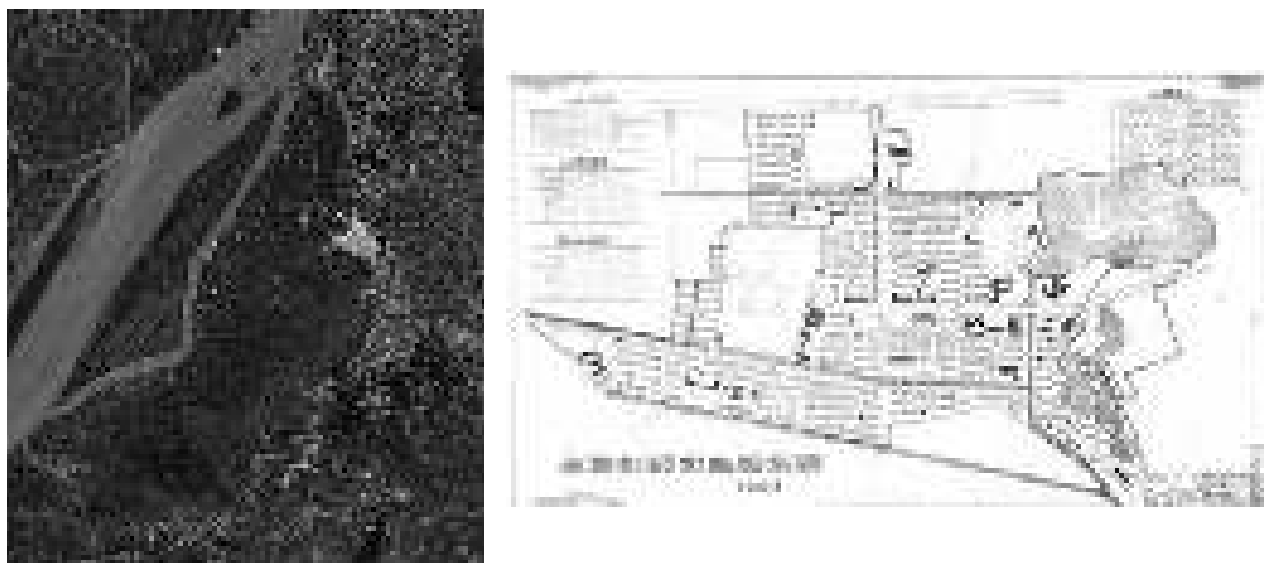


Figure 3. The location of Nanhu New Village resettlement house and its plan (1982). (Source: http://www.sohu.com/a/148271529_290858)

cilities. From 1985 to 1992, a number of new residential areas have been built around it, such as Chaxi Community, Mochou New Apartment, so on and so forth.

3. The germination of Hexi's urbanization (1984-2004)

To get an overview of the urbanization background of Hexi area, the satellite records have been traced on Google Earth from 1984, when the beginning of urban sprawl was already visible in Hexi. From 1984 to 2004, the annual satellite maps reveal the progressive urban expansion spread from the old town of Nanjing, located to the northeast of Hexi, to the west of Qinhu River. This paper picks out 6 years' images in which relative distinct changes can be observed and carefully draws out how the preliminary road structure gradually formed companioned by continuous expansion of urban built-up area.

Due to its geographical proximity to Nanjing old town, the initial urbanization of Hexi started from the northern and eastern parts of the area in 1984, while a road extending from the northernmost to the interior appeared. This road was actually the prototype of Jiangdong Road, now the largest arterial road in Hexi, which has five lanes in both directions, with a width of 60 meters including auxiliary roads.

Although 1988 witnessed no distinct growth in structural road visible in the map, however, the urban expansion kept extending to the west bank and the two initial built-up areas at the north and east side developed into a continuous one. In 1994, the roads extending from east to the west coast appeared and the north of Hexi had been basically urbanized.

When it came to 1997, the central primary road outstretched further towards south, companioned by several transverse access roads stretching to northwest towards the west bank of Hexi. In the meantime, still being confined within the north area, the built-up area had not followed in the footsteps of the road expansion to the central and southern Hexi. In this year, faced with the housing problem of college teachers, the government decided to build the largest high-rise

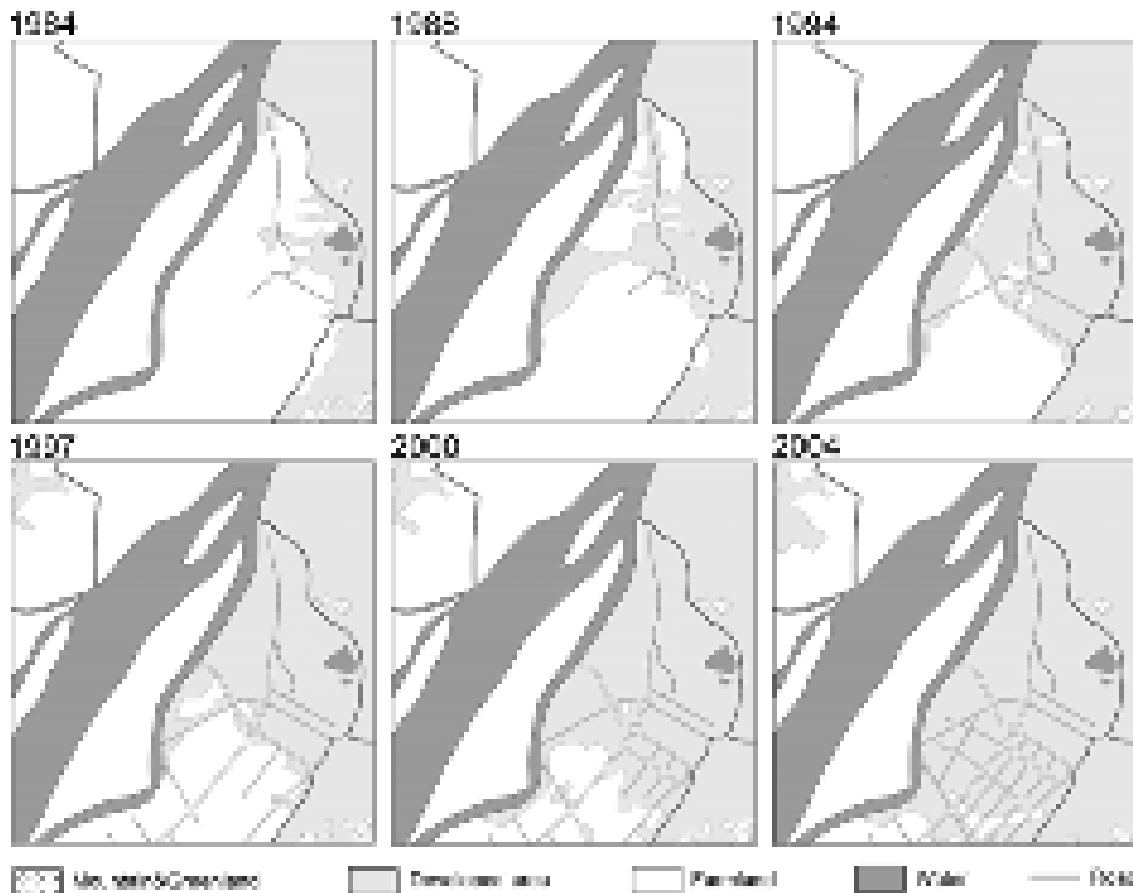


Figure 4. The changing process of road network and built-up area in the urban expansion of Hexi

residential community in Nanjing-Longjiang Higher Education Apartment, in the northern Hexi, which was also the prelude of large-scale construction in the north of Hexi.

In the *Nanjing City Master Plan (1991-2010)*, compiled in 1992 and started being implemented in 1995, the Nanjing Planning Bureau proposed the concept of Hexi as a new developing zone for the first time. The scope of the main city of Nanjing in the new plan also expanded by more than 1/3 to the southwest compared with 1983, which means the north and middle parts of Hexi were included in. It also positioned Hexi as a new urban area with residence as the main function, to accommodate the increasing population and people evacuated from the old city.

By the end of 2000, with the completion of several residential areas, a great number of residents, mainly college teachers, had moved in, thus promoting the emergence of large-scale commercial facilities. Around 2000, the 20 square kilometers in the north part of Hexi New Developing Zone was almost completed. There is no wonder why the road grids began to be observed in 2000. At the same time, the developed area kept expanding towards south, which continued into 2004, when a relatively regular road network took shape in the central part, and the urban expansion almost covered this region.

Overall, the road expanded from the north to the south, from the middle of the region to the west bank and east bank, while the developed area spread from the northernmost point as well as the east bank to west and then to south. 1994 marked the watershed year -- before that, the sprawl of built-up areas pushed roads westward, and after that, in the contrary, the growth of roads led the expansion of built-up areas.

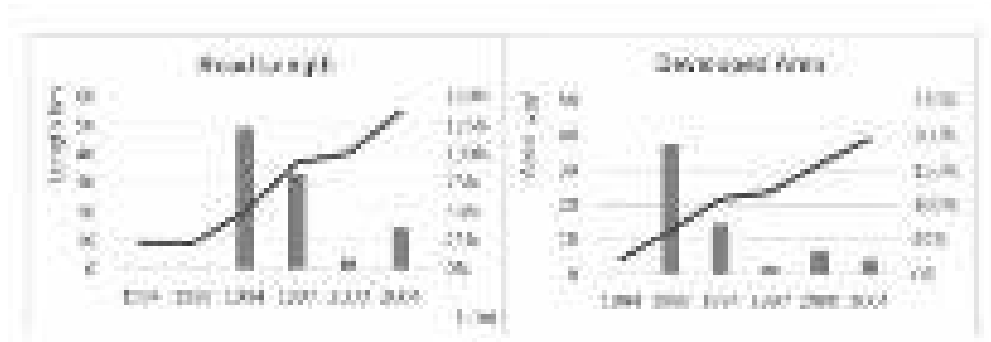


Figure 5. Changes in road length and built-up area during the initial urbanization of Hexi.

The largest growth in the road length was in 1997, with an increase of about 16.7 km, followed by 1994, with a figure of 11.2 km and the highest growth rate of 123%. The growth rate of built-up areas peaked earlier than the length of road, at about 180% in 1988. This phenomenon possibly resulted from the large-scale construction of resettlement housings in the northern Hexi during the period of 1985–1992, as mentioned above in the historical background.

It is interesting to see that follow up a significant decrease in the urbanization rate in 2000 after more than a decade's urbanization, the figures showed a clear rebound in 2004 reflected in the growth rate of road length. This was largely due to the new development opportunities brought by government's decision making. Dating back to 2001, in June, Jiangsu won the right to host the 10th National Games in 2005. After that, the *Partial adjustment plan* of "Nanjing City Master Plan (1991–2010)" was approved by the Standing Committee of Nanjing Municipal People's Congress, in which Hexi was listed as the key developing new zone of Nanjing main city. At the same time, Hexi was designated as the major venue of the 10th National Games. In the same year, the Nanjing government approved the *Hexi New Town Master Plan*.

In 2002, Nanjing City compiled the *Nanjing Construction Plan (2003–2007)*, in which stressed the priority of Hexi New Zone in Nanjing's urban construction. The same year, the Nanjing Municipal Party Committee and the Municipal Government approved the establishment of the Hexi Construction Command, which announced the official launch of Hexi New Developing Zone's construction. The year also saw the Olympic Sports Center start being built. As an important catalyst of the area, this large-scale public building was completed with high efficiency by the end of 2004.

It can be concluded that the germination of urbanization in Hexi New Developing Zone was a gradual process evoked under the influence of planned economy, and then triggered further development through large city events promoted by government policies.

4. High-speed development in central area (2005–2018)

In 2005, with the successful hold of 10th National Games, Hexi ushered in the beginning of its rapid development phase. However, the pace of construction once slowed down a bit in 2006, in the background of national macro-control. In the second half of the same year, the 4th World Urban Forum was settled in Hexi, which brought it the second valuable development opportunity. In November 2006, the Hexi Convention Center (now called Nanjing International Expo Center) prepared for the Fourth World Urban Forum in 2008 broke ground, and the construction intensity in Hexi was upgraded again.

In 2008, with the relocation of municipal authorities such as Nanjing Quality Supervision Bureau, Environmental Protection Bureau and Civil Affairs Bureau in Hexi, its popularity was further boosted. In November, the Fourth World Urban Forum was held as scheduled. Till then, the 21 square kilometers in the central Hexi had taken shape with the promotion of the two large-scale cultural and sports activities. After the Forum, Hexi's construction trend headed towards the south part, where is positioned as a new high-grade urban area mainly for living and leisure. The construction of 15 square kilometers in the south was fully launched before the 2014 youth Olympic Games.

From 2005 to 2018, Hexi Newly-Developed District experienced the most concentrated stage of construction. We chose the most representative part, the core area of Hexi centered on the Olympic Sports Center, as the research object in this section to present its formative process.

4.1. The formative process of road network

Through the annual road network drawn on the basis of the satellite images which can be traced on Google Earth since 2005, it can tell that the traffic structure was not formed at one time. We separate the arterial roads (here we refer to all of the expressways, arterial roads, sub-arterial roads as arterial roads) and branch roads with lines of different thickness, and highlight the newly-appeared roads as well as the removed roads in each year in these two categories respectively. An example of 2007 and 2010 is given (Figure 6).

By 2005, the arterial road frame was basically in place, except the part in the southwest, where several half-built dead-end roads left. Even Jiangdong Middle Road, the current broadest trunk road running from north to south through Hexi, also stopped at the southern edge of the study area before 2014, when it extended to the south of Hexi. During this period, a few changes happened. The connection between Yangtze River Avenue and the south end of Jiangdong Middle Road was firstly constructed in 2010, but then demolished in 2012, after which this interval of Yangtze River Avenue was rebuilt into an urban tunnel. Even though by 2015, the main road



Figure 6. Development of road structure in central Hexi area

structure had basically stabilized, there was still a tiny change in the connectivity of Yanshan Road, due to the late completion of Nanjing Youth Olympic Conference Center located on its west side.

The gradual process of construction is more obvious on branch roads. There were considerable newly-built branches in this period, especially in the year 2007 and 2009. A very interesting phenomenon shown through the figure is that some roads, rather than being constructed at one time, were suspended somehow for several years before they were fully finished. Let's take a section of Fuchunjiang West Street as an example (Figure 7). For convenience, we refer to it as "A", and other changed roads involved in the discussion are also represented with different capital letters, while the relevant plots are named after numbers.

Looking back from 2008, it is easy to find road A had been remaining a half-built dead-end road for at least four years until it was opened up in 2009. The reason leading to this situation can be revealed if we check to which developers each plot was transferred by browsing through the completion status of the four plots in 2012. Actually, plot 2-2, 3-2, and 1-1 shared the same developer called Rongqiao Real Estate Group, and they were three phases of one residential project. Differently, plot 2-1 and 3-1 were sold to different developers. The earlier built interval of road A was an "expropriated road" constructed by the developer commissioned by the government, so was the interval between plot 2-1 and 3-1, just different developers. So Rongqiao Real Estate Group just paved the way within the scope of land it had purchased, leaving road A unfinished until the other developers built up the part they were responsible for. If we zoom in to check to mappings above in detail, it would not be hard to find this is not an isolated case.

Another phenomenon worth noting is that some roads disappeared somehow after their construction. For instance, in 2009, road B, C and D were built up, which was consistent with

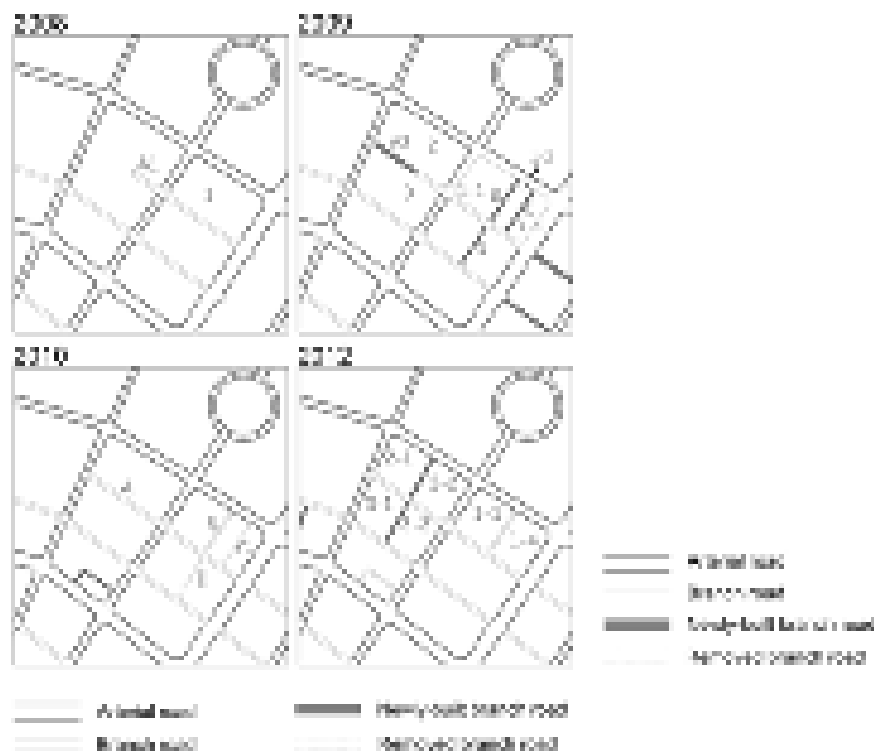


Figure 7. A case of changes in branch roads.

the initial urban planning. However, one year after, road C no longer existed. This also reflects the active participation of social economy in the realization of the new zone. The road B and C was firstly implemented, thus formed the three plots marked 1-1, 1-2 and 1-3 in the figure of 2009. Among them, 1-2 and 1-3, both initially intended for commercial use, were later sold to the same company. After the road being demolished in 2010, it could be observed on the satellite map that the reassembled plot 1-4 in figure of 2011 started being constructed as a whole. In this case, the land ownership had an impact on the shape of the road network.

Although the changes in road network seem to be relatively subtle, and sometimes the final results showed no distinct differences from the original planning, it is important to see from the several cases that except for the government, various stakeholders like developers also played negligible roles in the formative process of traffic structure in the new zone.

4.2. Development of Plots

The Plot Division

Closely related to the construction of roads, the division of the plots was not done overnight as well (Figure 8). The histogram below shows the annual change in the plot numbers. It can be seen the figure has been on the rise steadily before 2014 and almost keeps stable after. Among them, the year 2007 and 2009 experienced the most distinct increase.

If we calculate the total number of changed plots in the period, either divided or consolidated, in each land utilization category, it can be clearly seen that residential takes the majority with a portion of more than 50%, followed by commercial office accounting for a quarter (Figure 9-B). Let's take the following case as an example to explain why residential land experience the most changes. The division of block 1 experienced several stages (Figure 10). In 2008, block 1 as a whole was still a vast tract of undeveloped land. According to the Announcement of the Public Transfer of State-owned Land Use Rights in Nanjing, plot 1-1 was sold in March 2007. It was the first plot to be separated from the entire block in 2009 and developed into a residential

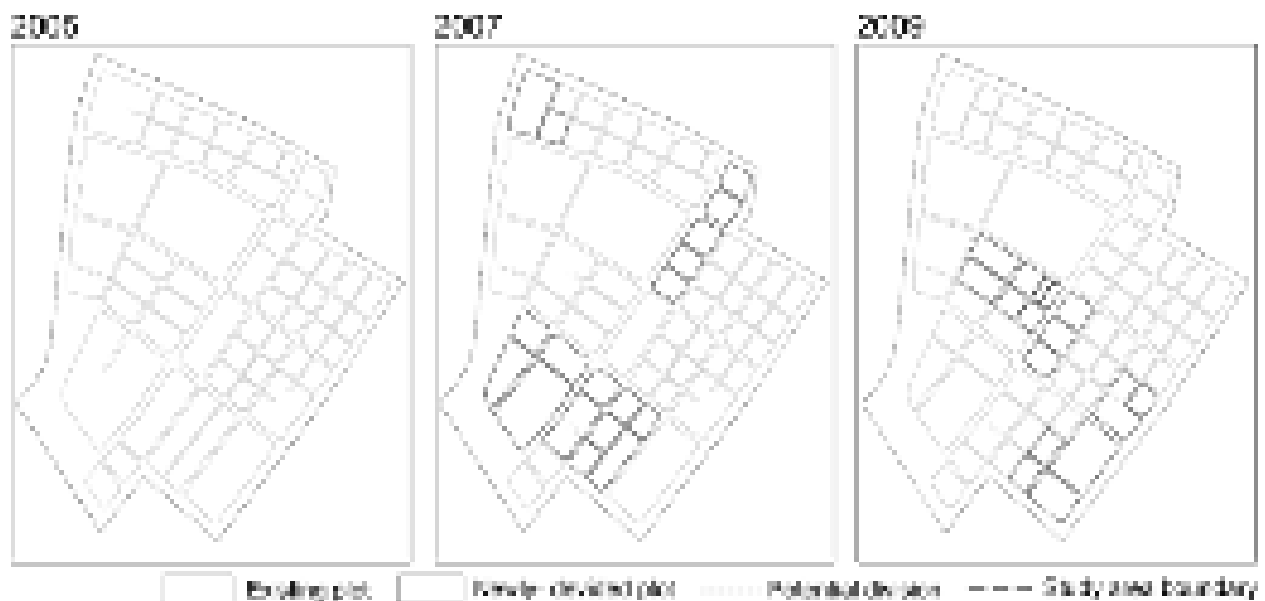


Figure 8. Plot division process.



Figure 9. Changes in the total number of plots(A), and distribution of changed plots in various functional categories (B).

area. Following on that, plot 1-2, which also belonged to residential land, was transferred out in October 2007, then started building in 2010 and was separated from plot 1-3. This reflects that the division of residential plots partly relies on the land transfer sequence, since it is not necessary to complete the division at one time when the ownerships are not clear.

The division of commercial plots was concentrated on the “Commercial Axis” – the list of plots adjacent to the east of Olympic Center. The axis consists of two construction phases in our study boundary, the part in the north of Hexi Avenue was planned as phase I and the one in the south was phase II. The construction of the projects in phase I started ahead of the further division of the plots, in the contrast, for the second phase, plots division generally went before the construction. The reason led to this difference roots in the economic pattern changes, also political and cultural intentions.

In preparation for the upcoming national games in 2005, the supporting facilities around the main venue-Nanjing Olympic Center, went all out to speed up construction. The first phase of the CBD, adjacent to the stadium in the west, was of great importance to present a glorious image of the new zone, so its construction process was vigorously promoted. The media once reported, “Sixteen high-rise buildings in Hexi CBD are being built at the rate of one storey within three days”, and addressed this high efficiency as “Hexi speed”. In this atmosphere, the construction of buildings was prior to the branch roads among the plots, since these roads need not be put into use by the National Games, while the high-rise commercial buildings need to be erected to display a better urban landscape to the whole country.

Similar to the construction background of phase I, phase II was also promoted by an important city event- the 2nd Youth Olympic Games held in 2014. After Nanjing’s successful bid in 2010, the construction of major projects of phase II was accelerated to meet the upcoming Olympic event. Different from phase I’s strategy of “buildings come first and industries are introduced later”, phase II aims at the simultaneous promotion of construction and industry, so as to achieve the higher positioning and better project quality than phase I (Nanjing Daily, 2011). With the golden decade of Chinese real estate, the commercial value of Hexi has greatly increased by then, which can be seen from the rise of average new house price in Hexi (Figure 11). On the basis of economic accumulation beyond original expectations, Hexi CBD elevated its positioning to “a high-standard financial center”. Actually, most plots of phase II had been transferred out between 2007 to 2009, mainly to financial institutions and corporate headquarters, to enhance “headquarter economy”. In this new situation, the improvement of supporting facilities became the basic condition to attract more high-quality investments.

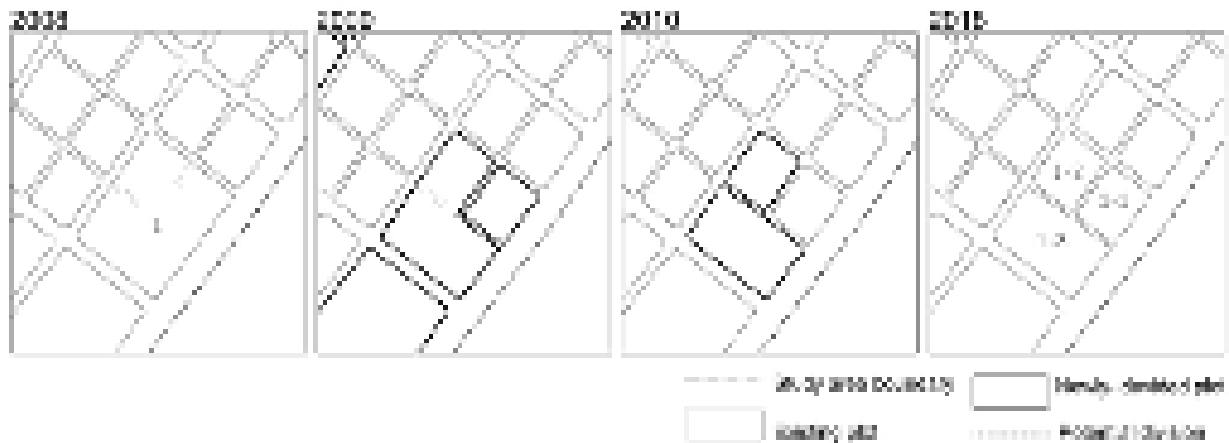


Figure 10. An example of the deviation of residential plots.

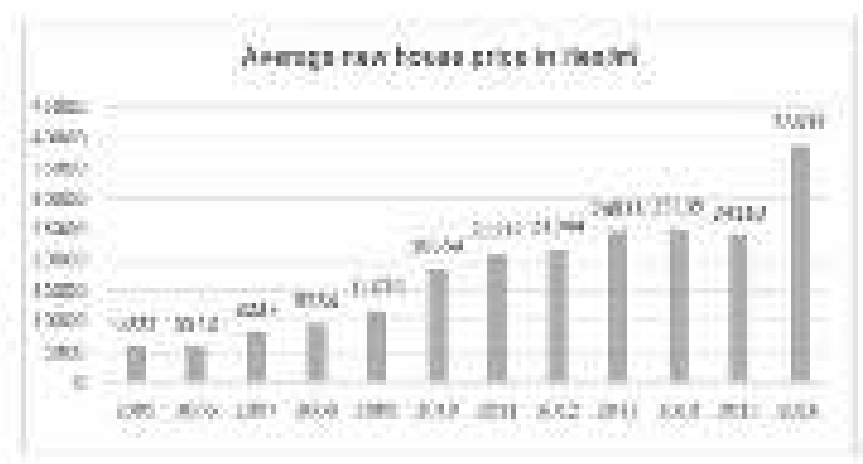


Figure 11. Changes in the average price of new house in Hexi. (Source: <https://blog.csdn.net/kwame211/article/details/86489571>)

Construction time sequence

In order to get a clearer view of the construction time sequence, the boundary of built-up area was outlined annually. The developed zone showed an overall trend of spreading from north to south, which is coincident with the original plan. More specifically, the progress can be described as three phases. In phase one, the north side surrounding the Olympic Center was developed firstly, then it jumped to the south where some large plots for public facilities followed up. In the last, the two developed regions spread out gradually into a continuous and relatively complete one.

However, in the built-up area that rapidly expanded and gradually stabilize, it should not be ignored that some plots were lagging in development, leaving some gaps, the existence of which is solid evidence to prove that the implementation of the new zone should not be easily defined as a “one-shot” process. Let’s take an example with a gap in the center of the study area, which has been left undeveloped yet until 2018. In the original planning, it was a part of the planned “Commercial Leisure Axis”, which consisted of a row of plots stretching from the west border of our study area to the east side (Figure 12). The plots within the axis were initially designed to be of relatively low floor area ratio and serve the neighborhood as a center for leisure and

entertainment. As we can see in the land use plan, the “gap” plot in our discussion was planned to be a green space with a strip of commercial land around it. Actually, it was in the early 2005 when the whole piece of land, with a specified FAR of no more than 2.5, was transferred to a Taiwanese developer, together with the two residential plots and a commercial plot in the north. However, after having been barren for more than a decade, the majority of the land was still unused except the two high-rise commercial office buildings built up respectively at the northwest and northeast corner of the plot in 2017. The media reported this stagnation in this way, “The project, which took more than a decade from land acquisition to finalizing the design, was once announced to start construction in 2010 but soon stalled. (Sohu News)”

On the satellite map of 2018, it can be seen the early stage of the construction has started. When the author went on a field investigation there in April 2019, a large-scale urban complex, which was seen just start from scratch on the satellite map of 2018, was about to be completed (Figure 13). Only a month after, by the paper was finished, the complex ushered in its opening ceremony. What happened during the 12 years in between was supposedly a negotiation between the developer and the government. On the one hand, the developer deliberately slowed down the pace of development to earn a premium by hoarding the land. It also negotiated with the authority to make changes of the original planning, for example to raise the planned FAR. This can be easily tell from the final implemented plan – with a construction volume of 0.73 kilo squaremeters in total, including four commercial office buildings over 100 meters, the actual FAR reaches around 8.5, which is much higher than the initially planned figure. On the other hand, the government realized, in all probability, that low FAR is not suitable for presenting the image of the business center, and more importantly, they could not achieve break-even by selling the land at a low price. The increase of FAR can bring supplementary land revenue to the government and also a wider profit margin to the developer, which is a win-win situation. To sum up, what led to the phenomenon of the white space was the game between government planning and social capital needs.

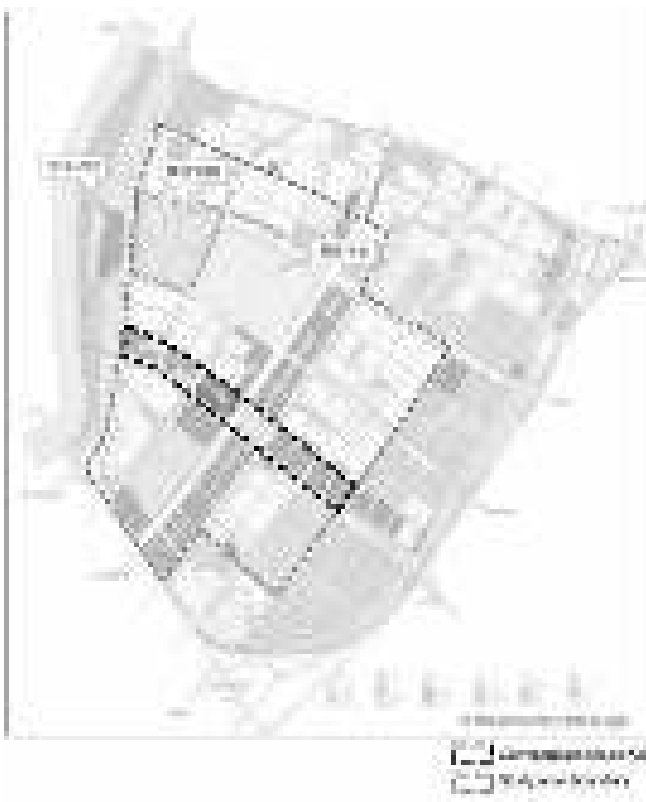


Figure 12. The “Commercial Leisure Axis” in the original land use plan of central Hexi. (Source: Analysis on the urban design of Hexi riverside center of Nanjing, Design Institute of Southeast University).



Figure 13. The recent status of the plot shot in April, 2019, a shopping mall was in construction (author's photograph).

As for the respective construction time sequence of various functional land, attention is mainly paid to residential and commercial plots, since they take the majority and impressionable. For residential areas, the overall trend of development is from the east to west, from the vicinity of the central stadium to further areas. The building sequence of commercial land also presents a similar trend in spatial distribution. Overall speaking, both residences and commercial land were developed from the places close to old city of Nanjing and the Olympic Sports Center.

Construction volume of various functional plots

The construction volume of different functional plots various. Figure 14 uncovers the changing process of the total area of built-up plots and the proportion of each functional plots takes. It is obvious that residential land always takes the lead in the proportion, and its development was relative earlier – most of the increment was concentrated in the period before 2009. Sports and cultural land has been accounting for the second largest proportion and its growth is phased. Land for neighbourhood facilities such as education & health care and commercial office show an increasing trend since 2009.

Through the separate charts showing growth rates of several major functional land-uses (Figure 15), it is easy to conclude the relationship between the construction time sequences of residence and other supporting facilities. A great volume of residences had been built by 2009, while other supporting facilities were not sufficient yet. When a sharp decline appeared in the growth rate of residence after 2009, the construction of supporting facilities such as commercial office, education and medical facilities started experiencing a considerate increase.

If we mapping the distribution of the planned residential plots and commercial plots, as well as the actual built-up ones by 2009, we can see that there were still quite a few unbuilt planned residential plots, and most commercial facilities around residence areas were undeveloped. The most possible reason that led to the distinct decrease in the residence construction could be that the developers were waiting for the improvement of the neighborhood facilities, which would definitely raise the housing prices. It is especially obvious for an upscale residential areas along the west riverside – Renheng River Bay City. The large piece of land was transferred to the developer as early as 2006, but it was not until 2009 when the first phase of the project was started. The construction of the four phases lasted for 7 years until 2014. During the period, the opening prices of the property have undergone a tremendous rise, from 16153 RMB/m² for the first phase, to the second phase of 22765 yuan, then to the third phase of 26896 yuan, and finally

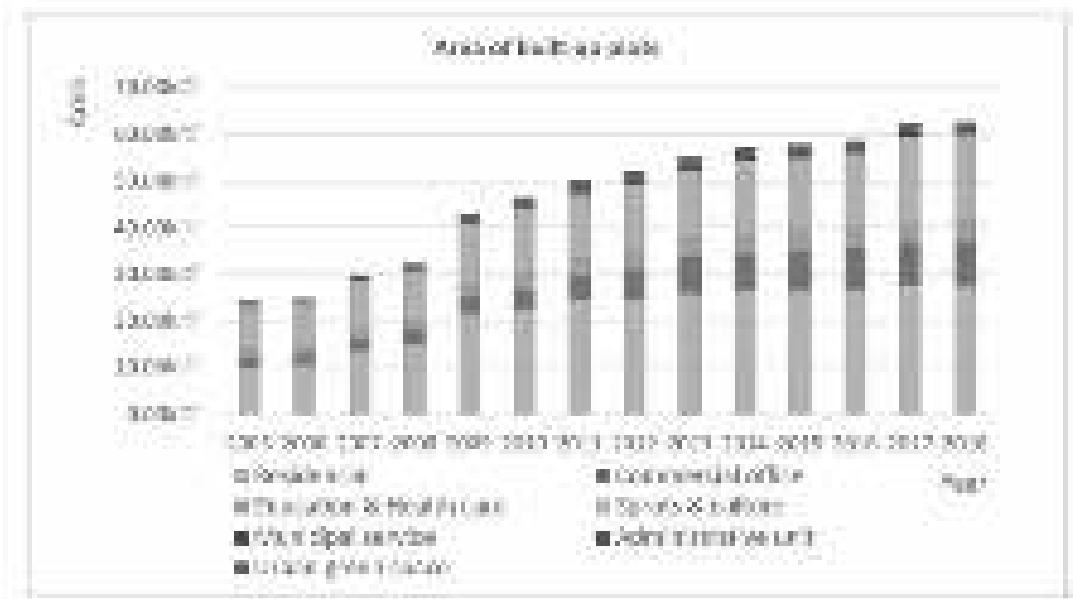


Figure 14. Area of built-up plots in various functional categories.

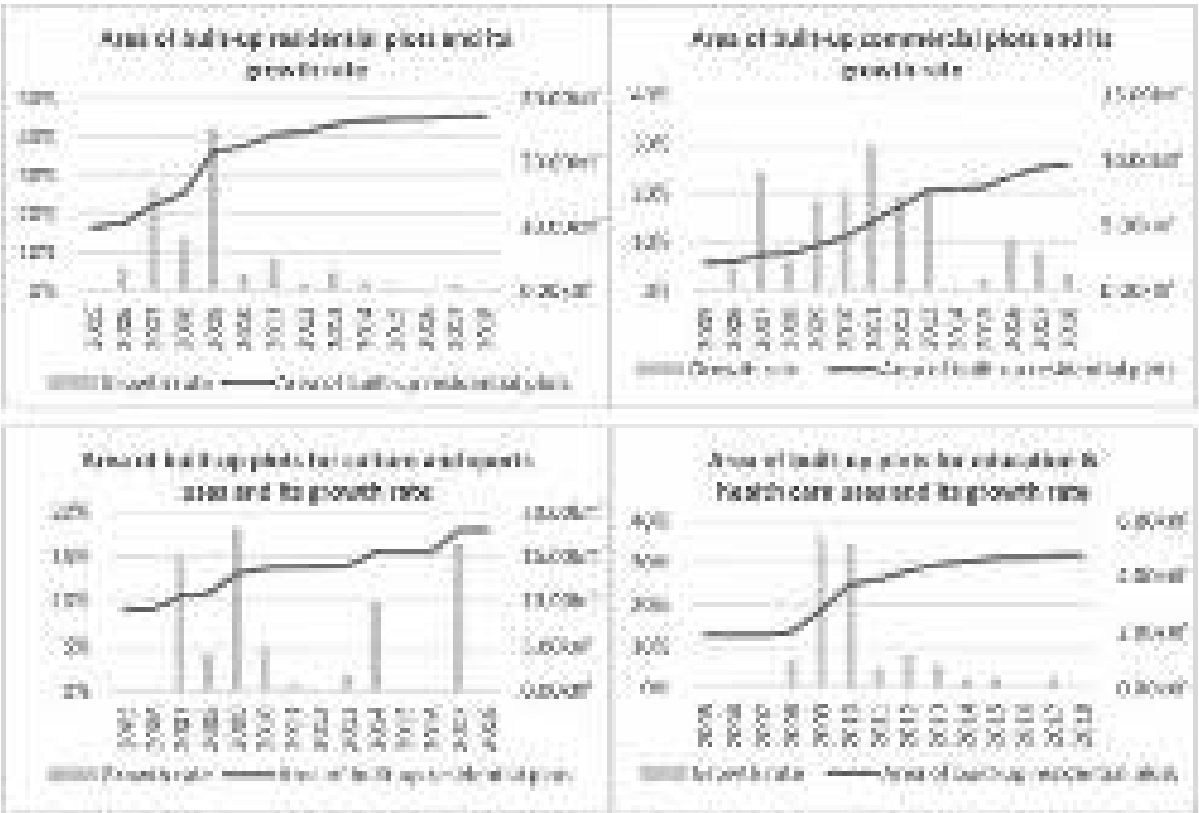


Figure 15. The respective annual growth rate of built-up residential areas and commercial land.

40340 yuan for the last one. It cannot be denied the developer's pursuit of maximum interest has affected the development process to some extent.

4.3. Buildings

In the urban planning context of China, a regulatory plan is important in controlling land rent and remise through hard rules on the capacity (mainly reflected in height and floor area ratio) and function of the land. Then at the phase of urban design, the basic plane form of each plot, including property line, fire fighting access and even the position of towers are further stipulated. Regulatory plan and urban design constitute the upper planning, which means there is no more other control to urban form from "the top". Land transfer and construction implemented under the restriction of this framework can be regarded as the operations at the "bottom", but there is still room for changes. In this case, through the analysis of the actual layout, height distribution, FAR and coverage distributions of buildings, it can be revealed to what extent the urban form of Hexi has been determined by the upper planning and influenced by the "bottom" operations. Here we chose residential buildings as a presentative object, because it is more sensitive to the market, cultural environment and other external conditions.

The layout of residential buildings

The orientation and arrangement of buildings are themselves part of urban form. The layout of residential buildings (Figure 16) shows that buildings with an angle to the streets account for the majority, at around 64%, while those parallel with the streets only takes less than 40%. The residential buildings not parallel to the road network mostly face south. This indicates the lighting requirements is more decisive in the housing orientation, instead of following the planned direction of urban road network. Indeed, the traditional Chinese dwelling culture of facing south is quite stubborn and it is rarely changed by planned road structure.

The building height distribution

Building height is mainly determined by urban design and also the developer's trade-offs of the interests, they always tend to make the best use of space within the allowed height at the least cost. It impacts people's perception of the street interface. We categorize the buildings into four intervals based on their floor numbers, which are villa /townhouse, multi-storey residence, small high-rise residence and high-rise residence. Small high-rise residential buildings take the largest proportion, approaching a half, followed by high-rise and multi-storey residence with similar figures around 20%. The villa/townhouse account for the least with a percentage of 11% (Figure 17).

The distribution of the heights of newly-built residential buildings changed each year (Figure 18). Small high-rise residence has always been a major component by 2009, while high-rise buildings took the lead from 2013. Among the three years inbetween, villa/townhouse showed a distinct rise and peaked with a percentage of 90% in 2012. Overall speaking, residential buildings tend to be higher over time, which reflects the changes in the market needs.

If mapping the height distribution of residential buildings geographically (Figure 19), we can see the few villa/ townhouses are mainly concentrated along the west river bank. The small high-rise residences, which were built relatively early among the four categories, spread out almost everywhere.



Figure 16. *The layout of residential buildings.*



Figure 17. Proportions of buildings in each height interval.

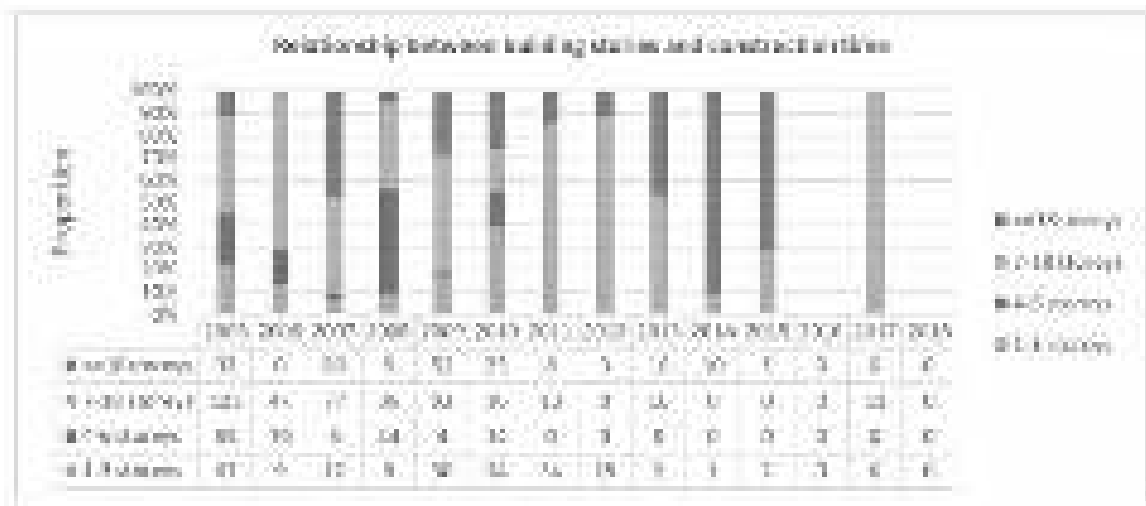


Figure 18. Relationship between building storeys and construction time.

The FAR and coverage distribution

Floor area ratio is an important dimension of urban spatial form. The number of FAR values falling within the range of 1.2-2.0 accounts for almost half (Figure 20). Considering the construction time, we note that residential areas with a relatively low FAR within the range of 1.2-2.0 were more popular by 2009 (Figure 21), and this index usually corresponds to small high-rise residential buildings not higher than 11 stories, or sometimes to buildings with 18 stories. Proportions of values in the range of 2.0-2.5 and 2.5-3.0 are very close, about a quarter respectively. The residential areas with FAR in the former interval started to become more common from 2019, while those in the latter range existed almost throughout the period. After 2007, low-density residence, which only takes apart 4% in the total amount, has become an old fashion. In general, FARs of residential land are mostly strictly in accordance with planning indicators.

When it comes to building coverage of residential areas, the leading position is taken by the value range of 10%-20%, with a proportion of more than 70% (Figure 22). Residential areas with a relative high coverage of 20%-30% account for a quarter, while there is no figure surpassing 30%. Overall, the coverage shows a declining trend over time, in contrast to the upward trend of FAR.



Figure 19. *The geographical distribution of residential building heights.*



Figure 20. Numerical distribution of FAR of residential areas

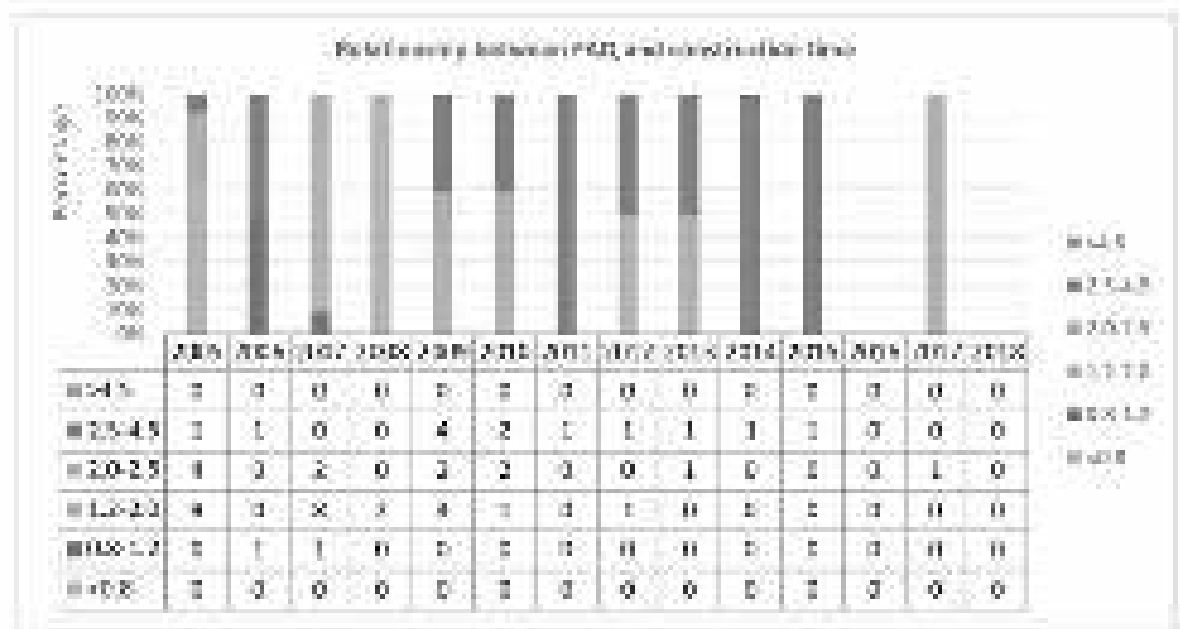


Figure 21. Relationship between FAQ and construction time

5. Discussion/Conclusion

Plot analysis has been widely applied to trace the morphological process of urban forms, but largely in the Western World, and among the limited existing studies aiming at Chinese cities, new developing zones, which play a significant role in the urbanization of the country during the past three decades, have rarely been noticed. In this study of morphological process of Hexi New Developing Zone in Nanjing, progress has been made in rectifying this deficiency. The paper also proves that Conzenian approach can also be taken for reference to the morphological study on new developing zones in China.

Catching up with the early days of Reform and Opening-up, the germination of Hexi's urbanization was firstly evoked under the influence of planned economy- the construction of the massive modernist settlement, Nanhu New Village, which served as the first step of the development in Hexi. Followed by the first introduction of the concept of "Hexi New Developing Zone"

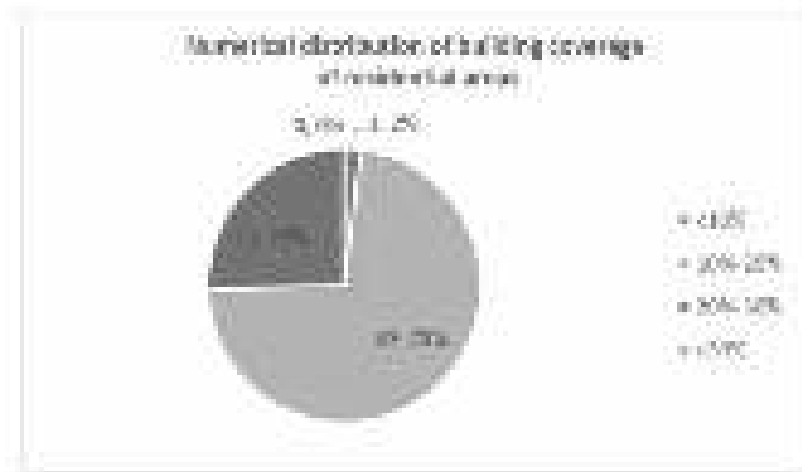


Figure 22. *Relationship between coverage and construction time.*

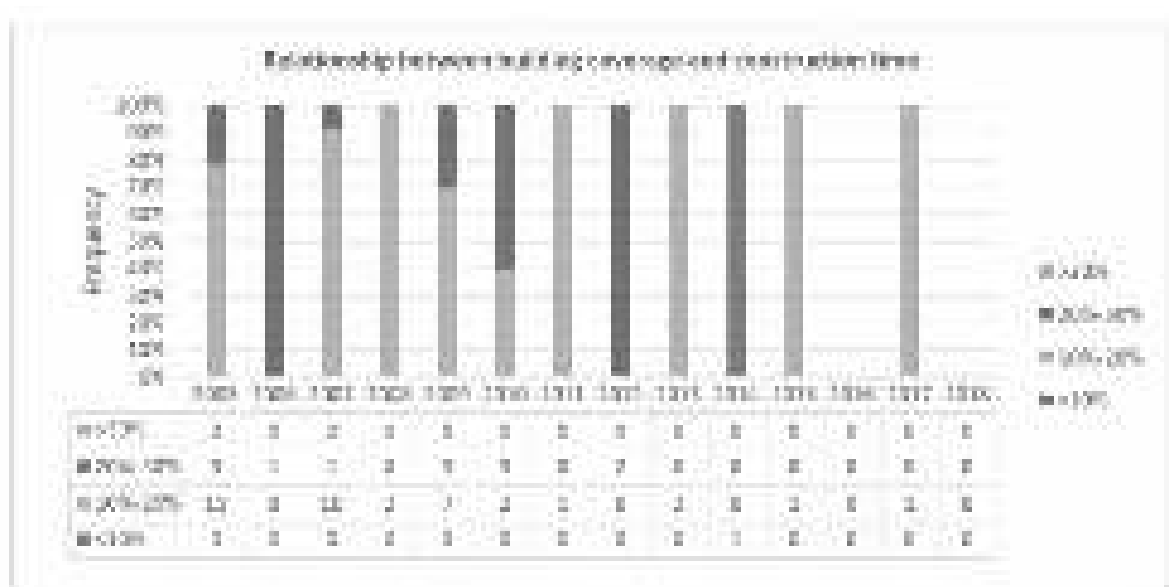


Figure 23. Relationship between coverage and construction time.

in the *Nanjing City Master Plan (1991-2010)* compiled in 1992, Hexi was positioned as a new urban area with residence as the main function, to accommodate the increasing population and people evacuated from the old city. In line with this positioning, the initial stage of the development was mainly concentrated in the construction of the vast residential areas in the north Hexi.

When we take a closer insight into the formative process of the core area, where centered with the Nanjing Olympic Sports Center, it can be seen that the urban master planning led by the government indeed determined the overall urban structure of Hexi, however, the time sequence and implementation degree of construction cannot be completely controlled by the original plan, which can actually be revised to balance the various interests. Geographically speaking, the area was developed from the places close to old city of Nanjing and the Olympic Sports Center, gradually to south. In view of time, the large-scale cultural and sports facility, Nanjing Olympic Sports Center was built first, as a catalyst for the development of surrounding areas. Then residential areas followed up on the construction to introduce households and

increase popularity of the area. The rapid growth in housing mainly occurred between 2005 and 2009, after which other supporting facilities such as commercial offices, education and medical facilities also caught up. When the development of the land for other functions was basically completed and entered a relatively stable phase, the construction of large-scale public buildings reappears, just like a final chapter echoing the opening.

Through the analysis of ground plan of the study area, the following results can be concluded. In terms of streets, the general road structure was founded by planning, while construction order of some branch roads, which were expropriated roads entrusted by the government, was largely influenced by the developers who acquired the land property. When it comes to plots, the division and land use of plots were mainly determined by planning, but the sequence of plot division and the construction cycle were influenced by the developer to a great extent, which was reflected especially in residential and commercial plots. In contrast, the interest game between social capital and government could lead to the revision of the planning to fulfill the social economic needs. In respect to buildings, with a focus on residential buildings, their layout mainly depends on the demand for sunshine and daylighting, which is inseparable from China's deep-rooted living culture. The building heights tended to increase over time, accompanied by the rise in FAR and decline in the coverage, which also indicates the growth of commercial value of Hexi.

The study has revealed that rather than a pure-government-led behavior, the morphological changing process of the new zone is driven by diverse forces as commercial values, cultural intension and social activities. Top-down planning built up the skeleton of the new zone, and the bottom-up social economic demands filled the flesh and blood of it. These interwoven forces complement each other, leading Hexi to where it is today.

6. Acknowledgements

The research was supported financially by the key project of the National Science Foundation of China on "Urban form – microclimate coupling mechanism and control" through Grant No. 51538005. Special thanks go to the teams of Professor Han Dongqing and Professor Duan Jin from Southeast University for their assistance in providing relevant design materials.

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The Evolution and Thoughts Based on Urban Form of Guangzhou

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Keywords: Urban morphology, culture hybridization, historical process, Guangzhou.

Abstract: History truly exists in every construction site, and provides a wealth of design resources for architects. The city is the working field of various forces. The evolution of the city is also closely related to economic, politics and other factors. This paper demonstrates the process of urban change from the beginning of the establishment to the present situation according to the historical processes in Guangzhou. Combined with several important points of time to analyze the various factors leading to the formation of urban typology changes. Focus on the urban changes from initial development of treaty ports, the cultural aggression and expansion after the Opium War, the economic and policy changes of Guangzhou after China's reform and opening up to the intermingling of population and culture in Guangzhou today. This paper summarizes the theoretical elements related to the urban form and the changes in the road, the composition of human beings and the urban hybrids in the historical process, which have an attempt to conceive the future urban construction.

1. Introduction

Why must culture be at the heart of sustainable urban development? City is not only the space carrier of historical culture, but also the cultural landscape of social economy. As the carrier of reflecting space of urban social life and institutional culture, the historical space pattern of ancient city is an important content of people's understanding and memory of historical and cultural city and context. Guangzhou is such a city. Here are some general information and essential data on Guangzhou.

Guangzhou, which is also called "Canton", borders the South China Sea, the Hong Kong Special Administrative region and the Macao Special Administrative region. It is China's southern gateway to the world. Guangzhou is a hilly area with a high terrain in the northeast, a low in the southwest, a mountainous area in the north and northeast, a hilly plateau in the middle and an alluvial plain in the Pearl River Delta in the south. The Pearl River, the third largest river in China, flows through Guangzhou. Due to the topography character of Canton, it has many commercial intercourses with other cities and countries.

Here is the basic data about Guangzhou population. According to the latest information on the Internet, Guangzhou's existing urban population has reached 15 million. Besides, the population in 2017 is around 14.5 million and in 2014 is around 13 million, increasing at an average annual rate of 5.1% since 2000. From 2004 to 2013, Guangzhou's household registration popu-

lation increased by 950 thousand people approximately, at an increase of 12.8%. By contrast, the number of residents in Guangzhou increased by 3.3 million, at an average of 33.8%, at the same time. What needs to mention is, there are more people without household registration in Guangzhou than those with household registration. And resulting in this situation is Guangzhou's culture, which is quite inclusive.

With regard to the spatial distribution of population density, compared with the change of population density in Guangzhou streets in 2000 and 2010, it can be seen that: Firstly, the population density is on the rise as a whole. Secondly, the number of high-density streets has not shown a downward trend, but has increased to a certain extent. Taking the street with the largest population density in the central district as the core, the law of decreasing in the outer layer is presented. Most streets have population densities of less than 2000 people per square kilometer. The population in the suburbs is growing rapidly and the density is increasing significantly, which the process of population suburbanization has been strengthened.

According to the data, the road width of Guangzhou over the past few years have no obvious change. Which reminds the concept of generic city. In Rem Koolhaas theory, the trend to globalization and generic city is inevitable to some extent. A. Smithson and P. Smithson appealed people to focus on the importance of city infrastructure. It is argued that the community should be divided in "perceptible unit" that the road constitutes the basic material infrastructure of the community. In terms of road traffic, the road width in Guangzhou has not changed significantly in this period of time, and it is no different from the average road width in other cities.

2. Methodology

The blending of different cultures in cities has become a topic of concern today. What needs to be focused is the relationship between urban morphology and hybridization of the culture especially on the invasion of foreign cultures and people in Guangzhou. Urban morphology as being continuously produced or reproduced through social practice are rooted in a given spatial context and at the same time to identify the most significant elements of the physical context in the terms of livability or inhabitability. The relationships between these elements can have a different nature, since they can express different emotions and behaviors to the space which is connected to the urban morphology and building typology. This relationship is never a deterministic one, but it is the result of a peculiar combination of multiple factors. According to the present situation of Guangzhou, different spatial configurations are generated.

Guangzhou is realizing a transition from a single-center city to a multi-center city. Guangzhou's urban space still shows a more typical single-center urban structure. From 2000 to 2010, the urban structure was centered on the central part of the city, and the population around the core presented the characteristics of a stratified distribution. Although there were a few sub-centers in 2000, their population capacity was insufficient relative to the central district, and until 2010, the population sub-centers were still not obvious. But in 2010, the population density in the central district still showed an upward trend.

By studying the spatial distribution of the present public facilities in the whole city and analyzing the common center, the Murphy index technology is used to combine three factors that the peak land price, the unit function and the traffic network, which are also define the boundary range of the present Guangzhou central district quantitatively. Furthermore, it makes clear that the central system of Guangzhou is composed of Beijing Road Central District. The ninety-three central districts which is located at upper and lower section constitute the framework of Guang-

zhou's urban center system and serve the whole city of Guangzhou. According to the data, the total land area of urban central system has reached 15.03km² and the total building area of 32.6 million m², distributed along the main city ring road to Jiefang Road, Guangzhou Avenue and Zhongshan Road, forming "two vertical and one horizontal" axis pattern.

The city is the working field of various forces. In 1973, D. Harvey proposed that it is necessary to evaluate the construction of the city from the different needs and values of different groups of people in the city, and the space must be divided into different spaces, from the point of view of political economy. The evolution of the city is closely related to economic, political and other factors. The Chinese government has established a yardstick for all cities. The most developed cities are called first-tier cities. First-tier city refers to a metropolis that plays an important role in the national political, economic and social activities and has the leading role and radiation-driven ability.

The urban axis is the product of the urban development planning and architectural design of the past dynasties. It is the symbol of urban culture formed to a certain extent, which reflects the cultural and historical heritage and changes of the city. During the long history of Guangzhou's development, the form of urban space has been changing constantly. So far, two urban centerlines, traditional axis and new axis, have been formed, carrying different urban development processes and assuming different functions.

The traditional axis is located in the central city of Guangzhou. The origin of the traditional axis can be traced back to the Qin Dynasty. Furthermore, the central axis of the node with political and historical significance is the political and cultural center in Guangzhou. The new city axis is developed after the reform and opening up, which is the product of urban planning.

Residential area is an element, is a part of urban form and closely related to the evolution and nature of the city. Residential areas themselves are made up of parts, which in turn make up the image of the city. Guangzhou is one of the fewer cities in the country that completely preserves the old urban areas. In addition, the problem of the villages in the city of Guangzhou is also prominent, and has its unique regional background and characteristics. The number of villages in Guangzhou is large, and the distribution is wide, the building density is high, and the population is large. Therefore, it is relatively complicated for the government to operate.

Besides, the historical blocks of Guangzhou generally have the defects of building aging and poor housing conditions, and the proportion of public rental housing and private housing is relatively high, and the housing forms are mainly joint low-row houses and ordinary multi-story houses. Secondly, aboriginal people leaving and ageing phenomenon prominent. The resident population in this block is moving out and the transient population is on the increase. The composition of resident is diversified and the service demand scope is larger. Thirdly, infrastructure and supporting facilities are imperfect. There is a lack of greening in many places and there is little room for activity. Finally yet importantly, traditional wholesale industry and modern life pump can be well integrated. According to the map and the corresponding data, it can be seen that there are more shops in the old city, but the economic contribution is less.

3. Analysis/Results

When put the spotlight into the Canton's Urban Development Time Point, some highlight upgrades have been showed. China is a country with a long history, and Guangzhou is the city that has existed from thousands of years ago, so it is very important to understand the history of Guangzhou. The following is a schedule of developments and related plans based on various types of information. The timeline will be based on the history of the Chinese dynasty. The

early days of Guangzhou's urban development were in ancient China. In addition, each dynasty has the phenomenon of intermingling and correcting each other.

Canton have the best-preserved, earliest and largest ancient sluice site in the world. The Sui and Tang dynasties were the flourishing period of Kaiyuan in Guangzhou. As a result, great construction, opening of canals, building palaces, and connecting traffic between the north and the south have become an indelible feat in history. Interestingly, some of these ancient canals have been preserved and become the urban texture of Guangzhou today. They are not only to defend against the enemy, but also to defend against the flood, in order to facilitate the discharge of accumulated water and waterlogging, the wall must also set up water closing gates.

At the highlight of the Tang Dynasty, Guangzhou has become one of the three major commercial cities in the country. At the heyday of the Tang Dynasty, Guangzhou had become one of the three largest commercial cities in China (the other two were Yangzhou and Bianliang). With the development of foreign trade, many people moved to Guangzhou. The city of Tang Dynasty is flourishing day by day, the population is large, the scope of the city has already broken through the idle of the city wall, and we can see the general scope and the form of the city of the Tang City. The city wall of Guangzhou in Tang Dynasty is very small, the city form has formed the layout form of sitting north to the south, forming a central axis of north and south, thus laying the foundation for the building of NanHan dynasty.

The second upgrade is the form of treaty port. Guangzhou was the only seaborne foreign trade port in the Qing Dynasty. The monopoly of foreign trade was named by the Qing government as the "Thirteenth Bank", or "Foreign Bank". With the continuous growth of the export trade volume of the Thirteen Banks, Guangzhou became the center of foreign trade in the Qing Dynasty.

The third upgrade is in China's reform and opening up. Since 1975, the Chinese government has carried out a series of measures to promote reform and opening up. Guangzhou, as the first city to be reformed, has been extensively developed. Therefore, the development during this period was mainly oriented towards political reasons.

History truly exists in every construction site, and provides a wealth of design resources for architects. Thus, the following is from the holistic perspective to introduce Canton. The city is the working field of various forces. The evolution of the city is also closely related to economic, politics and other factors. The following demonstrates the process of urban change from the beginning of the establishment to the present situation according to the historical processes in Guangzhou. Combined with several important points of time to analyse the various factors leading to the formation of urban typology changes. Focus on the urban changes from initial development of treaty ports, the cultural aggression and expansion after the Opium War, the economic and policy changes of Guangzhou after China's reform and opening up to the intermingling of population and culture in Guangzhou today. This paper summarizes the theoretical elements related to the urban form and the changes in the road, the composition of human beings and the urban hybrids in the historical process, which have an attempt to conceive the future urban construction. The following will highlight developments and changes in urban planning in Guangzhou, which is connected with the urban morphology and building typology coinstantaneous.

Shameen Canton is the product of this era. Guangzhou has signed two unequal treaties and then was colonized by France and Britain. Among the unequal treaties of the Qing Dynasty in China, Nanjing Treaty and Guangzhou Bay Concession Treaty is connected to Guangzhou, opening Guangzhou as a Trade Port, which attributed to the development of economy. As the seat of colonial power and the center of political-military activities in Guangzhou from 19th to

20th century, the Shameen Consulate region has a history that began with the delineation. The British government made urban planning here. A 15-foot-wide central thoroughfare extended from east to west. Parallel to this central avenue, there is a 6-foot wide road between the north and the south. Vertically, these roads are set up with several 3-meter roads to form a primary and secondary chessboard road network, which divides the sand surface into 12 regular zones. Britain occupies four-fifth of the land; France occupies 1/5 of the land. In the existing consulate building in Shameen, the United Kingdom, the United States, Germany, Russia and France stand out, not only because they played an important role in the recent history of China, but also because the consulates of these countries were built earlier and of higher quality. After a hundred years, more than 10 countries have set up consulates, foreign banks in Shameen, which witnessed the change of Guangzhou's Modern History.

Three cities pattern. The culture bleeding was obvious in Song dynasty from the ancient China first time. Due to the destruction of the wall during the Southern Han Dynasty, the Northern Song Dynasty was built, and then Guangzhou formed the spatial pattern around the triple city wall. The Song Dynasty was a connecting stage for Guangzhou. After the Southern Han Dynasty, the middle region of the north was still regarded as the political center. The commercial districts in the west and along the Yangtze River were consolidated, and the style of the city was greatly improved, and the characteristics of opening and popularizing were presented to promote the formation of the unique culture of Guangzhou. The three cities are Xicehng, Zicehng, Dongcheng. Xicehng is the major commercial district. Zicheng is built on a previous basis. Dongcheng is for the Palace people's residential and scenic area.

City wall is an important feature of the development of ancient Chinese cities and records the changes of a city. At the beginning of the Northern Song Dynasty, the city walls of Guangzhou were built from the Tang Dynasty to other five dynasties. As a result of many wars and hurricanes, the wall has been ruined, defenseless. The city wall of the Song Dynasty occupies a very important position in the history of Guangzhou's urban construction, not only because it created the city wall pattern of the three cities of east, middle and west, but also because of the large-scale expansion of the city area. What is more, the city wall of Song Dynasty was the beginning of the transformation of the wall of Guangzhou into a brick wall. The project is fairly solid. From the morphological point of view, the city wall in song dynasty can be summarized as the following characteristics.

Firstly, the function of the three cities is clear. This pattern continued until the Ming and Qing dynasties. The main functions of the three cities are politics, economy and houses respectively.

Secondly, planning facilities are more perfect. It can be summed up from the drawings that the street layout T-shaped, the largest area of the city for the commercial ship area, a well-shaped. Urban water supply and sewerage systems continue to play an important role in the period of the Republic of China. Thirdly, the material of city wall is transformed from soil into brick, and the city wall project is spectacular.

By the end of the Qing Dynasty, due to the weakness of the rulers and the policy of closing the country, China was repeatedly invaded by foreign powers. The first Opium War and the Second Opium War stagnated China's development, leading to changes in many cities, so as Canton. The first Opium War was launched jointly by Britain and France with the support of Russia and the United States. In order to further open up the Chinese market and expand the interests of aggression in China. The Qing government signed a series of unequal treaties with Britain. Among them, Nanjing Treaty opened five Chinese cities as ports of trade. At 1757,

the Qing government closed other customs and kept Guangzhou as the only treaty port. Thus, Guangzhou has been developed partly and Shameen Island has established.

When comes to the Anti-Japanese War and Civil War, years of internal and external wars have destroyed the development of urban space. In 1932, the Guangzhou government released the first official document in the history of Guangzhou city planning. In this document, the overall layout divides the city into four functional areas, industrial residential, commercial and mixed. Therefore, the internal forms of urban space are also gradually changing, showing a regional, diversified development trend, diversification development represents the basic characteristics of the overall urban spatial form in modern Guangzhou. The modern urban spatial structure of Guangzhou is roughly composed of the old city, the administrative center, the new commercial space and other collages. During the War of Resistance against Japan, Guangzhou was destroyed and the development of the city entered a period of retrogression and stagnation.

After the founding of People's Republic of China, Guangzhou began a modern urban planning attempt. All these are closely related to the evolution of the national system Beijing, and can be divided into three stages, taking the founding of the People's Republic of China and the reform and opening up as the demarcation points.

4. The period of the Republic of China: the attempt of Modern Urban Planning

When comes to the period of the Republic of China, it is an attempt of Modern Urban Planning. The 1932 draft outline is considered to be the first systematic and comprehensive master plan in the history of Guangzhou planning. From the drawing, we can know that this is only the road system designed by the city government at that time, not the road determined by the final field visit. It can be seen from the map that each road in Guangzhou is designed to form a grid. The planned road has been extended to Tianhe, the west of Fangcun and the whole island of Zhuhai. In 1932, the South China Sea and Panyu counties were successively moved to Foshan, newly built, and officially assigned to the jurisdiction of Guangzhou. Another drawing detailed description of the city's main streets and roads in 1932 is shown in Guangzhou, with yellow markings on roads built and red on roads that have not been built. It can be seen that at the beginning of the Republic of China, the roads built in Guangzhou were mainly concentrated in the old urban areas, and the streets in the city were expanded in the late Qing Dynasty. The planned new roads were mainly concentrated in Dongshan and Henan areas. It shows that Dongshan and Henan are the main developing regions in this period.

However, because of a lot of social resistance, part of the draft cannot be put into practice. Although most of the draft has not been effectively implemented due to the war and political turmoil, it still laid the foundation of Guangzhou's modern city and promoted Guangzhou from ancient city to modern city.

5. From the Founding of the People's Republic of China to the Reform and opening up: planning based on the layout of Industry and Infrastructure

From the Founding of the People's Republic of China to the Reform and opening up, the planning is based on the layout of Industry and Infrastructure. During this period, Guangzhou put forward corresponding planning targets around the national policy of urban construction at that time. Gradually change Guangzhou from a consumer city to a socialist production city.

Therefore, the planning scheme of Guangzhou in this period also presents the characteristics of service for production. From the urban layout, industrial land as the most important spatial elements. At the same time, considering the political reasons, the industrial zone should be distributed according to the principle of decentralization to ensure the safety of the city.

In conclusion, during this period, the political factor is playing an important role. And industrial projects, infrastructure and other spatial layout location have been designed during this time. However, as a result, many of the planning drafts were ultimately reduced to the tools needed to influence the political situation and were of little practical use.

6. Reform and opening up to the early 1990s: turning to Comprehensive cities

At the period of reforming and opening up to the early 1990s, Canton has turned to Comprehensive cities (China reform and opening up in December 1978). Under the influence of political and economic construction, Guangzhou's urban function changes from production to life and from industrial city to comprehensive city. Transformation of urban structure from single-center expansion based on the old city to zonal cluster pattern

After 1990s, Guangzhou has been steady developed. Due to the political changes in Guangzhou, Guangzhou began to develop slowly during this period. After this, Guangzhou government controls planning gradually, at present Guangzhou maintains stable development.

Furthermore, during this timescale, the Inflow and outflow of population need to be mentioned. Due to historical and geographical factors, Guangzhou attracted a large number of people from other countries to settle here. As a window of foreign trade, Guangzhou is called the third World Capital.

For economic reasons in the Pearl River Delta, many people who run small businesses come here, of whom there is a certain proportion of black people. When talking about the gathering place, it also has the unique feature. A WikiLeaks file in 2008 shows that the municipal authorities in Guangzhou are worried about the existence of black people. There is also a view that the black in speech will be excessive harassment to women in Guangzhou.

Compared with Beijing and Shanghai, Guangzhou is not the earliest development in the history of the city. But Guangzhou has an innate advantage in business. From the Song Dynasty to the Qing Dynasty, Guangzhou has been the center of China's foreign trade since ancient times. In the Qing Dynasty, the four customs offices of Guangzhou, Zhangzhou, Ningbo and Yantai were opened to trade with Western businessmen. However, the only open port is Guangzhou. Guangzhou has the policy of trade monopoly position, also gave birth to the "Thirteen HANG" such as government-business organizations. As a result, chambers of commerce have been promoted to promote the development of Guangzhou.

7. Discussion/Conclusion

Which influencing factors of Urban Spatial form can be summarized into four factors.

Firstly, planning factors. The construction of urban spatial form can be divided into "planning construction mode" and "organic growth mode". The former is the artificial molding and unified planning of the city shape. The latter has no unified planning thinking, but under the influence of many factors, it spontaneously develops in a reasonable direction. Talking about the development of the ancient city of Guangzhou, because it was the political center of the

feudal centralized government, the city layout of Guangzhou was special in the form of prefectures. However, Guangzhou was located in a remote area and foreign trade port play an important role at that time. Thus, the influence of economy on Guangzhou is greater than that of politics. Besides, the government did not attach much importance to the construction of the city and city in Guangzhou. The development of the Guangzhou is in a natural pattern. Guangzhou has become the capital of the local government three times in the history. Guangzhou became a commercial city comparable to other famous cities in Nanyue dynasty. The construction of the capital city of the Southern Han Dynasty broke the pattern of the Canton in the past, which continued to this day. In these two dynasties, the control of planning thought is embodied.

Secondly, economic factors. Due to the input of foreign power, the development of Guangzhou's Modern Urban form presents the phenomenon of cultural hybridization. According to the planning bureau, the modern urban form of Guangzhou is based on the principle of functional zoning, which including old urban areas, central districts, industrial zones, residential areas, etc. and has a growing momentum.

Thirdly, environment factors. Urban form is the comprehensive expression of both the material shape and the cultural connotation of the city as a whole. Guangzhou is a city of mountains and rivers since ancient times. In the course of modern Canton development, the main urban area was connected to the Dongshan area in the east direction, the binuclear development in the west direction and the Xiguan area, and the extension to the Henan area in the south, and the natural barrier effect in the north due to the Yuexiushan Mountains. Under the condition of modern technology, it is difficult to break through the mountain barrier and expand the urban space to the north. In the southwest of the city, the Shang Guan area was expanded and a



Figure 1. Timescale of Guangzhou.
(Draw by the author)

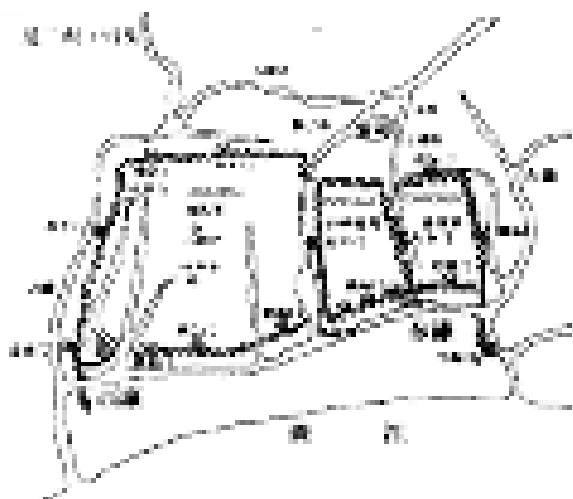


Figure 2. Map of Guangzhou in Song Dynasty
(Wang Yuan, Wang Jiangang, Cui Haiying, *The historic characteristic and evolution of Guangzhou urban form*, 2001).

new embankment was built. The Pearl River became narrower through the waterway of Guangzhou City, and the urban space was also expanded.

In 1933, the Huizhou Bridge was opened, and the development of the urban area broke through the Pearl River barrier. The old urban area and Henan area break through the Pearl River constraint and present the characteristics of continuous development. It can be seen that the change of natural environment is an important factor influencing the urban spatial evolution in modern Guangzhou.

Fourthly, political factors. As one of the ports of modern Guangzhou, with the overlapping of modern political power and political turbulence, the development of urban space was greatly affected by politics. Founded in the early Qing Dynasty, it was a merchant association that operated all the Chinese and Western trade in Guangzhou in the early Qing Dynasty. During the Nanhan dynasty, in order to embody the dignity of imperial power, the city adopts a symmetrical layout. After the decline of the “Thirteen Shops”, the eighteen monks who were founded in the Ming Dynasty flourished again, especially after the second Opium War. When the Shameen were opened up as concessions, this area was used as the pivot for Guangzhou’s external traffic. For a while, commerce flourished. During the timescale from 1920 to 1930, Guangzhou was in the period of peace construction, and the urban construction had entered a period of rapid development, and the space was also characterized by homogeneous development in different directions. In the late modern period, Guangzhou was occupied by the Japanese army, the government was busy resisting the Japanese invasion, and then was affected by the civil war. The urban construction entered the period of stagnation and restoration, but the overall change was not much.



Figure 3. Ancient maritime Silk Road (138B.C.-119B.C.), (http://blog.sina.com.cn/s/blog_406290f50102yae8.html)

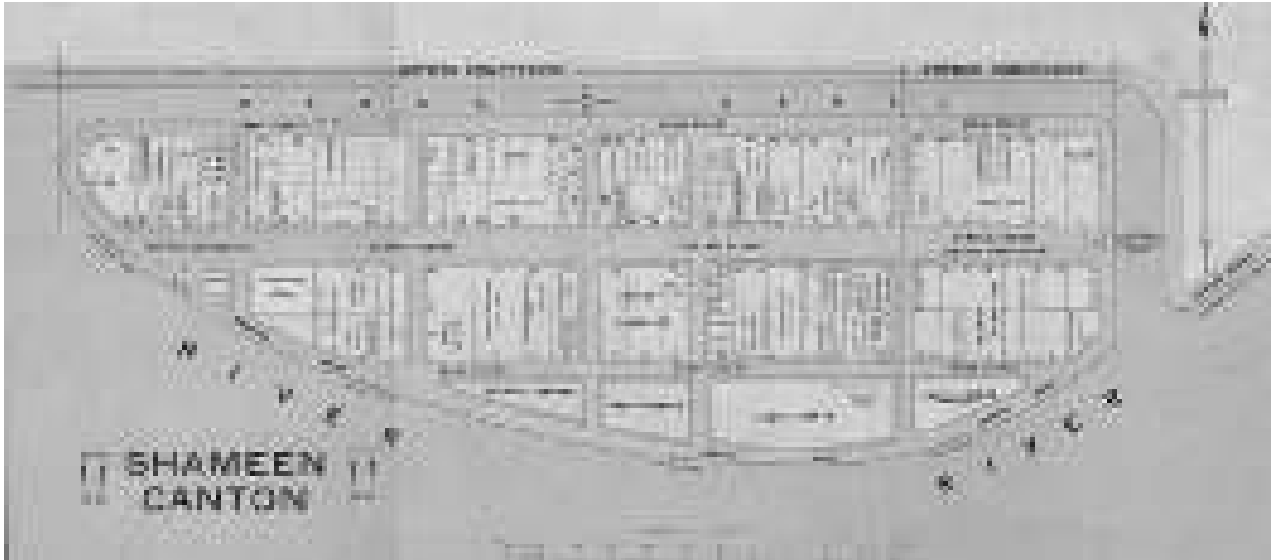


Figure 4. SHAMEEN CANTON, 1910.
(http://blog.sina.com.cn/s/blog_406290f50102w976.html)

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Typo-Morphology of Transportation

Looking at Historical Development and Multimodal Futures of Swedish Streets and Roads

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Keywords: typo-morphology, urban design, streets, transportation, multimodality.

Abstract: This paper is a part of a book on historical development and envisioning streets multimodal futures of Swedish streets and roads. It discusses typo-morphological methodology to study streets, roads and streets layouts. It looks in the history of Swedish cities to analyze types of streets and roads and proposes futuristic (scenarios) for the typical Swedish streets and roads considering new trends towards multimodal transportation (a mix of walking, cycling and public transportation) and new transport technologies such as self-propelled cars and carpools. Swedish morphologists have classified streets according to historical periods. There is also international research about historical street development and types. Currently new planning trends and new patterns of mobility are emerging such as energy efficient mobilities (walking and cycling), shared automobiles and bicycles, hybrid and electric cars and self-driving vehicles. These new transportation technologies will change the way in which streets and roads are designed in the future. Urban morphology can help with conceptualizing typologies and design elements in a context of morphologically informed design.

1. Introduction

Sustainable mobility is a new paradigm to understand the complex link between transportation systems and cities, mobility and society (Cervero, 1997; Marshall & Banister, 2000; Marshall, 2001; Banister, 2008; Rode *et al.*, 2017). The focus is on envisioning future sustainable cities, understanding transportation systems as human-scaled spaces and promoting multimodal transportation (sustainable mix of walking, cycling and public transportation). In a same time, technological innovations in automation, new mobility services emerge such as shared automobiles and bicycles, carpooling, hybrid and electric cars and self-driving vehicles. The sustainable mobility paradigm and new transportation technologies will change the way in which streets and roads are designed in the future.

This paper proposes and discusses a typo-morphological methodology to study streets, roads and streets layouts. The purpose is to develop historical typologies and create new visions about future multimodal roads and street design. It indirectly aims to open discussions about how to use the existing streets to facilitate walking and cycling alongside new mobility technologies (new transit systems, carpools and self-driving cars). Sustainable mobility and the process of

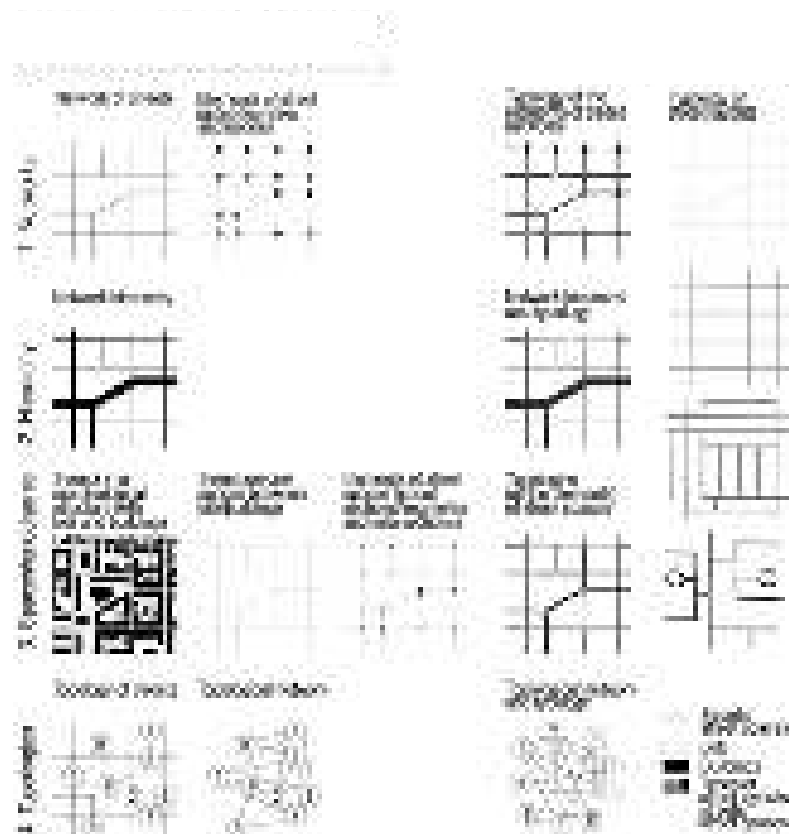


Figure 2. Streets and typomorphological representations (a. Representation of streets and creating typologies; b. typologies (typomorphological representation)).

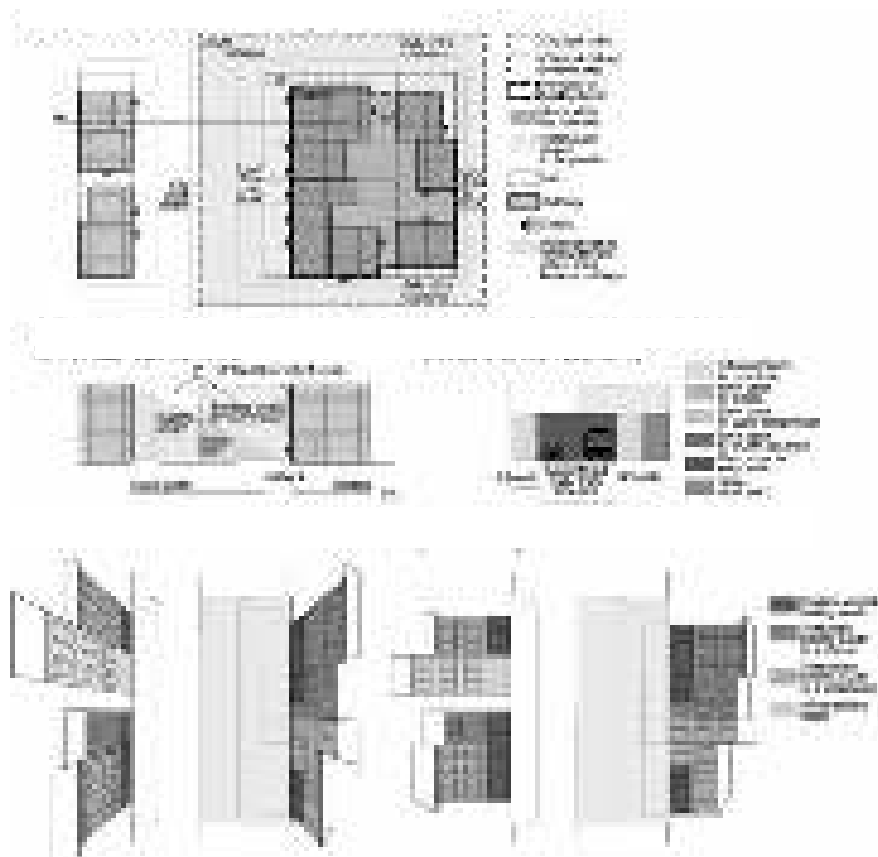


Figure 3. Street spaces and representations (a. Street space on a plan of a city block; b1. Street space as urban design elements in a street section (A-A); b2. Street section (A-A) as space with transportation elements; c1. Street space within top skewed perspective; c2. Street space within building façades (elevations)).

2.2. Technological change, development cycles and morphogenesis

Urban form and mobility are intertwined (Brotchie, 1984; Vance 1990; Brotchie *et al.*, 1995). Transportation revolutions, technological changes and visions of future mobilities (such as sustainable development) continuously shape, problematize and reshape cities (Figure 4A). This process implies continuous urban and transportation morphogenesis. There is urban morphogenetic processes is specific for every transportation technology. The transportation technologies integrate with cities through experiments, social evaluation and acceptance of transportation technologies, visioning and development of ideal urban forms (neighborhoods), construction of transportation infrastructures and establishment of mobility cultures in these communities (Vance, 1990). The garden suburbs in the 19th century could not function without railway stations and public transportation and commuting by public trains produced a unique mobility culture. A house with a garage encourages urban development that favors automobility as a mobility culture (Stojanovski, 2019). The transportation technologies create specific neighborhood types and mobility classes that support them (Figure 4B).

Cyclical changes and historical periods are crucial concepts in typo-morphology. Cities experience random development cycles of urban growth and refurbishment followed by recensions and inactivity (Hoyt, 1933; 1939; Whitehand, 1987; Whitehand & Gu, 2017). Henri Lefebvre (1996 [1968]; 2003 [1970]) further develops the cyclical changes by analyzing the process of industrialization and urbanization. He examines the evolution from the zero point (the non-existent city and the complete predominance of agrarian life) to fully realized urbanization and the absorption of the countryside by the city and the total dominance of industrial production (Lefebvre, 1996 [1968]; see also Soja 1989; Brotchie *et al.*, 1995; Graham & Marvin, 1996). The historical periods as development cycles manifest themselves through typical buildings, streets and street layouts, neighborhoods and so on that can be abstracted into typology.

2.3. Abstraction and scenario method

This paper uses abstraction methods to produce typology and a scenario method to create visions of cities with new automated vehicle systems. Typologies can be created by selecting representative examples (Goethe, 1988 [1817]; Steadman, 1979; 2014; Southworth, 2005b, Marshall & Çalişkan, 2011). Swedish typo-morphology has a long tradition (Abarkan, 2009; 2013). Urban typologies have been developed according to: architectural styles (Björk *et al.*, 1983; 2003; 2009); planning paradigm (Rådberg, 1988; Rådberg & Friberg, 1996); and social and economic development epochs (Engström *et al.*, 1988). Many municipalities (such as Stockholm and Malmö) use typologies (building types, urban development, city characteristics or city types) in comprehensive and detailed plans (SSBK, 1997; MSBK, 2001). Swedish city morphologists have also classified streets according to historical periods (Forshed, 1997; see Figure 1). There is also international research about historical street development and types (Southworth & Owens, 1993; Southworth & Ben-Joseph, 1997).

The scenario method are based on future explorations. The scenario is where automated cars will run in mixed traffic is not probable due to legislative constraints (the autopilot and its company will be always blamed for a car accident). The first future scenario assumes that the automated vehicles will be segregated. The second scenario is the convergence of private automobile and public transportation in a hybrid system of smaller on-demand vehicles or smaller vehicles that circulate on major paths and create major nodes (robo-taxis discussed by Cervero, 2017). These will require a nodes or squares/public spaces where they will load and unload pas-

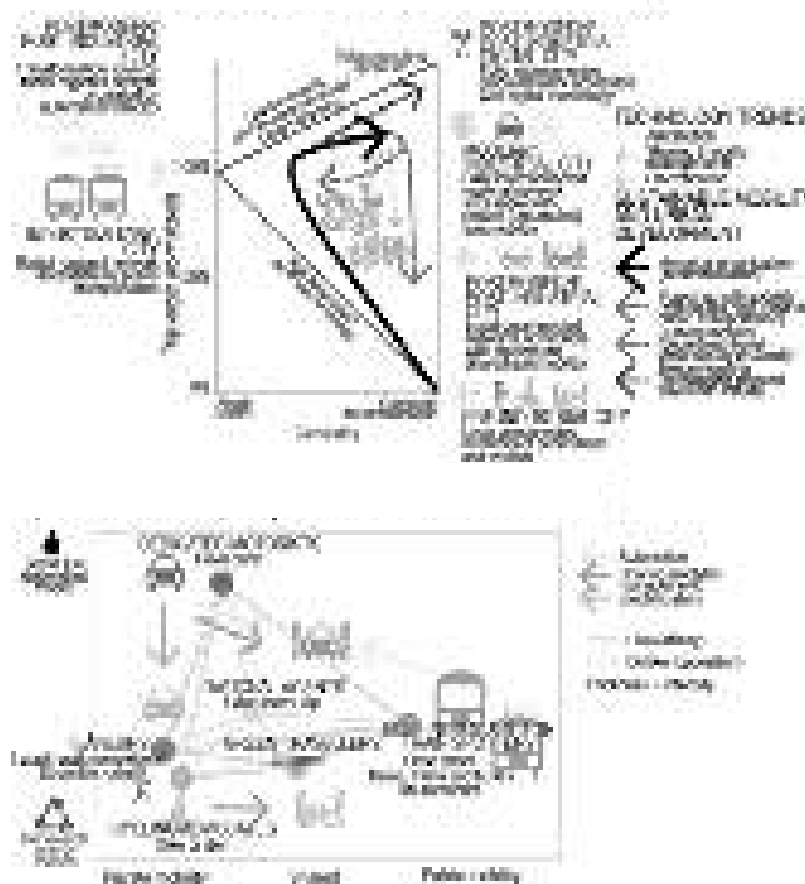


Figure 4. Technological change, transportation technologies, urban form and mobility classes in the “Brotchie triangle” (see Brotchie, 1984; Brotchie *et al.*, 1995) (a. Technological change and urban form (Brotchie, 1984); b. Technological change and new mobility cultures (Stojanovski 2018, 2019)).

sengers. The difference will be that they can travel from each node to another node at quickest speed (not system of lines as today’s public transportation). The second scenario is not used in this paper, but it will be considered in the book. In terms of spatial requirements the first and second future scenario differ little.

3. Analysis/Results

The analysis/results section shows a neighborhood typology and abstraction of street layouts and street spaces for one neighborhood type (NT5 in Figure 5). The same method will be used for other neighborhood types in the neighborhood typology presented on Figure 5. The Swedish neighborhood typology builds upon Lefebvre’s theory and previous typo-morphological classifications (Engström *et al.* 1988; Rådberg, 1988; Rådberg & Friberg, 1996; SSBK, 1997; 2000).

The Swedish streets and road followed the urbanization pattern of neighborhood types (NT). The typical traditional (preindustrial) Swedish city displays organic or rectangular street grids with wooden or stone houses organized in city blocks. The names *trästad* (wooden city, Figure 5 NT1) or *stenstad* (stone city, Figure NT2) denote these neighborhood types. The medieval cities were surrounded by villages with detached houses scattered organically in the landscape (Figure 5 NT3). These villages became urbanized with the rapid motorization in the second half of the 20th century. The industrialization produced a very dense urban core, an expansion of



Figure 5. Swedish neighborhood typology (a. Pre-industrial city (walking and carts); b. Industrialising city (cycling and transit); c. Modern/industrial city (private automobiles); d. Postmodern/post-industrial city (multimodal transportation)).

the medieval stone city (Figure 5 NT4-5). In a same time, it created an urban fringe of industrial zones, institutional (healthcare, education and so on) and sports complexes (Figure 5 NT9-10). The *trädgårdstad* or garden city (Figure 5 NT6) and its residential suburban *villastad* or neighborhood with villas (Figure 5 NT7) emerged along the first suburban railways on the end of the 19th century. The modernist movement and the welfare state inspired the biggest building boom in Sweden in the mid-20th century. The experimental early modernist apartment blocks emerged on the edges of the old cores and in the suburbs from the 1930s (Figure 5 NT11). In the 1950s the functionalist city (Figure 5C), so called ABC-city, mainstreamed. In ABC, A stands for *arbetsområde* or work areas (office parks and industrial zones), B for *bostadsområde* or residential areas with apartment blocks (Figure 5 NT14) or row houses (Figure NT17) and C for community/town centers (Figure NT13). In this period, parts of the old cores in the small or large cities were modernized (Figure 5 NT12) and transformed into office parks serving an entire region. From the 1970s a new type of residential suburbs with single detached houses (Figure 5 NT16) emerged, followed by external shopping malls (Figure 5R) and new office parks. The trend in the last two decades is to develop new postmodernist neighborhoods (Figure 5 NT 18/19) on the industrial fringes of the old cores. In the same time, the predominantly commercial old cores (Figure 5 NT12) are densified to increase the number of residents (Engström, 2008). Figure 6 shows neighborhood map and the typical street layouts in the neighborhood type NT5 on Figure 5.

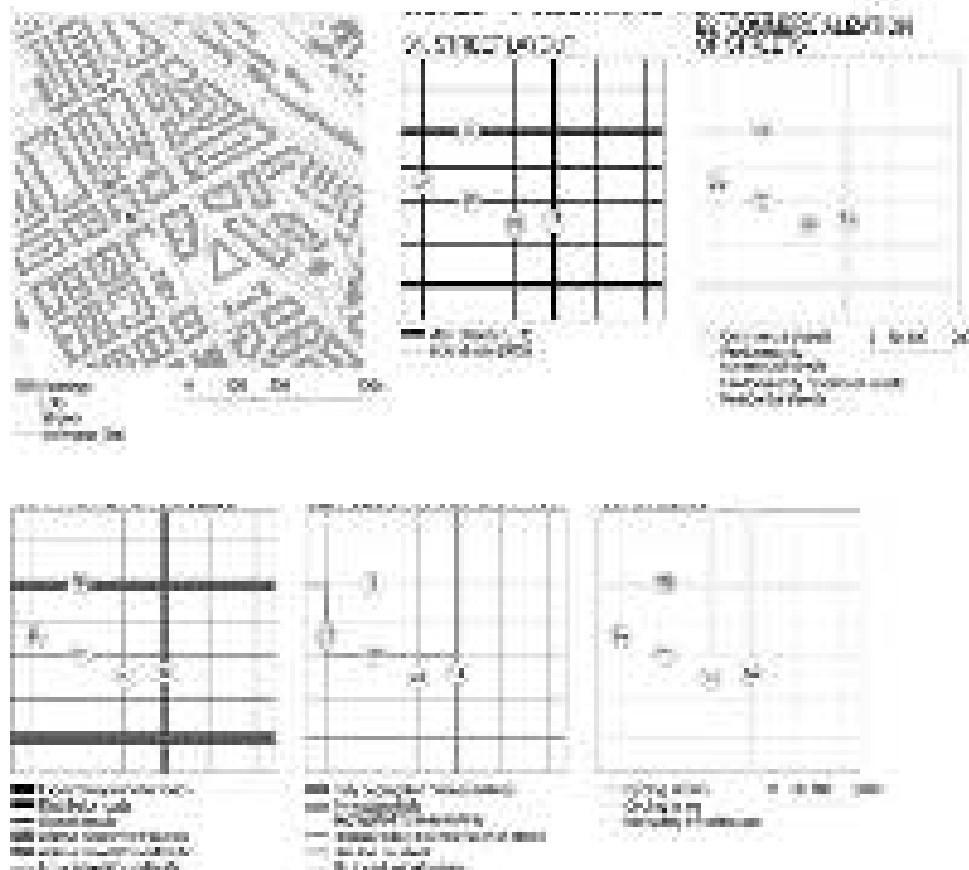


Figure 6. Typical streets in the typology (a. Map of neighborhood type nt5; b. Street typology and commercialization (b1. Street layout, b2. Commercialization of streets); c. Transportation modes (c1. Private automobile; c2. Public Transportation; c3 Cycling)).

Neighborhood type NT5 has rectangular street layout (Figure 6). The size of the city blocks is between 80 and 100 meters. The street layout with two typical streets. The main streets are 30 m whereas the side streets are 15-18 m. Figure 7 shows the variation of the typical streets in NT5.

Figure 8 shows a future scenario where segregated lanes for automated vehicles are introduced in the street layout of NT5 and in street spaces. The lanes can be introduced only on the major car arteries like Birger Jarlsgatan and side streets with mixed traffic. The segregated lanes for automated vehicles will create a parallel superblock structure. The traffic lights would need a new green field for automated vehicles. These lanes can disturb or replace the existing public transportation network. The traffic lights will also disturb the flows on existing cycling and car lanes and create new conflict points at intersections.

4. Discussion/Conclusion

This section discusses typo-morphological method to analyze streets and roads transportation systems. The transportation systems are underlying element of urban form and they cannot be separated by the typical neighborhood. Figure 5 shows a typology of neighborhoods, whereas Figure 6 abstracts underlying street layout for a specific neighborhood type (NT5) where different transportation modes circulate and create hierarchies. Figure 7 shows the typical streets

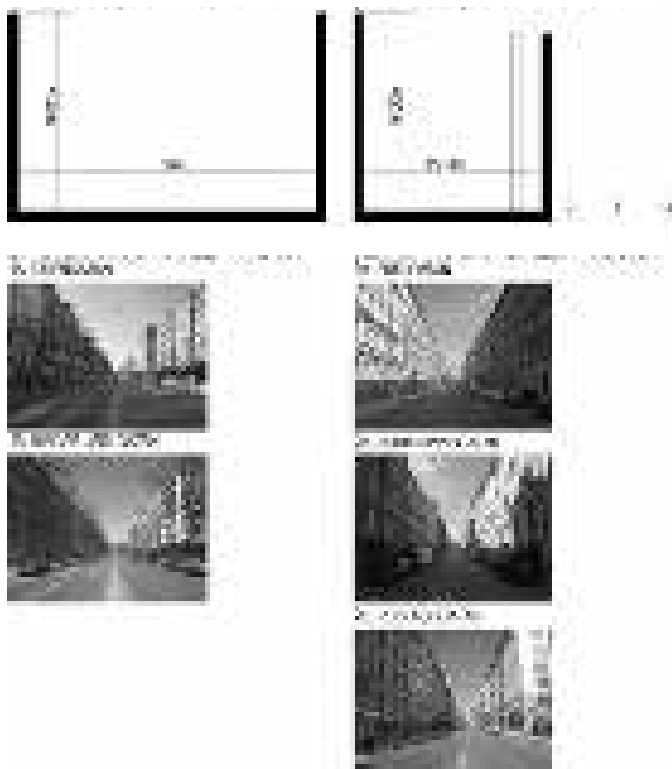


Figure 7. Typical streets in NT5 and variations (c1. Section of street type st1 (main street); c2. Section of street type st2 (side street); d1. Variations of street type st1; d2. Variations of street type st2).

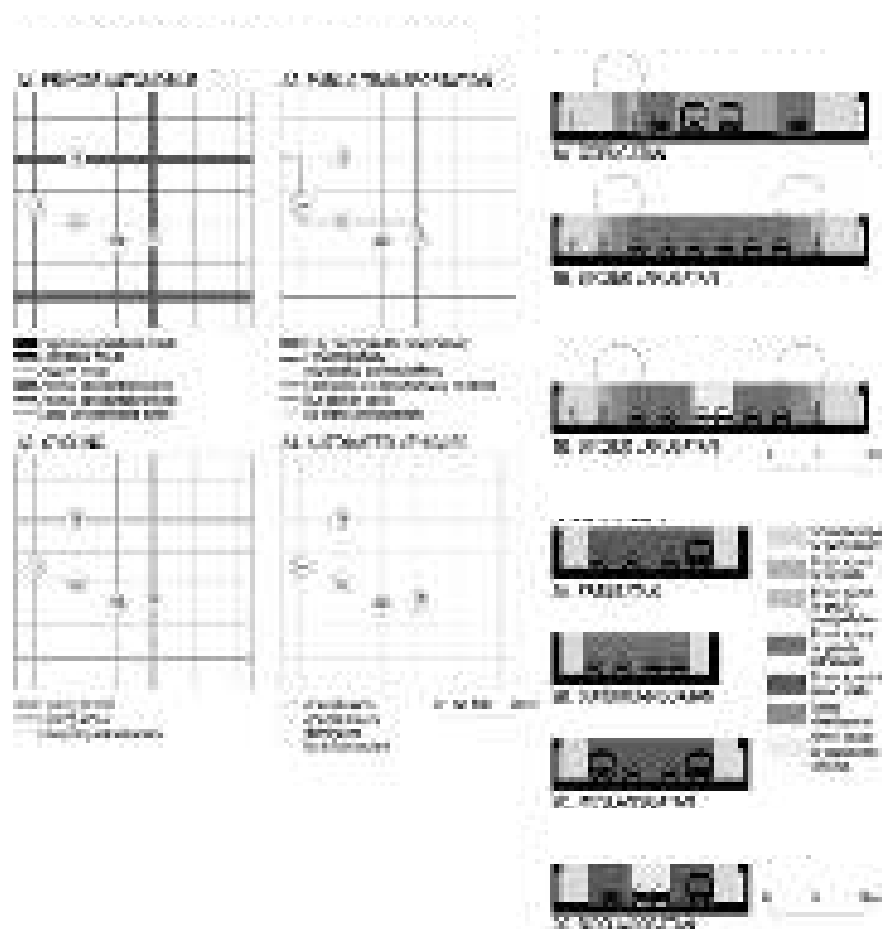


Figure 8. Future scenario of introducing lanes for automated vehicles in the street layout and street sections (a. Transportation modes in a future street layout of neighborhood type nt5 (a1. private automobile, a2. public transportation, a3. cycling, a4. automated vehicles) b1. section of street type st1 (main street), b2. Future section of street type st1 (main street); c1. Section of street type st2 (side street); c2. Future section of street type st2 (side street)).

of NT5 and its variation. This method can be applied to create street typologies of all the neighborhood types on Figure 5. This research and abstractions will be conducted in the future.

Figure 8 shows a future scenario where lanes for automated vehicles are inserted in the existing street layout and street sections for the typical streets for neighborhood type NT5. The segregated lanes for automated vehicles will create a parallel superblock structure and create disturbances in the existing public transportation, cycling and car network. This will create new conflict points at intersections that would need to be solved with traffic lights.

This paper does not show the interaction of the street with the surrounding façades (Figure 3C) that will suffer when lanes for automated vehicles are introduced. They will create barrier effects in urban space and change the interaction on the main streets. The pedestrian flows will divert towards the city block. Figure 9 shows the background images for such analysis and the future research will develop a methodology.

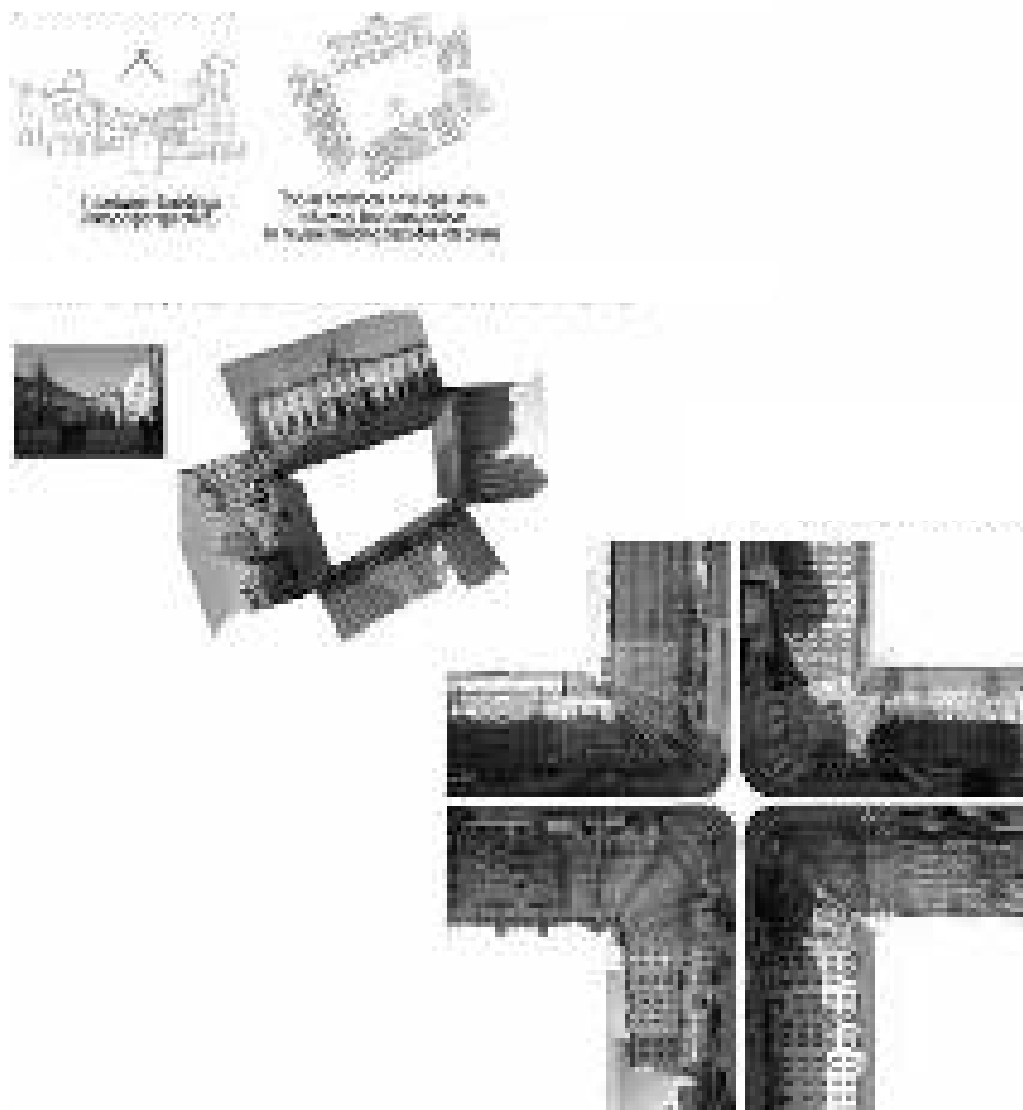


Figure 9. Analyzing street spaces and interaction between streets and building façades. (a. Conceptual representation of urban spaces/skewed top perspective in stora torget, Gamla stan, Stockholm/neighborhood type nt2 (Stojanovski; 2013;2019) b. Photographic representation of urban spaces/skewed top perspective) in stora torget, Gamla stan, Stockholm/Neighborhood type nt2; c. Photographic representation of urban spaces in birger Jarls gatan, Stockholm/neighborhood type nt2).

In the end, the process of urban design can be guided by typologies as a theory or doctrine of types (Steadman, 2014). The neighborhood types serve as points of references for designs (discussed by Schön, 1988). Neighborhood type is a combination of certain type of street, plot division, building type, building façade type and so on. The urban design processes often include various solutions (or patterns as composition of elements) and rules (see urban design experiments in Sanders & Baker, 2016). Furthermore, there are new procedural models for generation of cities. These procedural models or generative algorithms are based on creating compositions of urban elements. By classifying neighborhood typologies that consist of urban elements and characterizing them with urban form parameters (see Sanders & Woodward, 2015 for buildings and elements of buildings) it is possible to create new tools for urban design and modelling. This paper classifies neighborhood typologies with underlying street layouts, but future research would equally focus on the underlying metrics behind street layouts, interaction of urban elements in street spaces.

5. Acknowledgements

This research is supported by a scholarship from Stiftelsen Fredrik Bachmans Minnesfond and a grant from Energimyndigheten, the Swedish Energy Agency (P44455-1 or 2017-003267).

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Using Axial Analysis to Examine the Effectiveness of Reserved Road Development in Tainan City, Taiwan

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Keywords: Road-centre line, reserved road, axial analysis, local integration.

Abstract: The aim of this study is to investigate the effectiveness of reserved road construction in the city plan of Tainan using axial analysis. Tainan has a history of 400 years. Its urban fabric is an overlay of the street patterns from different periods. The post-war city plans have reserved many urban spaces for road developments, which have not been constructed for reasons such as difficulty in acquiring properties, or redundancy in the traffic networks. To investigate the necessity of these reserved road constructions, axial analysis was employed to examine the configurations of the reserved road constructions using local integration. A total of 41 reserved road sections grouped into four areas were tested in an overall analysis. The area with most reserved road sections, 15, were tested in different development scenarios to understand the best number and order for construction. The results show that the way a reserved road crosses the existing networks is the key factor for integration value improvements. The marginal measures in different development scenarios are also examined. The results provide a perspective for decision makers and practitioners to resolve the debate of reserved road constructions.

1. Introduction

Tainan has a history of 400 years and used to be the ancient capital of Taiwan. Its urban fabric is an overlay of the street patterns from different periods, i.e. Qing dynasty rule (before 1895), Japanese rule (between 1895 and 1945) and post-war periods. The modern networks of Tainan are based on Japanese rule city plans, which were designed mainly for vehicular circulation purpose (See Figure 1). As a result, the Japanese rule networks split the Qing dynasty rule networks into small sections. In addition, the vehicular based networks block the Qing dynasty pedestrian based alleys from connecting as a whole network.

The post-war city plans have reserved many urban spaces for road developments, which were supposed to complete the modern traffic networks. The roads rank higher in the hierarchy of roads such as arterials and collectors have gotten priority to be constructed. Those rank lower which have not been constructed till now are named as 'reserved roads'. In addition to low ranks in the hierarchy of roads, the reserved roads have not been constructed for decades due to difficulty in acquiring the properties. Also, these reserved roads might be redundant due to overlapping with the historical street patterns, which already provide the same connecting functions in the networks. Moreover, the mode choice options in Tainan are using scooters and walking

as a major choice in short trip. Such traffic does not need wide road and high speed and thus reduce the necessity of the reserved roads. Hence, to evaluate the effectiveness of the reserved roads construction is a crucial step to resolve this dilemma.

There are 18 reserved roads in the Tainan downtown area, and they can be divided into 41 sections (see Figure 2). All these reserved roads are categorized as local roads in the hierarchy of roads by its length, width and importance in the networks. They can be largely grouped into four areas according to the characteristics of the network patterns and distributions. Most of them are overlaid with the old constructed-road network patterns. Each area has its own characteristics, such as correlation between reserved roads, intersect angle of road sections and complexity in networks.

Space syntax is employed to examine the configurations of the reserved road constructions. This analytical method has been proposed as a new computational language to describe spatial patterns of modern cities (Hillier & Hanson, 1984). By using this method, various morphological parameters can be derived for the analysis of an urban structure, including the connectivity, control value, local and global integration (Jiang & Claramunt, 2002). Space syntax consists of many analytical techniques, in which the technique of axial analysis is used for the present study.

The axial line-based representation of an urban structure is the earliest approach of the space syntax (Hillier & Hanson, 1984). This technique is based on axial map, which constitutes the least number of longest axial lines (Hillier & Hanson, 1984). An axial line is a vista space that is small enough to be perceived from a single vantage point of view (Jiang & Claramunt, 2002), which is suitable for analyzing linear spaces system.

There are several methods to define an axial line. Batty and Rana (2004) suggested that the definition of an axial line should be broadened to include a range of differently specified sets of lines to be studied for their own interest. Axial maps based on centerlines may be more applicable than traditional axial maps (Dalton, Peponis, & Conroy-Dalton, 2003). The primal and dual representations are identical from the point of view of morphological analysis (Jiang & Claramunt, 2002). Street-based topological representations are superior to conventional axial maps via traffic prediction (Jiang & Liu, 2009). Road-centre line networks produce better correlation with observed vehicular flow than both standard axial analysis and metric distance measures

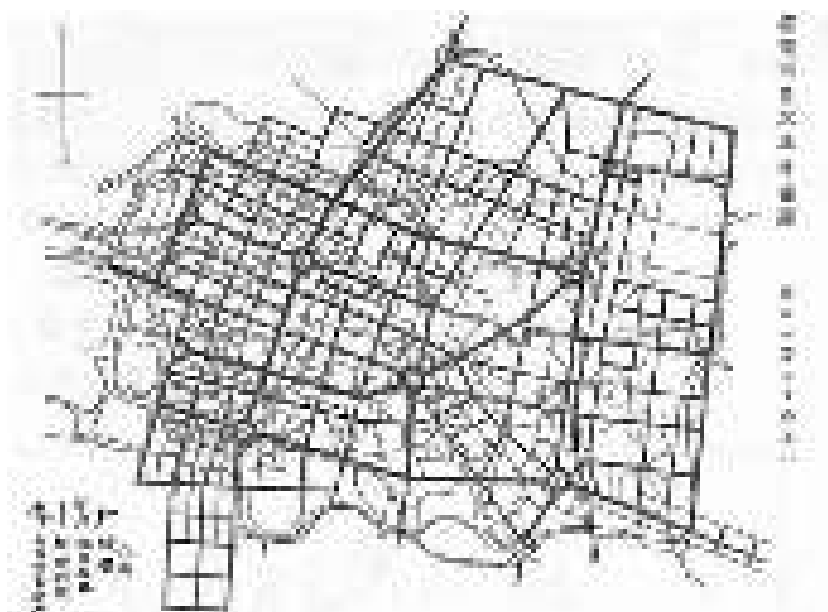


Figure 1. *Tainan Urban Plan in 1911.*
Source: *Tainan Prefecture (1911).*

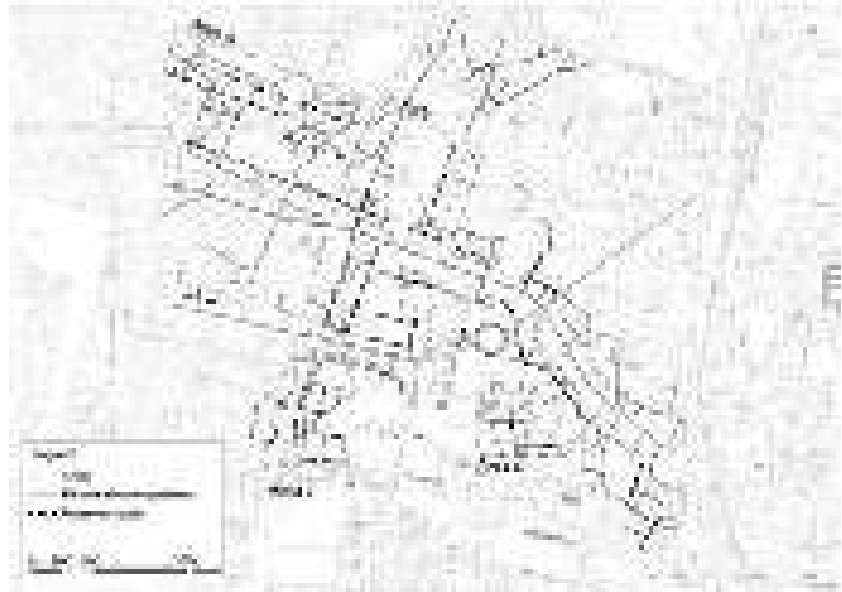


Figure 2. *Reserved road sections distribution map.*

(Turner, 2007), and thus have higher representation of vehicular networks. Hence, the present study used the road-centre line technique to construct the axial map for space syntax analysis.

This study is structured as follows: the Methodology section describes the methodology used in this research. Then, the Results section presents the results. Finally, the Conclusions and Discussions section presents the conclusion of this study.

2. Methodology

The aim of the present study is to use axial analysis to examine the effectiveness of reserved road development.

The evaluation process can be divided into two phases. First is an overall evaluation of the impact on the effectiveness of an area after all the reserved roads have constructed. Then, a subtler experiment is designed to evaluate the effectiveness improvement of the networks under different reserved road development scenarios.

2.1. Study area

The downtown of Tainan City, Taiwan was selected to be the empirical study area (see Figure 2). There are 18 reserved roads in this study area. The lengths of these reserved roads are shorter than average in the networks, ranging from 80m to 950m. These roads can be divided into 41 sections. The development of each section is evaluated independently. The reserved road sections scatter around the study area, overlaying with the historical pattern. Hence, the historical pattern would be split into smaller sections after the road constructions. This makes the evaluation of development effectiveness difficult.

2.2. Phase 1: Overall analysis

The reserved road sections in the empirical study area can be largely grouped into four areas (see Figure 2. Reserved road sections distribution map.). These areas have different character-

istics such as network patterns, intersection angles and the extent of complexity. The local integration values before and after all the reserved road sections construction are calculated. The effectiveness of reserved road sections in the four area can be compared by the improvement on the average integration value and the change rate.

2.3. Phase 2: Development scenario

An experiment for evaluating the effectiveness of reserved road construction is designed as the following process.

- Step 1: the integration value difference of the network before and after each single section construction was calculated. Given the area has n reserved road sections, a total of n integration value differences were calculated.
- Step 2: the reserved road section with maximum integration value difference was constructed.
- Step 3: under the condition of Step 2, the integration value difference of the network before and after each remaining single section construction was calculated.

Repeat Steps 2 and 3 until every reserved road section has been constructed. Hence, the marginal integration value difference of each road section can be calculated to investigate the improvement of network effectiveness under the scenarios of constructing 1 to n sections.

In the present study, Area A is chosen to demonstrate the results of effectiveness evaluation in Phase 2, as this area has the highest number, 15, of reserved road sections. This area is called the Old Five Channels Area, which used to be the ancient ports and commercial streets in Qing dynasty. The networks pile up in different ages, following different patterns such as river, channel, or coastal line. Based on the use of different ages, the networks have been improved for many times in the history. This background allows the observation of configuration changes under different circumstances.

2.4. Tool

The integration value calculated by using road-centre lines is employed to represent the effectiveness of the reserved road construction. In space syntax, different representations have the advantages on describing different spatial configuration characteristics, in which the road-centre line is employed to investigate the networks configuration in this study. Road-centre line represents one road segment between two junctions. Road-centre line is an appropriate way to interpret the segment of the network which is similar to the driving intuition. It is superior to conventional axial maps via traffic prediction (Jiang & Liu, 2009). This setup makes it suitable for describing vehicular linear spaces.

The main variables are numbers of road development and combination sets of road development. Then the parameters such as MD , Rn , $R3$ are tested to evaluate the improvement after the development in different scenarios. $R3$ value would be more appropriate to describe the local integration value of reserved road sections in a small scale. It is employed to evaluating process as the main parameter for calculating the impact around the reserved road sections.

The mean depth (MD) is calculated as follow:

$$MD_i = \frac{\sum_{j=1}^n d_{ij}}{(n-1)}$$

The integration value is actually a measure for relational asymmetry and it is measured with either Relative Asymmetry (RA) or Real Relative Asymmetry (RRA). These two variables are calculated as follows:

$$RA_i = \frac{2(MD_i - 1)}{(n-2)}$$

$$RRA_i = \frac{RA_i}{(D_n)}$$

The global integration value (R_n) can be calculated as the reciprocal of RRA. Where $n=3$, the R_n comes out to be local integration value (R_3). The variable is calculated as follow:

$$R_n = \frac{1}{(RRA_i)}$$

2.5. Data processing

Data processing started with vectorization axial maps. The network was defined by using the Traffic Network Digital Map from Ministry of Transportation and Communications, Taiwan. In addition, the data were refined by using other data source such as Google Map, ancient map and cadastral map.

The data processing focused on three parts, including generating axial line based on road-centre line, constructing different development scenarios on the axial map, and calculating with different parameters. The axial line generating process focused on vehicular access, which were supposed to have a higher improvement after the road construction.

After mapping out the correct linear space pattern, the software Autocad was used to convert axial map, which could be imported into DepthmapX 0.6.0 for calculating parameters value. Different axial maps were generated according to different development scenarios, and then the effectiveness of reserved road constructions in different scenarios can be evaluated.

3. Results

This section reports the results of evaluation of effectiveness improvements of reserved road constructions. Firstly, the overall effectiveness improvement in four areas were compared. Also, the marginal effectiveness of each reserved road section construction in the Old Five Channels Area was analyzed.

In Phase 1, before and after all the reserved road construction were simulated for the four areas (see Figure 3). Within these four areas, the integration values of the scenarios before and after the reserved road constructions were evaluated. A higher integration value indicated a more convenient local network. The results show that the average local integration value after

the reserved road construction of areas A, B and D increased slightly, whereas that of area C remained the same (see Table 1).

Areas A, B and D have their local integration values (R_3) slightly increased after all the reserved road constructions. These three areas share a common ground, i.e. the constructed-networks and the reserved road networks intersected with each other. In other words, the constructed roads were split more sections after the reserved road constructions. However, in Area C, all the reserved roads are the extension of existing constructed roads. This means that the network pattern remains the same after the reserved road constructions. Hence, the system had no improvement in the average integration value.

The results show that if the reserved road splits the constructed networks into more sections, a higher integration value improvement is expected. The reserved road networks crossed the constructed networks at right angles would cause small integration values. Also, a reserved road overlaid with a constructed road will not increase the integration value when the connecting relations do not change.

In the urban transportation planning conventions, the roads rank higher in the hierarchy of roads have less dense intersections. In this analysis, more intersections represent a higher integration value. This means that this approach might be suitable for evaluating the effectiveness of local street network circulation, and might not be suitable for evaluating that of arterials. Given that the reserved roads are defined as local streets, this approach is suitable for the present study.



Figure 3. Average R_3 value before and after road construction (a. Before construction; b. After construction).

Table 1. Comparative measures of the construction R_3 value.

Area	R_3 value before construction	R_3 value after construction	The rate of change
Area A	1.873	1.901	1.5%
Area B	1.765	1.787	1.2%
Area C	1.746	1.746	0.0%
Area D	1.753	1.755	0.1%

In Phase 2, the reserved roads in Area A were examined further. In Area A, reserved roads intersected with the existing network by in a certain degree, generating a large number of intersections, and splitting the existing streets into small sections.

Figure 4 presents the best reserved road section construction priority and the effectiveness improvement of each section. The horizontal axis lists the reserved road section in the order of construction priority calculated by the approach described in the Methodology section. The vertical axes present the marginal and overall effectiveness improvements to the network after a reserved road section has been constructed, given that the other higher priority reserved road sections have been built.

The results show that the average integration values increase and the marginal measures decrease for the first seven sections. These sections overlay the existing networks with more complex patterns than other sections do, and hence get higher value in effectiveness improvements.

The effectiveness improvements of other sections constructions are more complicated. The integration value of the network might not increase by a section construction, i.e. some of the marginal measures of section construction are negative (10th, 12th and 13th sections), which are caused by the sections not intersecting with the existing networks. In addition, the marginal measure rebounds for some particular reserved road section construction (8th, 9th, 11th and 14th sections). These rebounds are mainly caused by the synergy those sections create, i.e. these sections bridge the existing networks.

4. Conclusions and Discussions

The present study examined the effectiveness of reserved road development in Tainan City, Taiwan by using the axial analysis techniques of space syntax. Axial maps were employed for facilitating axial analysis, which were drawn based on road-centre line, which is suitable for describing the linear spaces for the vehicle user.

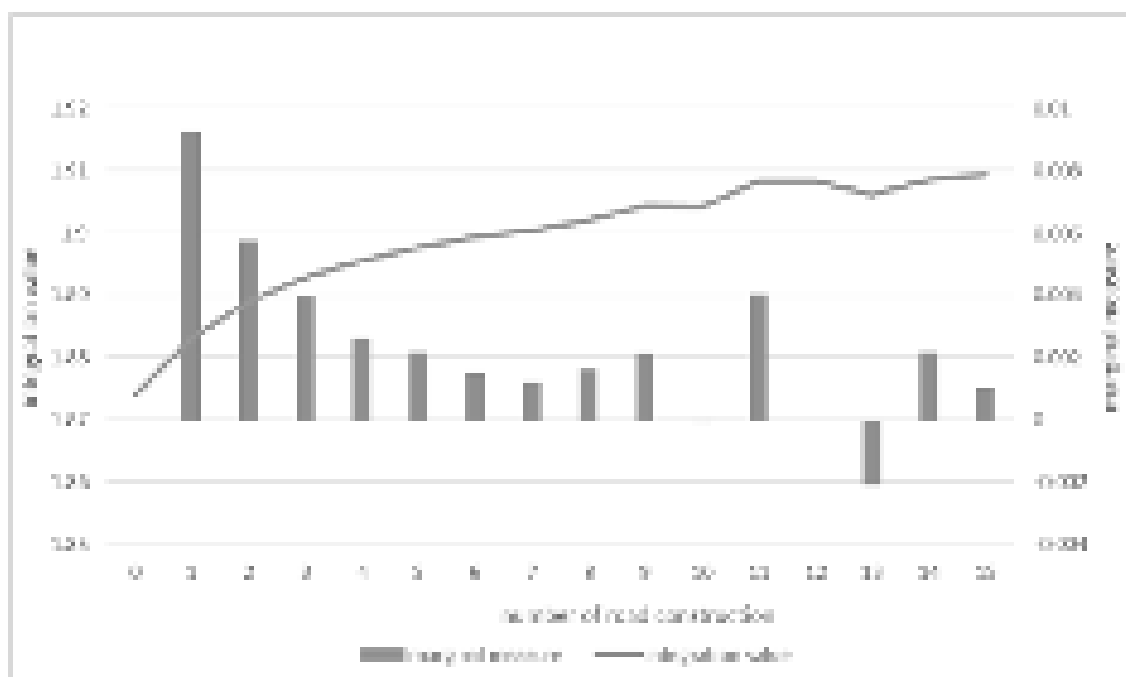


Figure 4. The effectiveness improvement by each reserved road section construction.

The results from Phases 1 and 2 show that the angle of overlaying between the constructed and unconstructed networks plays a crucial role in the improvement of integration value. The angle affects the manner of intersection generation when two network systems overlay to each other, which affects the connection relationship of the network and thus affects the integration value. As a result, the improvement of average integration value depended on the degree of networks overlaying. Generally, each construction of reserved road section would cause the average integration values increase. Moreover, the marginal measures decrease for an additional construction. However, some specific reserved road sections which bridge the networks can bring great improvements to the network effectiveness due to the synergy. All this show that the order of the reserved road section constructions and the design of the network pattern are important to the network effectiveness. Based on the analysis, the strategies for reserved road construction can be suggested

In addition to the above conclusions, this study finds that the local integration values (R_3) might be able to define the hierarchy of roads in the networks as this index is linked to the density of intersections. Also, the approach used in this study might be able to prove that some of the reserved roads are redundant, which might be the reason why these reserved roads remain unconstructed.

5. Acknowledgements

The work described in this paper is supported by the Ministry of Science and Technology (Project No. MOST 107-2813-C-006-021-H) of Taiwan.

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Centrality as a Tool for Sustainable Mobility

Building an Evidence-Based Spatio-Functional Planning Strategy for an Athenian Suburb

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Keywords: planning strategy, spatio-functional centrality, road network hierarchy, sustainable mobility, space syntax analysis.

Abstract: In this paper, we propose an evidence-based planning methodology that combines spatial and functional centrality to construct a discrete planning strategy towards sustainable mobility. A crucial component of our approach is that analysis and planning are treated as a unified process. Specifically, we present a three-stage methodological framework which combines space syntax and land-use pattern analyses in a GIS environment.

In the first step, we identify the established local centres of the suburban city of Alimos in Athens, using the Kernel estimated density of non-residential activities and the potential centres through spatial and functional centrality criteria. These criteria are derived from urban vitality notion and examine the functionality, land-use diversity and multi-scalar spatial centrality, as measured by space syntax angular analysis. Secondly, after taking into consideration the emerging dynamics of the centers identified, we re-configure the centrality pattern in order to achieve a sustainable urban form. The last step includes the re-organization of the road network hierarchy system, aiming at a comprehensive connection of the most significant centralities along with promoting sustainable modes of transport. The outcome of the research is a compact planning methodology that forms an explicit “road map” towards a unified urban and mobility planning strategy.

1. Introduction

Contemporary cities suffer from various issues concerning their efficiency and sustainability. A crucial part of these issues is caused by the car-oriented planning approach that dominated urban and transport planning procedure in many countries primarily after the middle of the 20th century (Marshall, 2005). Urban systems dependent strongly on motor vehicles, especially cars, resulted in unattractive street environment, mobility inequalities, urban sprawl, low residential density suburbs, increase in average travel distances, inadequate public transport service, intense traffic congestion, road accidents and major severances to the urban fabric (Nieuwenhuijsen and Khreis, 2016). These circumstances highlight that cities are not places for people but places with people (Gehl, 2010). Places that cannot sustain an adequate mobility level for all and a decent quality of life. Hence, cities and towns should develop the appropriate

strategies in order to counter the negative impacts of urbanization and improve the condition of the urban environment.

It is striking that in these described circumstances, a new perspective concerning cities and their future has emerged during the past decades; this perspective is the notion of unified urban and transport planning approach. This approach takes into consideration equally both urban and transport aspects and their interactions in order to compose an integrated strategy, more efficient than the conventional one. Another significant concept which is a derivative of unified urban and transport planning is sustainable mobility (Banister, 2008). This specific concept defines a system that meets contemporary transport needs through enhancing public transport, walking, cycling as well as innovative ways of transport and simultaneously, strengthens social equity, economic efficiency and environmental protection. Consequently, the above definition of sustainable mobility demonstrates the great role of active modes of transport in the making of accessible, just and social cities. It is urgent to shift from car-oriented urban forms to transit and pedestrian-oriented cities which facilitate human scale (Gehl, 2010), ensuring a prosperous quality of life.

The way towards efficient and better cities consists of various steps. A fundamental step in this process is the quest for a sustainable urban form. According to several studies (e.g. Rode *et al.*, 2006), urban form is strongly related to transportation issues and travel choice in particular. Possible changes referring to one dimension should take into account the other. Cities aiming at the revitalization of their urban environment consider their centers (local, citywide or metropolitan) as constitutional components in this procedure (Whyte, 1988). Therefore, centralities that ensure a sustainable urban form ought to be accessible and walk-attractive (Bielik, *et al.*, 2018) and thus vibrant conductors of human presence (Gehl, 2010).

A plethora of studies (e.g. Waitt *et al.*, 2019) highlights the crucial significance of walk-access in urban centers. A characteristic example is the methodology of TOD which suggest approximately 10 minutes walking (National Academies of Sciences, Engineering, and Medicine, 2004) and another case is the pedestrianization of central areas in numerous cities worldwide (Soni and Soni, 2016). Both of these cases transform a certain geographical area from a car-oriented space into a human-oriented zone. Moreover, the great importance of walk access is discussed by Alexander *et al.* (1977, pp. 168-173) who state that people are attracted to places that allow them to walk up and down, meet their friends, stroll and browse. Regardless of the built environment condition and the streetscape design, walk access of a center is directly affected by human presence. Hence, centers with great number of pedestrian flows attract ever greater of pedestrians (Alexander *et al.*, 1977, p. 164).

But what exactly are those centers? According to Legeby, *et al.* (2017), the centers that emerge in a city can be understood as descriptions of phenomena or symbols for a certain function in a larger context. The concept of 'center' within architecture and urban design is rather different from its more precise definition within physics: it is a kind of double meaning; both in a symbolic sense and in that it should be perceived as a centre in terms of their urban surroundings. However, urban centers are frequently described only as "places of concentrated non-residential activities" (Legeby *et al.*, 2017).

Nevertheless, a centre has the chance to be successful if is attractive to its users, but also functional for its residents. Diversity of activities and users is substantially important for a centre and indicates its strength, its vitality and viability (Jacobs, 1961). Furthermore, functional aspects of cities such as public open spaces, retail, commercial and public services are essential for a town centre and indicators of its existence (Thurstain-Goodwin & Unwin, 2000). Especially for suburban centralities, Vaughan *et al.* (2010) highlight the significance of all non-res-

idential activity to the vitality and viability of town centres by proposing that “the sources of vitality in local places are embedded in the diverse socio-economic and cultural activities that take place beyond the high street’s shopping hub” (Vaughan *et al.*, 2010, p. 77).

Moreover, a crucial aspect of centrality is the structural property of urban grid to attract human activity. Hillier termed this process as natural movement and defined it as “the proportion of urban pedestrian movement determined by the grid configuration itself” (Hillier *et al.*, 1993, p. 32). A significant tool for measuring urban grid’s structural property and thus centrality is Space Syntax Analysis. This tool constitutes a set of techniques, developed by Bill Hillier and his colleagues (1984), that attempts to conceptualise and quantify this urban mechanism; meaning the attribute of the urban grid to attract and generate movement and therefore economic activities. In addition, it is worth noting that a substantial amount of literature has proven the positive correlation of street centrality and economic activities (e.g. Porta *et al.*, 2012) or human movement (Hillier *et al.*, 1993). Rooted in graph theory, space syntax analysis encompasses a set of theories and techniques for the analysis of street network configuration in terms of topological, geometric, and metric distances. Space syntax in its essence is a structure-function theoretical model of human space, for analysing urban space and foreseeing functional outcomes (Hillier *et al.*, 1987).

Apart from the walk-attractiveness level of the major centers (established or emerging), it is essential to connect these points through sustainable means and ways transport. Therefore, a new hierarchy system of the road network should be formulated. Road network hierarchy defines the functional classification of roads and streets by which they are grouped into classes or systems, depending on the function they serve. Specifically, hierarchy signifies the role of each road or street in the whole urban transportation network (Tumlin, 2012).

According to the conventional approach, roads are defined chiefly by the degree to which they emphasize through movement for automobiles (mobility/circulation) versus local access. According to Liu *et al.* (2017), this car-dominated road classification has neglected the social dimension of roads and has also created a transport system, which undermines the role of other surface modes.

However, streets serve manifold functions and should not be destined solely for automobile throughput; on the contrary they should be multimodal and vital places (Tumlin, 2012). Viewed broadly, a street is not only a linear conduit, but it may also be a container of urban life. In this framework, notable research has been carried out towards this direction, highlighting the necessity of an alternative functional classification facilitating sustainable mobility. For instance, Marshall (2006) suggested the adoption of a transit-oriented hierarchy, which gives priority to public transport and enhances the cooperation between sustainable modes. Furthermore, numerous scientific papers and technical guidelines adopted a matrix-based approach of classification which takes into consideration both “Link” and “Place” functions (e.g. Svennson, 2004). Finally, Liu *et al.* (2017) proposed a three-dimension functional classification system based on Hierarchy, Activities and Mode, constituting an innovative solution in urban transportation field.

In that context, the present research is aimed at creating an evidence-based planning methodology that combines spatial and functional centrality to construct a discrete planning strategy towards sustainable mobility. Specifically, we propose an integrated methodology consisting of an analysis and a planning part. Regarding the analysis component, the suggested method identifies the existing centrality pattern and computes the walkshed area of the established centers, thus detecting the needs of the study area. After recording the needs, we proceed to the formulation of the planning part, which primarily includes the enhancement of the

centrality pattern by utilizing a vitality score index. This index is based on functional and spatial characteristics that depict the potentials for a vital, sustainable and walk-attractive center to emerge. The next steps contain the computation of the walkshed area of the new centrality pattern as well as the prioritization of interventions depending on the vitality score of each center. At last, our methodology promotes sustainable mobility through re-organizing the road network hierarchy system, which takes into consideration both urban and transport dimension of the study area.

2. Methodology

The present paper introduces an evidence-based planning methodology that integrates methods for identifying established and vital emerging centralities along with tools for evaluating the pedestrian accessibility and the vitality of suburban centralities and finally introducing a planning strategy for re-organizing centrality pattern. This strategy prioritizes urban planning intervention in centralities and re-organizes road network hierarchy towards sustainable mobility and walkability. Accordingly, a six-step combinatorial spatio-functional methodology framework is introduced and its steps are depicted in Figure 1. Methodological Framework..

The first step of our methodology framework is the identification of the established activity centres. The method for identifying established centralities and their area of influence is based in the Kernel estimated density (KDE)¹ of non-residential uses, for a bandwidth suitable for centre analysis but also representative of the research area². A cut-off threshold is set so as the areas of significant non-residential density (, thus established centres, to be determined.

The second step is the computation of the 10-minutes walkshed area defined by the established activity centres, in order to evaluate the sufficiency of existing centrality pattern to service the study area. To this end, the catchment analyzer of space syntax toolkit (QGIS 2.16.3) is utilized and specifically the 600-meters³ catchment area created by the existing centrality pattern is calculated.

The next step refers to the re-organization of centrality pattern by identifying emerging walk-attractive/vital centralities. The emerging walk-attractive centralities are identified via typological criteria, in order to ensure that these areas would have the “*predisposition*” to develop into functional, livable and vibrant centres.

To this end we introduce “Vitality Score” that combines functional and configurational (syntactic) criteria and their Kernel Estimated density in the study area. The Vitality Score is calculated based on the number of criteria identified in each area of the city. Specifically, if an area has two criteria or more, is deemed as an “emerging walk-attractive centrality” and is integrated in the re-organized centrality pattern In order to determine if a criterion is met, the density

1. The KDE estimates the density within a range (bandwidth) of each observation to represent the value at the center of the window. Within the bandwidth, the KDE weighs nearby objects more than far ones based on a kernel function. The KDE generates a density of the events (discrete points) as a continuous field (e.g., raster). By using the density (or average attributes) of nearby objects to represent the property at the middle location, the KDE captures the very essence of location: it is not the place itself but rather its surroundings that make it special and explains its setting (Wang *et al.*, 2011).

2. Relevant literature proposes a bandwidth of 100 to 300 meters (Porta *et al.*, 2009, pp. 457 – 458; Porta *et al.*, 2012, p. 1479). After experimentation with different bandwidths, we select a 200-meters bandwidth for identifying the centralities of Alimos.

3. According to studies regarding Athens urban environment, a 10-minutes’ walk in Athens corresponds with 600 meters walking distance.

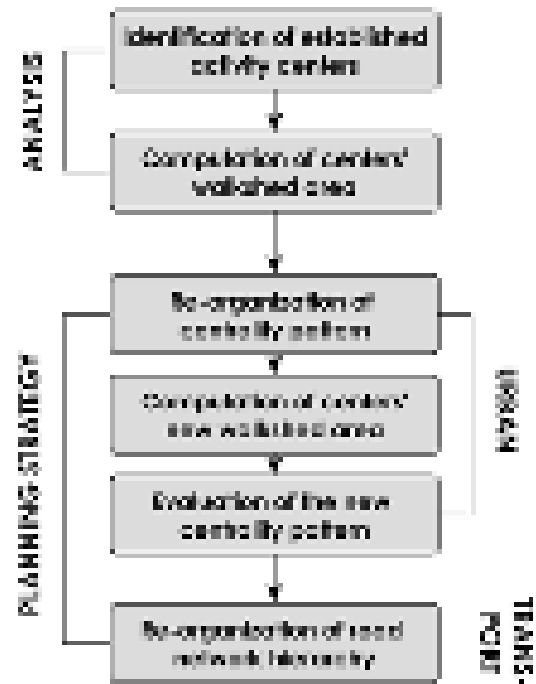


Figure 1. *Methodological Framework.*

of each criterion is calculated and a suitable cut-of threshold is implemented, as also shown in Table 1. The typological criteria are the following:

(1) Public Open Spaces which contribute to the quality of life in a city but also to the creation of liveable and sustainable central areas as they provide a public meeting place for the city, with social meaning and free access.

(2) Commercial Centrality refers to the activities of retail, markets, commercial services, cafes, catering, entertainment and other activities that facilitate the everyday needs for retail and recreation.

(3) Communal Centrality concerns the wide spectrum of uses beyond commercial that facilitate the everyday needs of residents, such as health facilities, religion, education and municipal and public services. The presence of *community function* is essential for the 'place identity' of a centre, especially a local one, and is what makes a city functional, competent and self-sufficient.

(4) Active Centrality refers to all the other non-residential uses not included in the above-mentioned criteria, such as offices, professional workshops and automobile repair shops and as mentioned by Vaughan et al (2010) are crucial for the vitality and viability of suburban town centres

(5) Configurational/Spatial Centrality (Local and/or Mixed), is essential for a walk-attractive centre since it refers to the ability of the urban grid to shape human activity and attract dense pedestrian movement. Specifically, the configurational/spatial centrality measures used in this research are the space syntax measures of angular choice (betweenness) and angular integration (closeness) constrained by multiple metric radii which are found to be instrumental in detecting major to- and through-movement routes in a street network (Al_Sayed et al., 2014, p. 73). For detailed depiction of the radii used, see Table 2.

The fourth step of our methodology framework concerns the (re-)evaluation of the new 10-minutes walkshed area generated from the new centrality pattern and the identification of any underserved areas, if any, even after the re-organisation of the centrality pattern.

The fifth step refers to the evaluation of the liveability, functionality and vitality of the re-organised centrality network in order to construct a prioritization planning strategy. Based on

Table 1. *The typological criteria forming the 'Vitality Score'.*

Type	Criteria	Centrality Threshold (Kernel Density >)
Functional	Public Open Spaces	Mean + 1 SD
	Commercial Centrality	Mean + 1 SD
	Communal Centrality	Mean + 1 SD
	Active Centrality	Mean + 1 SD
Configurational	Local Centrality and/or Mixed Centrality	Mean + 1 SD

Table 2. *The definition of configurational/spatial centrality.*

Configurational Centrality	Measures	Radii
Local	High Values of Segment Angular Choice and/or Integration (Values > Mean + 1 SD)	200m. and/or 400m. and/or 600m.
Global	High Values of Segment Angular Choice and/or Integration (Values > Mean + 1 SD)	1600m. and/or 2000m and/or n
Mixed: Local + Global	Local and Global Syntactic Centrality	

the vitality score introduced on the third step (see Table 3), each centre is graded from A to F (0/5 to 5/5 criteria) and if a centre is graded with E or lower (1/5 criteria or lower) is classified as urgent priority, The rest of centralities are classified into 3 same-sample size classes (quantiles) representing low, medium and high priority areas.

The sixth step concerns the re-organization of the road network hierarchy in order to achieve a sustainable and efficient way of connecting the major centers to each other. The proposed hierarchy system is based on two dimensions, coordinated with innovative approaches (Marshall, 2006), differing from the conventional one-dimension system. The first dimension refers to the geography of the route and the second to its significance. Therefore, we divide the existing main road network (primary and secondary arterials and collector roads) into 4 new categories, which are presented at the table below.

In a more detailed analysis of the above paper, we should mention the following.

- Roads belonging to category O1 connect metropolitan centres to suburban centres;
- roads that belong to category O2 connect municipality centres to each other;
- roads belonging to category I1 connect major urban centres to each other;
- roads which belong to category I2 are entities of the existing main network that do not connect major urban centres to each other.

Furthermore, the new hierarchy system re-defines the existing priority to the means of transport. Precisely, it prioritizes car movement in primary roads (O1 and O2) and public transport in secondary roads (I1 and I2), in order to gradually create the appropriate conditions for promoting alternative mobility.

Table 3. Conceptual explanation of 'Vitality Score'.

Vitality Score	Explanation	Criteria (n/5)
A	Excellent	5/5
B	Very Good	4/5
C	Good	3/5
D	Sufficient	2/5
E	Fail (some more work is required)	1/5
F	Fail (considerable further work is required)	0/5

Table 4. Conceptual explanation of the proposed road network hierarchy.

Geography/Significance	Primary	Secondary
Outer route (exceeds municipality borders)	O1-Metropolitan Route	O2-Intermunicipal Route
Inner route (inside municipality borders)	I1-Major Municipal Route	I2-Minor Municipal Route

3. Analysis/Results

3.1. Study Area – Data Sources

The study area is the city of Alimos, a municipality in South Athens in the region of Attica in Greece. Alimos is a coastal suburb of Athens, situated on the Saronic Gulf coast, 8 km south of Athens city centre. The municipality has an area of almost 6 km² and in the 2011 census had 41720 inhabitants. Alimos is a heavily car-dependent⁴ city that has the morphological and functional characteristics of a residential inner suburb of Athens meaning high residential density, a significant amount of green spaces and low urban density. However, the city has the particularity of a significantly diverse character. The southwest neighbourhood of Alimos has the attributes of an upper middle-class suburb while its northeast part has these of a typical Athens commuter suburb, and the zone between them simulates a high-class 'bedroom' suburb. This is the result of its fragmentary urbanization, typical of Athens suburbs.

The commercial activity in Alimos is concentrated in the primary routes that cross the city: Leof. Eleftherias, Leof. Poseidonos, Leof. Alimou, Leof. Vouliagmenis, and the streets that are inside the city links: Thoukididou, Kalamakiou, Theomitoros, Ionias, Dodekanisou. In the coastal zone, the focus of commercial activity is the commercial centre of 'South Alimos' (Thoukididou

4. According to a report by OASA S.A. the Athens Urban Transport Organization, in Alimos, 70% of all transportation in 2011 was conducted by private means (OASA S.A., 2012).

Street) while in the northeast part of Alimos, the commercial activity is concentrated in the market of ‘North Alimos’ (Dodekanisou, Leof Ionias).

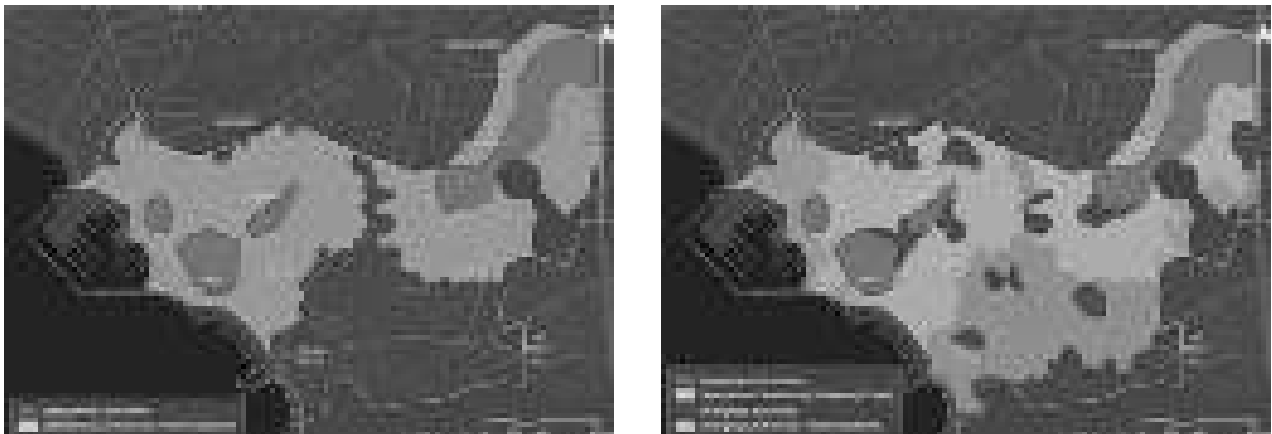
This paper constitutes a quantitative research on spatio-functional centrality and sustainable mobility, and relevant datasets are used to this end. Data regarding land-uses were granted by “Polis L.P” and were gathered by on-site investigations in 2011. Urban blocks and cartographic backgrounds data come from the Hellenic Statistical Authority. Additionally, the existing classification derived from the “General Land-Use Plan” published by the Municipality of Alimos.

3.2. Results

The compact methodology that was analyzed in the previous section is implemented in the suburban city of Alimos and its results are described below.

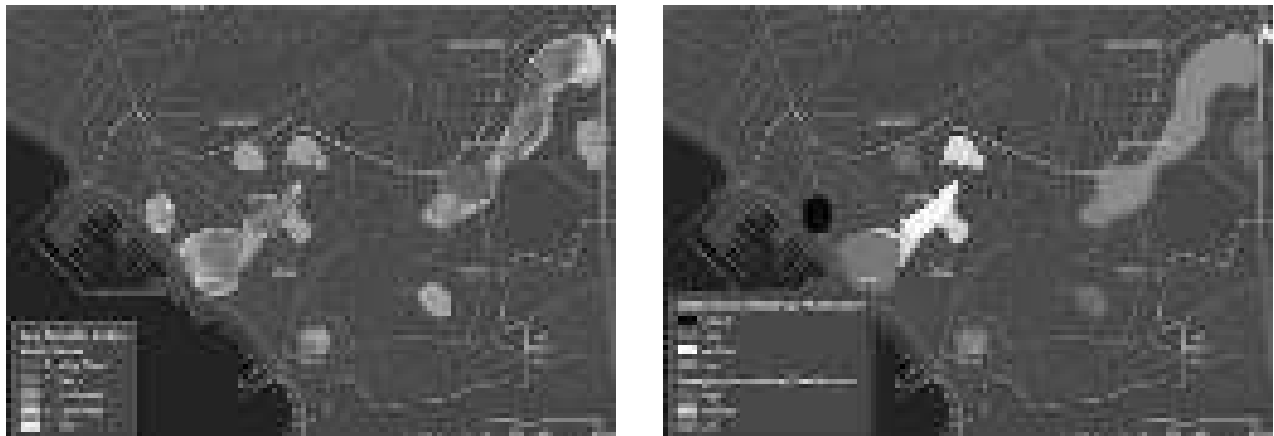
The following map depicts the established and emerging centralities and their correspondent 10-minutes’ walkshed areas. As shown in Map 1 (below) the existing centralities are located in two main clusters. In the western part, a network consisting of three proximal centralities and the traditional centre of Municipality is found. While in the eastern part a most recent centrality has been identified which consists of a longitudinal shape and includes an arterial road with dense land use mix. However, these two centrality clusters cannot service the whole of area of the municipality, thus creating inequalities and an unsustainable form. Precisely, the walkshed area of the centers occupies only the 56% of Alimos, meaning that a large proportion of the population is out of a pedestrian service area. This is the reason why the existing pattern of centrality has been evaluated as not sufficient, leading to a car-dependent urban form and thus is being re-organized in order to include the emerging walk-attractive centralities of the study area, which are depicted in the relevant Map. The new centrality pattern improves substantially the pedestrian accessibility of the study area, since the 10-minutes walkshed area increases and now occupies the 76% of Alimos, leaving only a limited part of the city not accessible by 10-minutes walking.

Subsequently, the liveability and vitality of the re-organized centrality pattern is evaluated via the “Vitality Score”. As shown in Map 2. Evaluation of the new centrality pattern (Above) & Prioritization of urban planning interventions. (below) the Vitality Score has accomplished to evaluate the vitality of existing and emerging centralities of Alimos since it promotes areas with



Map 1. *Established Centralities and their walkshed (Left) & Established and Emerging Centralities and their walkshed (Right).*

diverse activities and strong street network centrality instead of areas with intense mono-functional activities. Specifically, the centrality clusters of “Lower Alimos” were graded significantly lower than their “Upper Alimos” counterparts. This insight is due to the fact that the more recent centralities of “Upper Alimos” demonstrate both dense and diverse functional centrality and configurational (syntactical) centrality. Following this stage of our methodology, the prioritization of interventions regarding centralities is implemented and the results are shown in Map 2. Evaluation of the new centrality pattern (Above) & Prioritization of urban planning interventions. (below). Based on the vitality score, the centralities of the study area are classified into 7 categories regarding the urgency level of active mobility interventions needed and the type of centrality (established or emerging). The centralities characterized as ‘High’ and ‘Medium’ priorities are clustered in the western part of our study area -older part of Alimos- while the centralities evaluated as “Low” priorities are mainly located in the eastern part of Alimos. It is worth noting that in the western part, one of our established centres is evaluated as urgent priority, meaning that the planning process should concentrate its focus primarily there.



Map 2. Evaluation of the new centrality pattern (Left) & Prioritization of urban planning interventions (Right).



Map 3. Re-organization of road network hierarchy.

Finally, Map 3 presents the re-organization of the road network in order to sustain active modes and public transport and also to connect the centers with each other through a comprehensive way. As we can observe, the major arterials of the area are located outside the main core of Alimos, deterring in some degree, through vehicular traffic. On the contrary, municipal roads either major or minor spread through the area, thus bridging the gap between the centralities.

4. Discussion/Conclusion

In this paper a unified urban planning-transportation approach is presented, combining functional and spatial centrality along with road network hierarchy in order to produce a compact planning strategy towards sustainable form, walkability and active mobility in general. To this end a methodology framework is introduced for identifying existing and emerging centralities and its walkshed area, evaluating the vitality and functionality of centres and prioritizing urban planning and transportation interventions. Furthermore, a simple functional street hierarchy is proposed, integrating the need for inter-connection and protection of the urban centres while promoting sustainable mobility and transportation justice.

The findings of this research indicate that the presented methodological framework is generally successful in identifying established and walk-attractive emerging centralities, evaluating the vitality, functionality and liveability of the centres and proposing a strategy prioritizing urban planning and transportation planning interventions. What is more, the utilization of multiple methods, techniques and data makes the proposed methodological framework a compelling integrated approach for active mobility strategy. Furthermore, the results of the presented research demonstrate that an upper middle-class suburban area has significant problems when it comes to sustainable urban form and active mobility since the existing centrality pattern preserves the car-dependent development of the study area. Moreover, there is a substantial proportion of the study area that is not supported by the 10-minutes walkshed areas of the existing centrality pattern. Nevertheless, an emerging walk-attractive centrality network underlies and if enmeshed, the suburban form of such cities can be significantly more sustainable.

This research, recommends an alternative and unified approach in urban and transport planning, thus presenting a high significance value for spatial planning procedure and cities in general. We introduce an explicit methodological framework that could function as a decision support tool for urban mobility planning process and could be applied to other cities with similar characteristics. Probably, the most notable element of this study is that regardless of any shortcomings that may occur in the implementation of such a strategy, the rationale nominated has the potential to leverage the current institutional aspects of urban and transport planning procedures. Especially in Greece where urban and transport fields are not treated as a unified entity, the urgency of such scientific studies is great.

Centrality identification, sustainable urban form, active, inclusive and just mobility, road network hierarchy etc. are components of a broader scientific field (urban and transport planning), which is full of complexity and ambiguity. Therefore, the issues addressed in this research cannot be entirely analyzed in one single research. In this context, this study concentrates its interest on formulating a unified process which produces general planning directions. Hence, the results do not refer to a microscale level affecting designing issues. In other words, a crucial research step moving forward is the creation of a methodology concerning the design of the centers (established or suggested) in order to re-organize in a complete way, the urban “status quo” of the area. Furthermore, there are numerous approaches for centre identification and fur-

ther research could contribute in better understanding the various components that compose centrality and the different methods for identifying it. Therefore, the integration of additional spatial morphology metrics and implementation of weighted space syntax analysis could contribute significantly in the strength of our centre-identification and centre-evaluation method. Moreover, another issue that might arise is the edge-effect on space syntax calculations and as a response normalized measures of space syntax could be utilized or the extension of the study area. Another take is the enrichment of the methodological procedure either by inserting more vitality score criteria (walkability features, etc.) or by changing the radius of the walkshed area (e.g. 300m). The improvement of our approach and the acquiring of an adequate flexibility level by adapting to various circumstances would definitely enforce our results in the future.

In addition, the exploitation of more data (pedestrian or vehicle flows, users' perception, etc.), the utilization of more evidence-based tools and the integration of different evaluation methods for our proposed planning strategy would be a substantial contribution in the improvement of the unified approach in spatial planning.

Undoubtedly, the elaboration of more research papers and projects about centrality pattern, sustainable urban form and inclusive mobility issues in the near future can contribute considerably to the making of more livable, vibrant and social cities.

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Multi-Scalar Mapping of Transit-Oriented Assemblages

Metropolitan Mobilities, Neighbourhood Morphologies and Station Design

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Keywords: Multi-scalar mapping, transport network, urban morphology, walkable access.

Abstract: With the vast expansion of cities enabled by motorised transport, the conjunction between metropolitan and neighbourhood mobilities has attracted increasing attention in transport and urban research. Within these fields, transit-oriented urbanism has become a key paradigm for environmentally sustainable, healthy and creative environments. While the importance of urban design has been acknowledged, research has generally focused on exploring correlations between metrics of built form characteristics and transport, health or environmental outcomes. However, many of these metrics are not capturing the spatial complexity of actual urban forms and are poor proxies for capacities for movement. Urban morphological studies on the other hand, while exploring historical change at neighbourhood scale with spatial precision through mapping, often neglect the importance of metropolitan transport networks. Based on case studies from Chicago and Melbourne, this research is seeking to bridge the gap between micro-, meso- and macro-scalar urban morphological studies, by focusing on metro stations as the inter-scalar interfaces between walkable neighbourhoods and rapid transit networks. In this pursuit, new mapping methods for capturing capacities for movement at multiple scales are developed. It is shown that urban mobilities are mediated by the complex assemblage of station architecture, neighbourhood form and the metropolitan transit network.

1. Introduction

As a result of rapid global urbanisation and urban expansion throughout the last century, now more than a quarter of the global population is living in cities with populations of over half a million.¹ In such large urban agglomerations, everyday social interaction is highly reliant on mechanised mobilities, including tram, train/metro, bus and car. At the same time urban sociality and economic productivity still rely on face-to-face interaction in public space (Sennett, 2007; Storper & Venables, 2004). Thus the multi-scalar relationship between local and metropolitan mobilities is becoming an increasingly important aspect of 21st century urbanisation. In this context, transit-oriented development (TOD) has emerged as a key urban paradigm (Calthorpe, 1993) and field of research for environmentally sustainable, healthy and creative

1. United Nations. (2016) The World's Cities in 2016 – Data Booklet.

neighbourhoods. In TOD approaches the premise is that dense, mixed-use and well-connected neighbourhoods around transit nodes support walking, while also harnessing the economies of scale of large metropolitan agglomerations (Salat & Ollivier, 2017).

Within urban planning TODs have become a key policy aim with an emphasis on rail transport and land use mix, scheduling of transit services, and development mechanisms. This has been reflected in metropolitan plans such as Melbourne's '20-minute City' or Perth's 'Network City'. In streetlife studies, an area of investigation is the role of public transport stations as major attractors of pedestrian flows. The mechanical rhythms of public transport can be a key component of place-specific polyrhythms (Pafka, 2017). Thus the spatial distribution of transport stations is also important in understanding everyday rhythms of streetlife.

Much of the scholarly literature on transit-oriented design to date has been focused on exploring correlations between metrics of built form characteristics and measures of active transport, human health or carbon emissions (Cervero & Kockelman, 1997; Frank *et al.*, 2005; Newman *et al.*, 2009). However, often such metrics are based on highly simplified abstractions of built form, rather than being direct measures of urban morphology. Previous studies have shown that many of these metrics, including within space syntax approaches, are poor proxies for actual urban morphologies and capacities for movement (Pafka & Dovey, 2017; Pafka *et al.*, 2020), and that walkability is a multi-dimensional spatial property that cannot be reduced to simple indices (Dovey & Pafka, 2019). Urban morphological studies on the other hand, have been focused on capturing with spatial precision historical change at neighbourhood scale (Moudon, 1994), and generally without close examination of metropolitan transport (Vance, 1990).

Thus the main aim of this research is to bridge the gap between urban morphological studies and transport research, by focusing on transit nodes as the inter-scalar interfaces between the walkable neighbourhood and the metropolitan rapid transit network. While this multi-scalar aspect of stations as 'global' nodes as well as 'local' places has been previously recognised (Bertolini & Spit, 1998), multi-scalar urban transit research is still in incipient stages (Dovey & Woodcock, 2014). Thus this research aims to advance our understanding of multi-scalar access, by examining the nexus between metropolitan rapid transit networks, station design and neighbourhood morphologies. We seek to understand to what extent the complex assemblage of network configuration, neighbourhood morphology and station design can impact on mobilities in the 21st century.

2. Multi-scalar assemblage approach

The conceptual framework is assemblage thinking as an integrative multi-disciplinary approach that avoids reductionism to the confines of any single discipline or research method (Dovey & Pafka, 2016). Such an approach is inherently multi-scalar, but hasn't been yet sufficiently explored (DeLanda 2006; 2016). In recent years assemblage thinking has been increasingly applied to urban mobilities at a conceptual level (Jensen, 2014; Kärrholm *et al.*, 2017) and also in empirical spatial analysis (Dovey & Woodcock, 2014; Duric, 2017). It has been also argued that the relationships and liaisons between spatiality and sociality are key to understand how a transit node works, as well as to explore the capacity of a transit node to produce urban intensification (Peimani, 2017). Such an understanding is also geared to a multi-disciplinary analysis, interrogating the ways in which shaping of urban morphology and public spaces at neighbourhood scale is connected to metropolitan rapid flows at larger scales.

Understanding transit-oriented assemblages is also reliant on making the distinction between actual and possible interrelations at multiple scales of both space and time. This relationship between actual/material and possible/emergent is laced throughout transit urbanism. To put it differently, rather than only studying existing objects or relationships, it is important to make sense of the yet to be realized connections. In this sense, mapping has been outlined as an abstraction that has the capacity to unravel what DeLanda (2006) calls ‘real virtuality’, which is a reality that has not been actualised yet. In effect, while the ‘thick description’ of the connections that have assembled transit nodes is important, it is also important to focus on the space of possibilities that are associated with latent capacities. In this way, mapping has an agency to produce a kind of spatial knowledge (Dovey *et al.*, 2017) which can be interrogated to explore the space of possibilities for the existing transit-related problems and embodied capacities for transformations. To explore the space of possibilities here can become a particular line of inquiry in both theory and practice where built environment professions can benefit from the process of ‘design as research’ (Kamalipour & Peimani, 2015).

Hence in this research we have developed new methods of mapping spatial data of street and rail networks, in conjunction with population densities and station use. We relied on transport patronage and census data for the metropolitan scale, cadastral maps for morphological analysis, and satellite imagery and street view for the station scale. We chose case studies that have simple mono-centric tree-like rail transport networks, where network effects are limited to the central node and branch bifurcations, and thus allow a focus on neighbourhood morphologies. For comparability of station usage across different cities, we selected large cities and metropolitan agglomerations with 1–5 million inhabitants, a size category comprising over 500 cities globally with over 13% of global population.² The final selection criteria was the availability of up-to-date reliable data. While our investigation included Stockholm, Chicago and Melbourne, in this paper we are presenting only the latter two, which are the most car dependent and where transit improvement has the potential of leading to the greatest urban transformation.

3. Metropolitan transit

As a first step towards understanding transit-oriented urban assemblages, we have retrieved the statistical data of railway station entries and exits,³ to identify stations with high usage outside the city centre. The data for each station was ranked for each metropolitan area, then divided into septiles and mapped using a light to dark gradient (Figure 1). A typical condition of high usage we noted was at the bifurcation of branches, which may be in part due to the higher frequencies and interchange usage. We have excluded these from detailed analysis, to allow a focus on neighbourhood morphologies. Then using satellite and street view imagery we examined the stations outside the CBD with exceptionally high usage. We found that many of these highest use stations were in very low-density environments, but well connected to a bus interchange, a large car park, or a combination of the two.

A first finding at metropolitan scale is that in these car-dependent cities, the stations with the highest usage tend to be those that have an extended catchment enabled by other motorized transport modes, such as bus or car. In Chicago bus interchanges are more prevalent, while in

2. United Nations. (2016) The World's Cities in 2016 – Data Booklet.

3. Chicago Transit Authority (2017) Annual Ridership Report 2016, www.transitchicago.com, accessed 31 October 2018.
Public Transport Victoria (2015) Passenger Activity by Metropolitan Station, www.ptv.vic.au, accessed 31 October 2018.

Melbourne there are also a large number of park-and-ride interchanges. The stations with such facilities often attract more potential drivers. Interchanges with high patronage often appear at end of lines and mid-way between the CBD and network end. Thus in these cities, rail infrastructure is to a significant extent supporting the mobilities of suburban dwellers, rather than simply being a driver of urbanisation. The implication is that an uncritical assumption that investment in rail automatically leads to more sustainable urban forms is problematic. Rather a more nuanced understanding of the conditions under which synergies between metropolitan rail transport and urban neighbourhoods emerge is required.



Figure 1. Railway stations in Chicago and Melbourne by passenger patronage.

4. Walkable catchment densities

Metropolitan-scale studies of transport and urban form attributes have long identified a general relationship between population densities and public transport patronage (Newman *et al.*, 2009). Yet the empirical evidence so far relied on administrative and statistical areas of variable sizes, which can heavily bias the results (Dovey & Pafka, 2014). Thus in this study we used a regular grid cell of 1x1km as reference area to analyse residential densities across the metropolitan area. The population data has been extracted from fine-grain census data at the level of census blocks⁴ and mesh-blocks.⁵

The residential densities of Chicago and Melbourne have been mapped within a consistent frame of 40x40km, using a base-scale of 1x1km (100 hectares) roughly corresponding to walkable neighbourhoods (Figure 2). The maps show non-urban densities (below 5p/ha) in white and suburban densities (below 50p/ha) in light grey. The gradients of grey darken as densities increase from 50 to 150p/ha typical of row-housing and low-rise or scattered apartment buildings, and then darken further above 150p/ha in higher-density neighbourhoods. Both Chicago and Melbourne are dominated by suburban sprawl (below 50p/ha), with only few patches of higher densities of 100-200p/ha, and no areas with densities over 200p/ha.

The walkable densities shown here capture the patchwork of different neighbourhoods that form the metropolis, bringing together the territorial reach of walking and motorised transport. The densities of 100-hectare grid cells are relevant to capacities for face-to-face encounter, but also to transit station catchments. Residential densities in Chicago follow a mono-centric and radial pattern, while in Melbourne a mono-centric pattern with some gaps around it due to large parklands between the central city and the inner suburbs.

The use of overlayed mapping here provides indication of whether differences in transit station use are correlated with residential densities (Figure 2). In Chicago the clusters of high usage along the northern lines converge with the clusters of higher residential densities. In Melbourne the convergence between higher residential densities and higher station use is concentrated in the CBD and along the south-eastern line. The more one gets further away from the CBD, the less noticeable any increase in residential densities around high-use stations. At the same time, in both cities, within the low-density suburban areas there are significant fluctuations from low to high station use. As discussed in the previous section, much of this can be explained by modal interchanges rather than local densities and morphologies. In the following section we will examine cases where the increased station use did not appear to be simply a result of such interchanges, but instead local morphologies may be a contributing factor for high station usage.

5. Station access

To explore the role of neighbourhood morphologies and station design on railway use, we have selected pairs of stations in each city, with a large gap in patronage between consecutive stations, and that also stood out from the metropolitan patterns related to residential densities described in the previous section. In this paper we present one such pair from each city. In Chicago we focus on two elevated stations: Loyola with a weekly patronage of 34,000 people en-

4. US Census Bureau (2010) Census, <https://www.census.gov/>, accessed 31 October 2018.

5. Australian Bureau of Statistics (ABS) (2016) Census of Population and Housing, <http://www.abs.gov.au/>, accessed 31 October 2018.



Figure 2. *Railway station patronage and residential densities.*

tering and existing the station, and Granville with a patronage of 26,000 despite being located closer to the CBD. In Melbourne we focus on the underground station at Box Hill with a weekly patronage of 66,600 and Mont Albert, a station at grade, with tenfold lower patronage of 6,500 despite its location closer to the CBD. At this stage of the research we have only focused on the vertical access configuration of the railway stations. The vertical location of stations in relation to their associated streets (i.e. the extent to which the station is well connected to the surrounding street network) have a significant impact on pedestrian access and potential for higher-density redevelopment (Dovey & Woodcock, 2014). In Chicago the elevated platforms at both case study stations allow direct access to the street via escalators and lift. At Box Hill the access is through the internal lanes of the shopping mall, which we included in the mapping of

the area, as in a Nolli map. At Mont Albert access to the north is through an underpass, which was accounted for by subtracting the length of the ramps from the overall walking distance threshold of 400m.

We analysed the neighbourhood around each station according to the capacity of the urban morphology to allow through movement and attract to-movement (Figure 3). The measures of these properties are the area-weighted average perimeter (AwaP) of urban blocks for access through the urban fabric, also known as permeability, and interface catchment (IC) for access to potential attractors, as developed by Pafka & Dovey (2017). Jacobs' principle of short blocks, often expressed as a rule of thumb for urban blocks to be shorter than 100m in length, corresponds to an AwaP of 400m. Higher AwaP scores indicate a lower permeability. The area-weighting based average of block perimeters accounts for the major effect a single large block can have on the permeability of a neighbourhood. Interface Catchment measures the total length of public/private interfaces, within a given walking distance. The total length of interfaces relates to the capacity of the urban fabric to incorporate a mix of attractors, such as entries to various buildings with various functions. Combined AwaP and IC can distinguish between traditional central-city morphologies with high-permeability and high catchment, labyrinthine morphologies with low-permeability and high catchment, modernist morphologies with high-permeability and low catchments, cul-de-sac suburbs with low permeability and low catchment.

The mapping and measures have been calculated in QGIS with the AwaP and IC plugins developed by Majic & Pafka (2019). These plugins use innovative algorithms that empower urban morphological analysis with the computational capacity of GIS. The interface catchment has been calculated for a 400m walking distance, calculated from the middle of the platform. While the interface catchment takes various spatial configurations for each station, the cumulative length for each station is remarkably similar, around 10,000m, with variations of 10% only. On the other hand permeability varies more significantly. The highest permeability is around Loyola with an AwaP of 571m, followed by Granville with 644m. Both Melbourne case studies have very poor permeability, with AwaP of 800m and 740m. Thus the significant differences in patronage between these two pairs of adjacent stations are not linked to street network, and as shown previously neither to residential density.

Walkability is however a more complex property that emerges from the synergies between density, mix and access (Dovey & Pafka, 2020). Looking at functional mix the major differences between the railway stations become apparent. In Chicago the area around Loyola station incorporates a university campus, while Granville only has a small local shopping street. In Melbourne the Box Hill station is at the core of a shopping mall which is connected to two short retail streets, while Mont Albert only has a small local shopping strip. Thus the differences in station patronage seem to have less to do with station design or neighbourhood street configuration, but rather with the regional attractors (university and mall) located next to the station.

6. Discussion

In this research we aimed to better understand transit-oriented assemblages in large metropolitan areas. Our approach was informed by assemblage thinking and involved a multi-scalar exploration of mobilities at metropolitan, neighbourhood and station scale. We developed new mapping methods to capture station usage and neighbourhood capacities of movement in metropolitan areas. While one of our key goals was to uncover emergent transit-oriented neigh-



Figure 3. Walkable access of railway stations.

bourhoods as envisioned in the literature (Bertolini & Spit, 1998; Calthorpe, 1993; Dovey & Woodcock, 2014) we haven't discovered any station area that would neatly fit the TOD model. Instead we found that many non-CBD stations with high levels of patronage are either linked to bus or park-and-ride interchanges, and thus support suburban mobilities within car-dependent cities. In the few exceptions where the high station patronage could not be simply linked to extended catchment through other motorised transport modes, we found regional or metropolitan scale attractors, such as university campuses or shopping malls located in close proximity of stations.

In our multi-scalar analysis of station patronage we found three key factors for high usage: (1) the necessity to pass through the station in order to get somewhere else, as in the case of a bus, car or train interchange (i.e. station acts as a multi-modal hub), (2) the desires and needs

of residents in high-density residential areas to access other functions of the city and leave their neighbourhoods, and (3) the desire to access a key visit or work attractor located within walking distance of the station, such as a CBD, university campus, shopping mall or stadium. The two stations with higher use we focused on in this paper fall in multiple categories. In the case of Loyola in Chicago, the station is next to a university campus as a work destination, while it is also within a higher-density residential area. In the case of Box Hill in Melbourne, the shopping mall on top of the station is a key regional visit destination, while there is also a major bus interchange above it. Most stations with high use outside the CBD we found in these car-dependent cities are seemingly dull places that serve utilitarian purposes only, such as interchange, mono-functional residential or work district, or an occasional major attraction such as a stadium. However, high station usage in some cases can be related to a more intensive place of encounter, when it is part of a mixed-use neighbourhood, with visitor attractions as well as higher-density residential spaces.

The effective integration of private shopping malls with their suburban hinterlands has been considered as multimodal transit hubs embodying potentials for transit-oriented intensification within low-density car-dependent cities particularly those that characterise North America and Australia. Hence, there is no prospect of simply wishing them away. However, different forms of shopping malls considering their associated morphologies (e.g. permeability within the malls, connection to the surrounding street network and local neighbourhood, connection to the large car parks) as well as their multi-modal nature can be further investigated to better understand the extent to which such major attractors can encourage or constrain transit-oriented urbanism. This is also linked to the question of how to leverage such developments (e.g. shopping malls) to fund better public transport connections.

The diagrammatic representation of the metropolitan organisation of rail, bus, park-and-ride catchments in Chicago and Melbourne (Figure 4) shows how their spatial logic is linked to the simple radial network structure. The further the rail station from the centre, the bigger the gap to the next rail branch, and the greater the opportunity for radial bus connections to increase the catchment of a station. Once a station is designed to accommodate a bus-interchange, multiple bus routes can be directed to that station, covering the metropolitan interstices between the rail branches.

This research advances methodological tools for a multi-scalar understanding of the neighbourhood morphology – station design – transport network nexus, contributing to a novel approach to studying urban mobilities. Innovative methods of mapping and diagramming multi-scalar mobilities have been developed. We hope that these methodological tools can help advance urban research across disciplinary boundaries, bridging between morphological and transport studies. Such an endeavour will require a non-reductionist approach that includes the broader assemblage of urban elements at multiple scales. It also requires a socio-spatio-temporal thinking, that avoids the pitfalls of reductionism in the pursuit of capturing urban phenomena with ever greater precision.

7. Acknowledgement

We thank Fujie Rao for an insightful critique of an earlier version of this paper, and Ran Pan for the residential density base maps shown in figure 2.

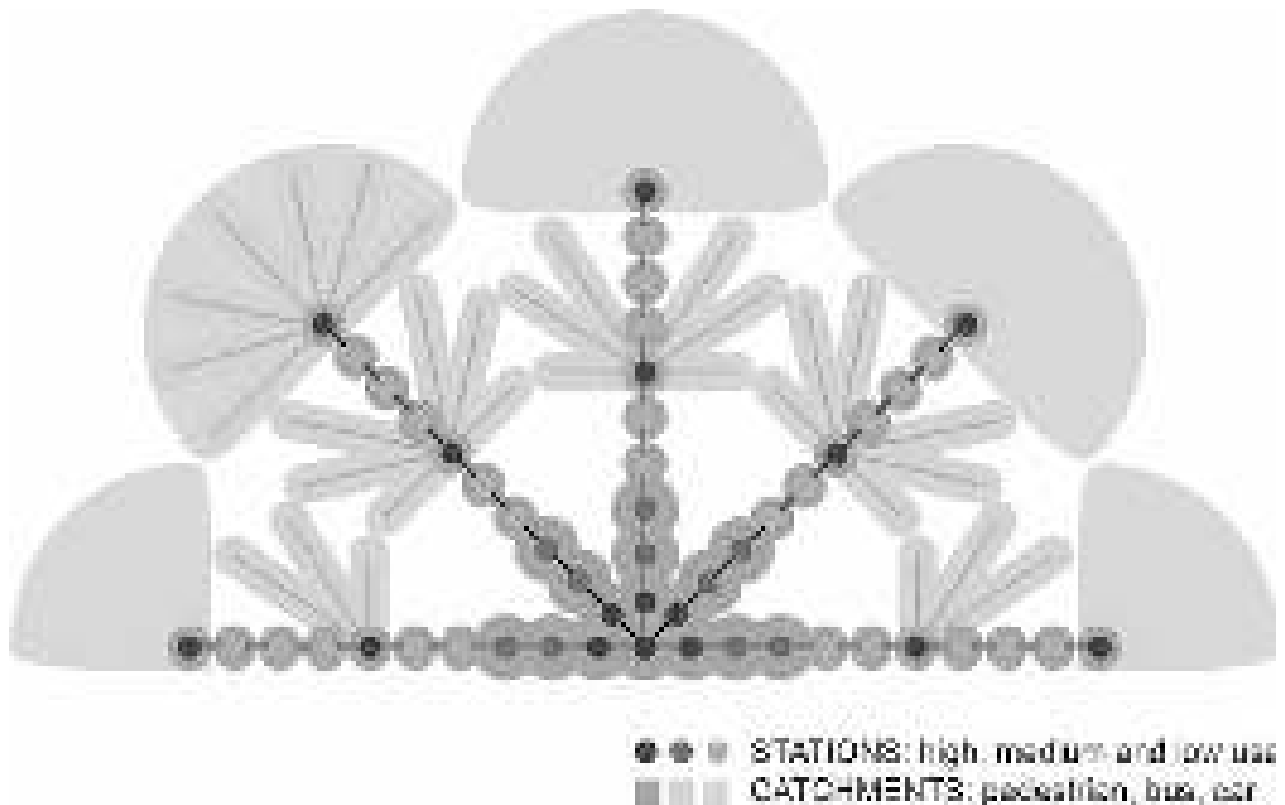


Figure 4. Pedestrian, bus and rail catchments – a diagrammatic representation.

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Spatial Pattern Evolution and Industrial Characteristics of Economic and Technological Development Zones and High-Tech Industrial Zones in China

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Keywords: economic and technological development zone, high-tech industrial zone, spatial pattern.

Abstract: Economic and technological development zones (ETDZ) and high-tech industrial zones (HTIZ) are important types of development zones (DZ) in China, but there are differences and similarities in connotation and function between the two. This article collects basic data about ETDZ and HTIZ at the national level and the provincial level, and it analyzes the spatial pattern of their evolution from 2006 to 2018 using GIS spatial analysis techniques. First, the intensity of agglomeration is compared by measuring the degree of regional agglomeration and dispersion in 2006 and 2018. Second, the kernel density method is used to explore the evolution of the spatial layout and location of ETDZ and HTIZ and analyze their commonalities and differences. Finally, the trend and reasons for the spatial evolution of DZs are explored for three different industry groups. The research results show that: (1) the intensity of agglomeration of HTIZ layouts is stronger than that of ETDZ; (2) the distribution of labor-intensive, capital-intensive and technology-intensive DZs is concentrated at smaller scales and dispersed at larger ones; and (3) despite the differences between ETDZ and HTIZ in the establishment of goals, support, structural functions, and management systems, the spatial development of the zone shows a trend of convergence. In the future, while strengthening urban and rural planning and public management, the government should optimize the spatial layout of DZs by adjusting industrial structure, layout, transportation and land use in combination with the trend of industrial transformation and upgrading.

1. Introduction

The year 2019 marks the 41st anniversary of China's reform and opening up. During this period, China's GDP rose from ¥367.9 billion in 1978 to ¥90.03 trillion in 2018, a remarkable rate of growth. Such a huge development achievement reflects the success of the regional economic development strategy and policy implementation since the reform and opening up. Among the most successful development strategies is the planning and construction of the development zone which is seen as a uniquely "Chinese experience", brought to the attention of the international community especially other developing countries (Zhang J.K., 2010).

With the development of the commodity economy, international trade, science and technology as well as the international division of labor, DZs have gradually formed and expanded. Since the middle of the 20th century, there have been two new DZs in the world characterized

by export processing zones and scientific industrial zones. In the past 20 years, driven by the reform and opening up policy and the wave of new technologies, China has successively created different types and levels of DZs, such as special economic zones, economic and technological development zones, high-tech industrial development zones, border economic cooperation zones, and bonded zones. Studying the evolution process of spatial layout and industrial characteristics, and adjusting the spatial organization and layout of DZs are conducive to realizing complementary advantages, resource conservation and high economic development efficiency of DZs, which is of great practical significance for promoting economic growth and an inevitable choice of development strategy for China. (Gao C., 2015).

Similar concepts in foreign countries include “enterprise zones” and “high-tech parks”. Foreign scholars have long paid attention to the great impact of scientific industrial parks on urban development. Davelear (1991) realized that scientific industrial parks are not only the core of urban high-tech industries, but also stimulate local cities through re-industrialization, technology and industrial transfer and creation of synergies. Taubmann (1993) believes that the urbanization process induced by the construction of DZs in China will be the cause of another period of great urban development in China. Some scholars regard it as the product of a government system of space production. They believe that DZs with various titles can strive for additional construction land indicators, resulting in real estate speculation and the spread of urban inefficiency (Cartier, 2001; Walcott, 2002). In recent years, scholars have also studied cases of various countries and affirmed the role of DZs. They suggest that science parks effectively promote innovation and regional development in developed countries (Ratinho, 2010); In economically backward countries and regions, some export processing zones play a role in easing unemployment and promoting economic growth (Ham, 2011). With the rapid construction and development of all kinds of DZs in China, the research on them is also deepening gradually. The research on the early stage of the DZ mainly focused on the necessity of construction and location selection (Chen H.X., 1989), foreign experience (Zhao, 1989), etc., to cope with the lack of theoretical support at the beginning of the establishment of DZs in China. Later, the research focus shifted to new phenomena and problems (He, 1999; Long, 2000), DZ strategies (Liu, 2003), DZ and urban spatial structure evolution (Zhang X.P., 2003), etc. In recent years, research on DZs has presented a trend of multi-perspective diversification. Scholars pay attention to the harmonious development of DZs and regional economy, population, resources, environment and society (Zhang X.H., 2012) and spatial pattern evolution (Gao C., 2015; Wu, 2018; Cai, 2019), as well as research on the transformation and development of DZs (Zhou, 2017). In terms of research methods, due to the change of research topics and the progress of research technology, qualitative description has shifted to a combination of qualitative and quantitative methods.

In general, rich achievements have been made in the research on DZs, but most of them are economic DZs, lacking comparison and quantitative analysis of different types of DZs. At the same time, the research areas are more concentrated in the developed coastal areas, and the research on the spatial pattern and industrial evolution at the macro scale is insufficient, which makes it difficult to solve problems such as the optimization and integration of the spatial structure of DZs. In view of this, this paper takes national and provincial ETDZ and HTIZ as research objects and adopts GIS spatial analysis and other methods to analyze the spatial and temporal distribution and industrial characteristics of China's DZs from 2006 to 2018, to provide a benchmark for the future development of DZs.

2. Methodology

2.1. Research objects and data sources

Since the 1990s, there have been three peaks of “development zones fever (kai fa qu re)” in China. The first clean-up was after the DZ boom of 1992-1993, when the scale of construction was far beyond the actual needs and economic capacity. The second occurred in 1997, when most of the DZs were set-up by local governments in violation of regulations. In 2003-2006, the state council rationalized the DZ regulations and cut the number of national DZs from 6,866 to 1,568 and the planning area of 386,000 square kilometers was reduced to 9,949 square kilometers. By publishing *List of China development zone audit notice (2006 edition)*, the national DZ land use scale was brought within a reasonable limit (Zhang Pu, 2007). In 2017, the general office of the state council issued *several opinions on promoting the reform and innovative development of development zones*, which was China’s first overall guidance document on various types of DZs. In 2018, the Ministry of Natural Resources issued *List of China development zone audit notice (2018 edition)*. This article selects 2006 and 2018 as the two points in time to represent the temporal development of ETDZs and HTIZs. Each DZ is represented as a point on the map, with the help of BMap software to query the geographical coordinate data for all types of DZs, using Arc-GIS10.2 software to establish “China DZ geospatial database”.

2.2. Research methods

Three models were used for the spatial analysis of the DZs represented in the China DZ geospatial database: nearest neighbour analysis, kernel density and the standard deviational ellipse.

2.2.1. Average nearest neighbor(ANN) analysis

This method was first proposed by Clark and Evans (Clark P.J., 1954) and later introduced into the spatial analysis of urban settlements. The ANN analysis method compares the average distance between the observed nearest neighboring elements and the average distance between the random distribution patterns to judge the scale of their spatial agglomeration. The corresponding calculation formula is as follows:

$$ANN = \frac{\bar{D}_0}{\bar{D}_E} \quad (2.1)$$

Where, $\bar{D}_0$ is the average distance between a spatial point and its nearest neighbor:

$$\bar{D}_0 = \frac{\sum_{i=1}^n d_i}{n} \quad (2.2)$$

$\bar{D}_E$ is the average distance of the random distribution of points:

$$\bar{D}_E = \frac{0.5}{\sqrt{\frac{n}{A}}} \quad (2.3)$$

where d_i is the distance between point i and its nearest neighbors, n is the total number of regional points, and A is the area of the region where the points are located. If the average ANN

is less than 1, a clustered pattern is indicated. If ANN is greater than 1, it shows a tendency towards dispersion.

2.2.2. Kernel density estimation method

The kernel density estimation method is to estimate the density of a point pattern by means of a moving cell, which is one of the most commonly used and effective methods in point pattern analysis (Wu, 2018). This method has been widely used in the study of spatial distribution characteristics of geographical elements, which can directly and succinctly reflect the spatial agglomeration area.

Assuming the density at p is, and the estimated value is the specific form of the kernel density model is shown below:

$$\widehat{\lambda}_h(p) = \sum_{i=1}^n \frac{3}{\pi h^4} \left(1 - \frac{(p-p_i)^2}{h^2} \right)^2 \quad (2.4)$$

2.2.3. Standard deviational ellipse (SDE)

This is an analytical tool for measuring spatial differentiation of regional geographical elements. The main parameters of SDE analysis include gravity center, azimuth, long axis and short axis. The center of gravity reflects the relative position of the whole spatial distribution of each point. The azimuth reflects the main trend direction of its spatial distribution. The long axis is the direction with the most spatial distribution, while the short axis is the direction with the least spatial distribution. The ratio of long axis to short axis reflects the spatial distribution pattern of elements. Arc-GIS10.2 is used to calculate the SDE and then to analyze the overall development space of the DZ.

3. Analysis/Results

3.1. General situation of ETDZ and HTIZ

As the two main forms of DZs in China, ETDZs and HTIZs have both similarities and differences in strategic objectives, development models, management structure, and overall functions. ETDZs are important components of China's opening to the outside world strategy. Their purpose is to attract foreign investment, create an environment with a strong attraction to foreign capital to introduce technology and management, promote scientific and technological progress, expand exports, and provide a window on the world for host cities and regions. In order to reduce the cost of investment, ETDZs focus on the advantages of geographical resources, and are mainly located in urban or suburban areas of coastal port cities with superior access to inland transportation hubs. The main task of HTIZs is to promote the transformation of traditional industries and the development of local economies by relying on China's scientific and technological strength and industrial foundation, and to accelerate the commercialization, industrialization and internationalization of China's high-tech achievements. Therefore, their layouts rely mainly on access to intellectual resources, and the location selection is based mainly on the concentration of universities, scientific research institutions and large enterprises with strong scientific research strength

(Chen, Y. S, 2002). In 2006, after reorganizing the DZs, the state published *List of China development zone audit notice*, cataloging 1,395 economic and technological DZs and 118 high-tech industrial DZs. In 2018, Ministry of Natural Resources reissued the list, which included 2,210 economic and technological DZs and 339 high-tech industrial DZs.

3.2. Spatial Analysis: Clustering and Dispersion

In this paper, Euclidean distance is the measurement method used in the ANN analysis which is adopted to quantify the spatial distribution of ETDZ and HTIZ in 2006 and 2018 respectively, and the calculation results are shown in Figure 3.1. Figure 3.1 (a) shows the results of the ANN calculation in ETDZ in 2006. The ANN ratio is 0.64, indicating that the spatial layout of the economic zone in 2006 presents a clustered state. Figure 3.1 (b) shows the calculation results of the ANN of HTIZ in 2006. The ANN ratio is 0.48, indicating that the spatial layout of the high-tech zone in 2006 also presents a clustered state, and the degree of clustering is higher than that of the economic zone. In 2018, the ANN ratio of the economic DZ is 0.72, and the ANN ratio of the high-tech DZ is 0.64, which is higher than the ANN ratio of 2006, respectively. This indicates that the spatial layout of DZs the two regions is clustered, and the difference in intensity of agglomeration is gradually decreasing. However, the HTIZ is still more clustered than the ETDZ.

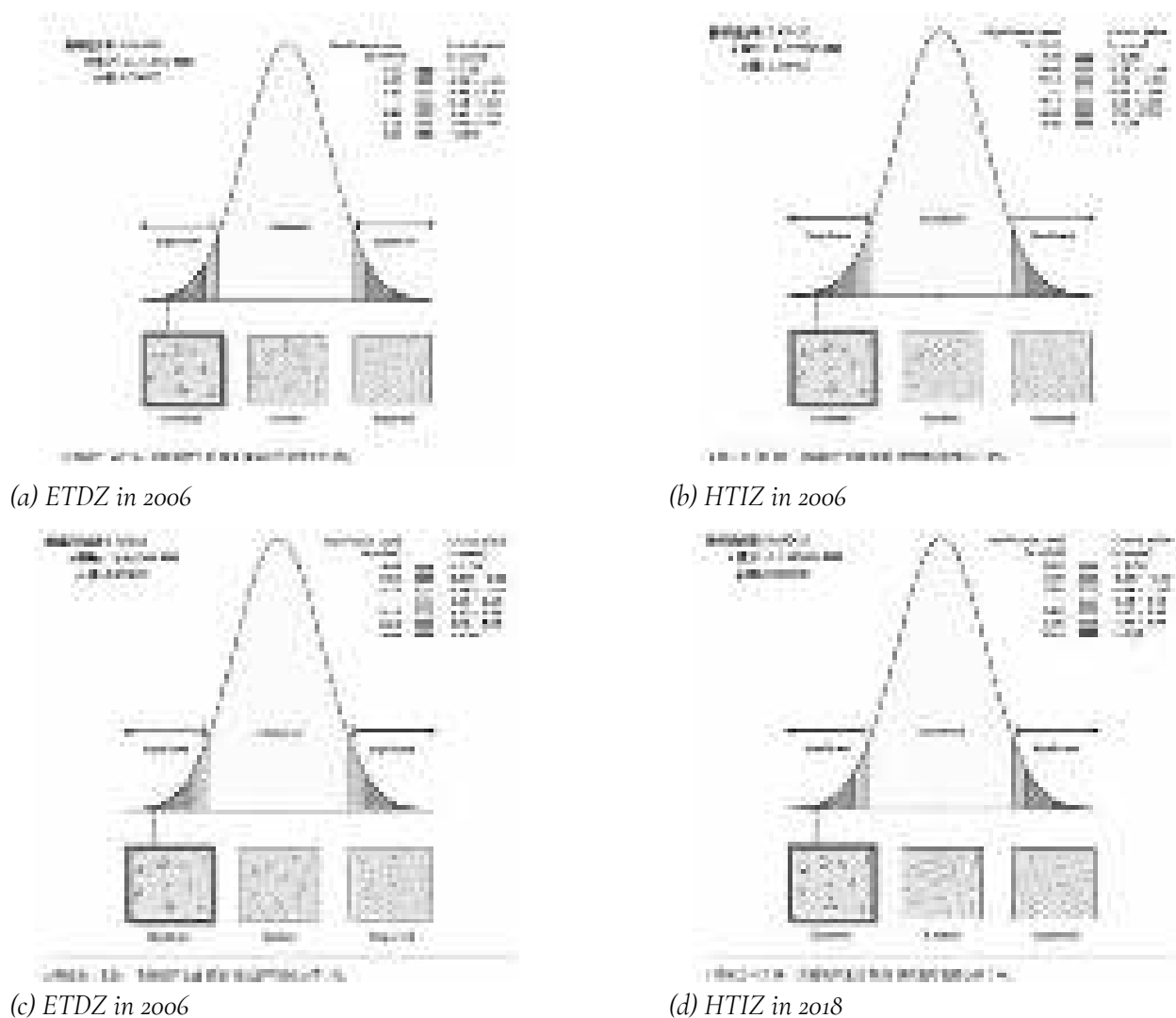


Figure 1. ANN analysis of ETDZ and HTIZ, 2006 and 2018.

3.3. Agglomeration of ETDZ and HTIZ

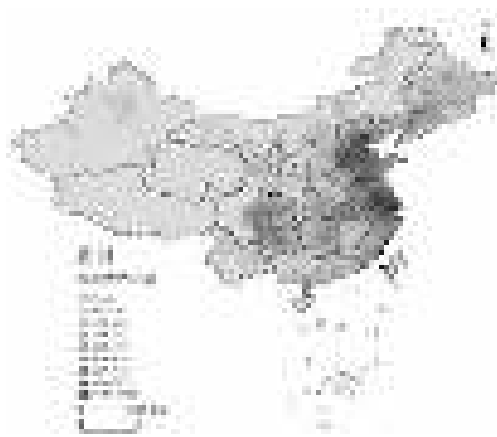
The spatial distribution and agglomeration of ETDZ and HTIZ in 2006 and 2018 were analyzed. The research adopted the kernel density analysis method to obtain four spatial agglomeration distribution maps, as shown in Figure 3.2. On the whole, the distribution of DZs in China has obvious regional distribution characteristics that differentiate between the dense eastern region and the sparse western region. Its distribution is highly consistent with the distribution of urban agglomerations. However, some regions show a significant spatial transfer trend.

In 2006, ETDZ in the eastern region formed a continuous cluster of DZs based on the Beijing-Tianjin-Hebei and Yangtze river delta city clusters, the central region formed a cluster of DZs based on the central Yangtze river central plains city clusters, and the western region formed a cluster of DZs based on the Chengdu-Chongqing city clusters. In 2018, the continuous agglomeration trend of the Beijing-Tianjin-Hebei, Shandong peninsula and Yangtze river delta regions gradually expanded, and the Chengdu-Chongqing-Guizhou city cluster also gained new agglomeration points, while the agglomeration trend of the central Yangtze river city cluster weakened.

In 2006, the distribution of HTIZ was mainly concentrated in the Beijing-Tianjin-Hebei region, the Yangtze river delta, Henan province, the central plains of the Yangtze river and the pearl river delta city clusters; in 2018, the agglomeration trend has been greatly strengthened,



(a) ETDZ in 2006



(b) ETDZ in 2018



(c) HTIZ in 2006



(d) HTIZ in 2018

Figure 2. *K* density analysis of ETDZ and HTIZ, 2006 and 2018.

with the formation of agglomeration peaks in the city clusters of the Yangtze river delta, and significant agglomeration trends in the central plains and east of Liaoning province peninsula.

3.4. Industrial agglomeration status of ETDZ and HTIZ

According to the leading industries assessed by *List of China development zone audit notice*, this paper classifies the industries into technology-intensive, capital-intensive and labor-intensive industries according to the importance of the use of input factors in the process of industrial development. The food industry, shoes and clothing manufacturing, wood furniture, and paper making and printing are classified as labor-intensive industries; petrochemical industry, ceramic building materials, non-metallic products, metal smelting, and plastic manufacturing are classified as capital-intensive industries; and communications, electronics, automobile manufacturing, and biomedicine and equipment manufacturing are classified as technology-intensive industries. The ANN method was adopted to calculate the agglomeration degree of the three types of industries in 2006 and 2018. The results passed the significance test, and the ANN ratio is shown in Table 3.1. It can be seen that the distribution of the three types of industries has grown more dispersed from 2006 to 2018. The technology-intensive industries are more concentrated than either of the other two, and the newly established capital-intensive industries are more dispersed.

To further analyze the spatial characteristics of three types of industrial development, this paper uses ArcGIS10.2 to conduct the SDE analysis, and obtains the spatial pattern of the development level of three types of industries and the relevant parameters of the SDE (Tables 3.2, 3.3 and Figure 3.3). On the whole, the SDE spindle of the three types of industries in 2006 and 2018 generally shows the direction of “northeast – southwest”, and the direction of the spindle moves to the northwest. The SDE covers most areas in the southeast, and its distribution range shows an increasing trend over time. Capital-intensive industries have the most obvious development trend to the west and north, followed by labor-intensive industries, which show a gradual diffusion trend to the western inland areas. From the shape of the SDE, the ratio of the short axis to the long axis has decreased from 2006 to 2018. It can be seen that the spatial distribution of the DZ is increasingly extending to the northeast and southwest, indicating

Table 1. The ANN ratio for three industry types, 2006 and 2018.

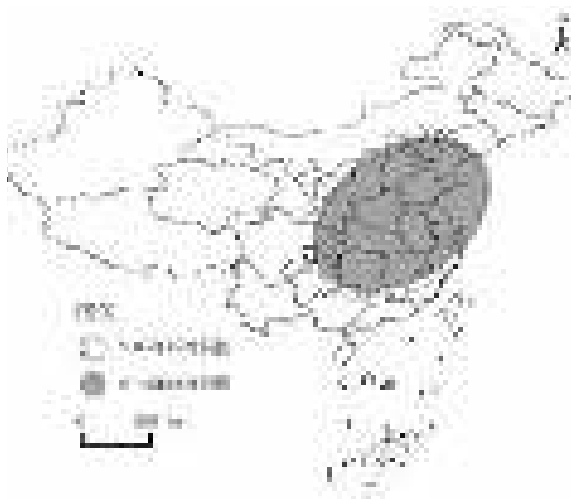
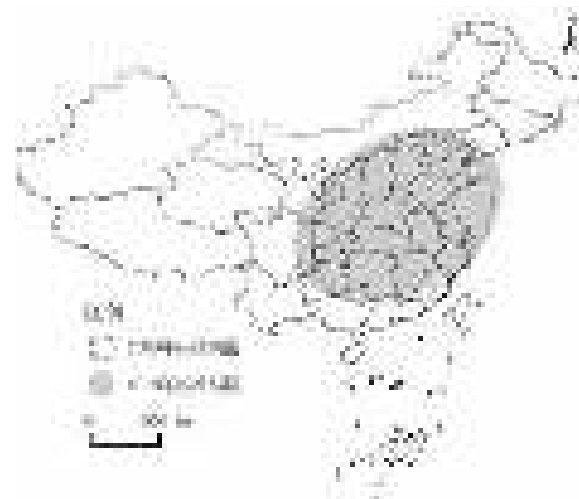
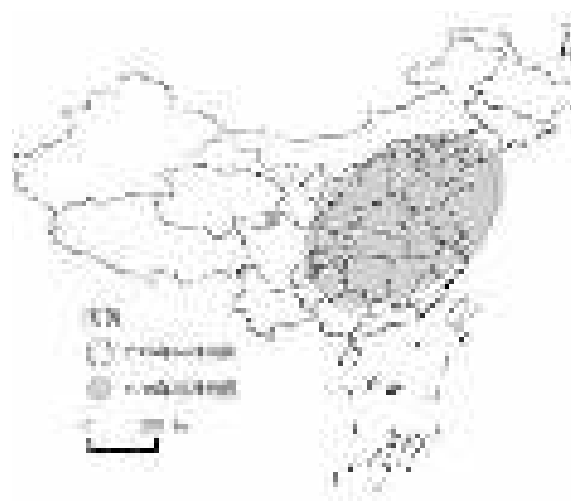
2006年		2018年	
Industry types	ANN ratio	Industry types	ANN ratio
Technology-intensive	0.561684	Technology-intensive	0.612738
Capital-intensive	0.612888	Capital-intensive	0.713115
Labor-intensive	0.633458	Labor-intensive	0.708602

Table 2. *The spatial pattern of three industrial types in 2006 according to the SDE method.*

Types of ellipse	Gravity center	Azimuth	Shape exponent
technology-intensive	115.44°E, 32.78°N	47.35	0.683014277
capital-intensive	114.83°E, 32.90°N	50.32	0.775503017
labor-intensive	115.48°E, 32.82°N	48.15	0.669838471

Table 3. *The spatial pattern of three industrial types in 2018 according to the SDE method.*

Types of ellipse	Gravity center	Azimuth	Shape exponent
Technology-intensive	115.58°E, 33.57°N	55.03	0.675380754
Capital-intensive	114.43°E, 33.53°N	60.36	0.694571416
Labor-intensive	115.39°E, 33.67°N	54.51	0.618682398

(a) *Spatial pattern of technology-intensive industries*(b) *Spatial pattern of capital-intensive industries*(c) *Spatial pattern of labor-intensive industries*Figure 3. *Standard deviation ellipse of the three industry types.*

that the centripetal force is gradually decreasing and the dispersion degree of the distribution is increasing.

The three types of industries were analyzed for their kernel density, and their spatial distribution patterns were obtained (Figure 3.4). It can be seen that there is a distribution pattern which is concentrated at small scales and dispersed at large ones. In 2006, there were 1,173 technology-intensive industries, accounting for 77.53%, and 1,969 in 2018, accounting for 77.25%. These industries are mainly distributed in the Beijing-Tianjin-Hebei region, Yangtze river delta region, and the central plain city cluster of the Yangtze river. The agglomeration scale of Beijing-Tianjin-Hebei region is expanding, and it forms a contiguous pattern with central Shandong province and the Yangtze river delta region in the south. In 2006, there were 705 capital-intensive industries, accounting for 46.60%, and 1,219 in 2018, accounting for 47.82%. These industries were mainly distributed in the Beijing-Tianjin-Hebei region, the Yangtze river delta, and the central plains of the Yangtze river. In 2006, there were 908 labor-intensive industries, accounting for 60.01%, and 1370 in 2018, accounting for 53.75%. The distribution of labor-intensive industries is more concentrated: the central area of the Yangtze river shows a weakening trend while the agglomeration trend of Chengdu-Chongqing area is strengthening.

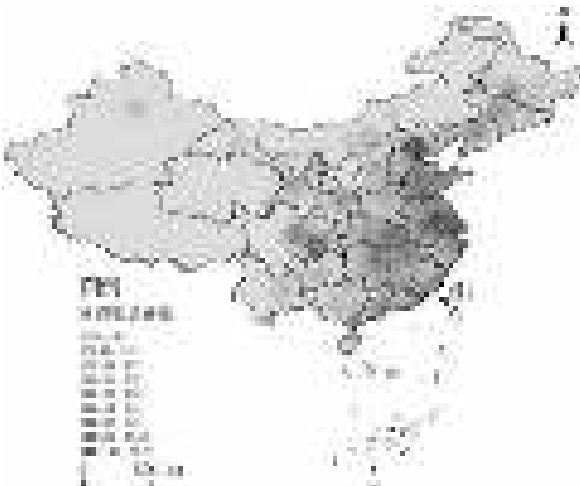
4. Conclusion

This study uses three modern geoscience analysis methods: nearest neighbor index, kernel density estimation, and the SDE to understand the overall spatial distribution of three industrial types in China's economic and high-tech zones in 2006 and 2018. Three conclusions may be drawn from the analysis.

4.1 Both the ETDZs and HTIZs show an agglomerated spatial distribution. The HTIZs are more agglomerated than the ETDZs, but the difference in intensity of agglomeration is gradually shrinking. In terms of the overall distribution density characteristics, the two kinds of DZs are densely distributed in the east and sparsely distributed in the west. At a large scale, the ETDZ in the Beijing-Tianjin-Hebei region, Shandong province and the Yangtze river delta region show a trend towards concentrated contiguous development. With the continuous strengthening of infrastructure, these regions have made great achievements in attracting foreign investment. The trend of the HTIZs is more obvious in the Chengdu-Chongqing city clusters, the central plains of the Yangtze river, the Yangtze river delta and the pearl river delta. The open external environment encourages the clustering of a large number of high-tech talented workers, laying the foundation for the development of more HTIZs.

4.2 The distribution of labor-intensive, capital-intensive and technology-intensive DZs presents a distribution pattern which is concentrated at smaller scales and dispersed at larger ones. The distribution of technology-intensive industries is more concentrated than the capital and labor intensive industries, mainly in the Beijing-Tianjin-Hebei region, the Yangtze river delta and the central plains urban agglomeration of the Yangtze river. Capital-intensive industries are more dispersed and mainly distributed in the Beijing-Tianjin-Hebei region, the Yangtze river delta and the central plains of the Yangtze river. Labor-intensive industries in the central plains of the Yangtze river showed a weakening trend, and the agglomeration trend in Chengdu-Chongqing area was strengthened.

4.3 Although there are differences between the ETDZ and HTIZ in the establishment of goals, support, structural functions, management system and other aspects, their spatial development shows a trend of convergence. Due to the strategic adjustment of their macro-eco-



(a)Density analysis of technology-intensive industries in 2006



(b) Density analysis of technology-intensive industries in 2018



(a) density analysis of capital -intensive industries in 2006



(b) density analysis of capital -intensive industries in 2018



(a) density analysis of labor-intensive industries in 2006



(b)density analysis of labor-intensive industries in 2018

Figure 4. Kernel density analysis of three industrial types in 2006 and 2018.

economic structure, the ETDZs are actively committed to the development of high-tech industry while vigorously developing modern industry. Due to the poor foundation of some high-tech industrial DZs, their development does not reflect the distinctive characteristics of high-tech industries, especially since the Ministry of Foreign Trade and Economic Cooperation and the Ministry of Science and Technology began to implement the strategy and action plan of promoting trade through science and technology. Therefore, the high-tech industrial DZs are also actively choosing an export orientation (Chen, Y. S., 2002).

From the development of ETDZs and HTIZs in China over the years, we can see the same growth trajectory of the two types of DZs: starting from policy support, through various infrastructure construction, moving towards comprehensive innovation and sustainable development. As a test of reform and opening up policy and as new spatially grounded instruments for economic development, the two types of DZs are facing new opportunities and more severe challenges in the new millenium. The two types of DZs need to continue to advance from mainly relying on policy support and infrastructure construction to focus on management and industrial innovation while constantly enhancing their capacity for sustainable development and continuous organic innovation. The findings of this paper inspire the need for future research on the mechanisms that drive the knowledge economy and the factors that encourage the clustering or dispersion of ETDZs and the HTIZs in China's space economy.

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Planning Sustainable Urban-Industrial Configurations

The Influence of Industrial Complexes Morphology on Industrial Placement

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Keywords: Urban Planning, Industrial Morphology, Industrial Placement, Centrality, Space Syntax.

Abstract: Forthcoming shifts towards network-integrated production models, such as Industry 4.0, may change industrial organisation and production. As these transformations advance, demands for methods allowing to foresee their effects on urban spaces increase. Urban road-network configurational properties' analyses can depict changes in industrial placement tendencies under this new paradigm, enabling planners to design, evaluate industrial complexes' morphology and develop strategies that contribute to urban productive areas resilience and long-term sustainability. This study undertakes methods to perform these analyses using as empirical cases three Brazilian industrial complexes located in Porto Alegre's Metropolitan Region (PMAR) municipalities of Alvorada, Cachoeirinha Gravataí and Viamão. Hypothesis is that movement potentials and flow probabilities informed by urban road-network centralities' hierarchies have direct correlation to industrial placement patterns; therefore, higher movement distribution can improve endogenous firm-to-firm relations, favouring inner-complexes' clustering effects. Premises are verified through geo-statistical correlations between road-circulation networks centralities, constructed through Space Syntax Angular Analysis methodology, and industrial structures placement and agglomeration. Results demonstrate significant statistical correlations among structures and road-circulation centralities, indicating greater industrial clustering and occupation in complexes with more distributed movement potentials. Hence, complexes' morphology can inform industrial placement tendencies, and their analyses should be employed as planning tools for sustainable productive environments.

1. Introduction

Complexity of industrial activities' spatial organisation has increased in past decades, outcome of globalisation processes, the "Third Industrial Revolution" and subsequent flexibilization of production models in capitalist economies. Once integrated into urban centres, these activities were relocated from cities' cores and moved to planned industrial complexes scattered in metropolitan areas, following an urban deindustrialisation dynamic described by Rocassalva & Pluviano (2012) for Europe, likewise occurring in developing countries, such as Brazil, as stated by Alonso (2001), and further discussed, regarding spatial implications, by Altafini (2018).

As far as these deindustrialization effects from the "Third Industrial Revolution" still linger,

Hoffman & Rüsch (2017) mention that the rapid post-revolution technological progress in “*smart manufacturing*” and “*integrated industries*” may, in the near future, lead to another industrial paradigm shift, idea endorsed by Germany during early 2010’s, following the *Industrie 4.0* (*Industry 4.0*) initiative. Its premises, as projected by Kagermann, Wahlster & Helbig (2013), will be based on flexible mass-production, automation, real-time coordination, optimisation of value chains, and reduction of process complexity, leading to the emergence of new production models. Hoffman & Rüsch (2017) advocate that major implications of this forthcoming shift will befall on logistics, as real-time tracking of material flows, and improved transport handling, both are crucial for providing envisioned *Industry 4.0* production systems required input factors at right steps of manufacturing processes and with consistent quality. In this sense, industrial complexes territorial planning should be able to cope with demands of transportation efficiency, as well integrating its conceived inner grid morphology to existent road-circulation networks of urban and metropolitan environments. Though now a rather unexplored topic in *Industry 4.0* studies, these subjects have potential to be a crucial part of future Industrial Economics and Urban & Regional Planning, since time-saving and synchronicity ought to be main issues in forthcoming production models, requiring specific sets of analyses, evaluating complexes’ inner-morphologies and relating physical and virtual networks to optimal industrial placement and movement efficiency.

Henceforth, paper assesses methods to investigate if road-circulation networks configurational properties, such as centralities hierarchies, can inform trends about placement, clustering and organisation of industrial activities in urban spaces, and how the inner-complex morphology may favour or disfavour industrial relations and agglomeration processes. Space Syntax (Hillier, 2007) is a theory whose methods can fulfil these analyses, capable to abstract and represent morphological features of urban spaces, depicting configurational properties of road-circulation networks in multiple scales. Through its models, associated with geo-statistical analyses, it is possible to unveil interaction potentials amid built structures (economic activities) and circulation structures (movement network and centralities) also devising statistical correlations to support conclusions about urban design efficiency. Empirical analyses encompass three Brazilian Industrial Complexes located in *Porto Alegre’s Metropolitan Region* (PMAR) of *Rio Grande do Sul State* municipalities of *Alvorada*, *Cachoeirinha*, *Gravataí*, and *Viamão*. Hypothesis is that movement potentials and flow probabilities informed by road-circulation network centralities’ hierarchies have direct correlation to industrial placement patterns, and that a higher movement distribution can favour inner-complexes’ clustering effects, improving important endogenous firm-to-firm relations, which may lead to competitive and innovative environments, contemporaneous and forthcoming industrial models’ quintessence. Premise is verified through geo-statistical correlations between road-circulation networks’ centralities, modelled through Space Syntax methodology, and industrial structures (sites) placement. These analyses empower urban planners and decision makers – both public and private – to better design and evaluate their proposals regarding industrial complexes construction and firm placement, imbedding them to road-network centrality structures, contributing to lower transportation costs, and improving development and sustainability of industries on urban environments, in adequacy to physical-virtual network integrated realities of future industrial activities.

2. Methodology

To evaluate inner-complexes morphology, and how road-circulation networks and its centralities patterns relate to industrial placement and agglomeration, two datasets were apposed on GIS

(Qgis, 2019): the *Porto Alegre Metropolitan Region* (PMAR)¹ industrial complexes, comprehending its area and industrial built structures; and their inner-complexes' road-network, represented by road-centre line maps, built as graphs and modelled through Depthmap X 0.5. (2015).

PMAR industrial complexes data comprises three expanses which have standardized rules for land-use. The complexes' of *Alvorada-Viamão*, *Cachoeirinha* and *Gravataí* are state planned industrial districts (ID's), dedicated for exclusive industrial placement; Spatial data regarding the ID's perimeters was acquired from *Rio Grande do Sul* state government (2017). Aforementioned areas were enacted as policies during the mid-1970's which intended to disperse industrial activities towards *Rio Grande do Sul* capital, *Porto Alegre*, boundaries, developing other municipalities of the recently created metropolitan territory (1974). Soares *et al.* (2015), state that the policies' goals were to minimize PMAR's territory uneven development patterns, as the placement of manufacturing activities was thought as a solution to increase spatial occupation, population, employment and income in the capital fringes. Successful in some degree, these policies resulted in a substantial growth both in cities' population and industrial activities participation in the regional economy during the 1980's & 1990's. However, the authors (*ibid*, 2015) point out that this trend has shifted during the late 2000's, as the industry general rate of participation on PMAR's economy has dropped, especially from 2008 onwards, indicating possible resilience problems concerning industrial activities, an aftershock of 2007-2008 global financial crisis.

Data regarding industrial sites' locations encompasses all industrial dedicated structures within selected complexes. Obtained through Open-Street-Map (2016a, 2016b), the spatial database was crosschecked through empirical data collected *in situ*, between March and October (2017), for functioning industrial structures and mapped in a single polygonal shapefile database. Spatial data contains built area information for each structure, employed as weighting variables in geo-statistical analyses. Analyses also employs Kernel Density Estimation (KDE) (Bailey & Gatrell, 1995), which allows to measure industrial agglomerations spatial density, to establish the sphere of influence² (*buffer*) for each industrial site, and to estimate proximity correlations between industrial structures and the road-circulation network different centrality measures.

Datasets for configurational analyses are based on a set of PMAR's axial maps organised by Zampieri (2017) and updated by Altafini (2018) to incorporate industrial complexes most recent urban expansions. Using these datasets and complexes' perimeter spatial data as guidelines, the inner-complexes' road-network was clipped from the regional map and reconstructed using, instead of axial representation, road-centre line representations, better suited for Space Syntax angular analysis (Turner, 2001, 2005). Such adaptation was made because the angular weighted topological steps provide a finer portrayal of *choice* (*betweenness* centrality), also refining slight differences in movement potentials for orthogonal and regular grids (Turner, 2007), morphological traits which are deemed to be prevalent in industrial zones.

Configurational analyses draw from Space Syntax theories, methods and tools, since they provide a group of measures (Normalised Angular Integration and *Choice*)³, both depicting dif-

1. *Porto Alegre's Metropolitan Region* located at *Rio Grande do Sul* State is currently (2019) comprises 34 municipalities. Road-network analysis use only 14 municipalities which represent the first iteration of PMAR (1974), chosen due to higher conurbation indexes (Rigatti, 2009), that frame a cohesive road-network. These municipalities concentrate most of regional industrial production. Of these 14 municipalities, only four have continuous territorialized industrial areas, and thus were chosen as empirical cases for the research: *Alvorada*, *Cachoeirinha*, *Gravataí*, and *Viamão*.

2. The influence radius (Kernel Buffer Radius) is delimited in 500m, stipulated as a maximum travel distance value from industrial firms' structures to the main public roads.

3. Angular integration and *choice* normalization processes were developed by Hillier, Turner & Yang (2012) to allow more accurate comparisons between different sized urban networks, thus, with different depths. It is also important because it betters the depictions of *choice* routes distribution, as it considers for calculus systems' total depth.

ferent urban centrality hierarchies', and evaluating distinct properties of movement potentials in the road-network, at local scale (with limited step or radius) and at global (whole network) scale. Normalised Angular Integration (NAIN) denote *closeness* centralities in an urban system. It establishes the accessibility of a single segment relative to all other road-network segments (to-movement). Normalised Angular *Choice* (NACH) reveals *betweenness* centralities in an urban system. It describes the most crisscrossed (preferential) routes in the road-network from all origin-destination pairs (through-movement). It is tested if centralities hierarchies represented by high NAIN & NACH values (high movement and flow potentials) are correlated with industrial placement and if that these centralities' hierarchies distribution, influenced by complexes' inner-morphology, favours agglomeration, also facilitating labour and transport relations among firms in an industrial complex. Hence, urban centralities can exert attraction towards economic activities, in a spatial process hinted by Hillier (2000) and explored by Cutini (2001), and later by Roccasalva & Pluviano (2012); and these centralities distribution will result in more efficient inner-complex connections, improving closeness amid firms, a factor that, as stated by Porter (1990, 1998) may lead to a better environment for competitiveness, innovation, development and resilience of industrial agglomerations.

On this premise, a group of configurational analyses is apposed to industrial spatial data, in order to assess if any correlations between high movement potentials denoted through NAIN & NACH and industrial placement exist. The statistical significance threshold is determined through the Pareto Distribution Principle (Pareto, 1971), which states that: to have significant correlations, at least 20% of causes – represented by the 20% highest segment values for angular analysis (centralities) – needs to be responsible for at least 80% of the effects – the placement of industrial structures⁴. Synergy correlations are employed to further investigate relations between industrial agglomeration, centralities and movement distribution on industrial complexes. Synergy is a Space Syntax measure that correlates the global (R_n) and local (R_3) measures of integration, thus, assesses movement potentials and its tendencies of distribution within a network. Higher values for Synergy correlation will denote a concentration of movement potentials in a few same groups of segments along the network, thus the centralities will be represented the same segments in both scales. Lower Synergy correlation values will be found on networks that exhibit more distributed movement potentials within the network, with centralities being in different groups of segments within the network⁵, indicating that local movement gathering structures are more distributed resulting in a more beneficial condition for industrial activities placement and, above all, for firm-to-firm relations to happen.

3. Analysis

Configurational analyses reveal a dichotomy amongst the selected industrial complexes inner-morphologies, which possess quite opposing road-circulation network configurations and significant structural differences:

4. If the industrial site sphere of influence (500m) intersects with at least one part of segment within the establish centrality threshold value (top 20%) there will be a valid spatial correlation.

5. Synergy correlation interpretations here are counter-intuitive to Hillier (1996) original proposition, in which high synergy values denote the *control* of some segment groups over the whole network (movement potentials concentration). From the social point of view this is desirable as it produces co-presence, since the *to-movement* relations are centred, in both scales, to same groups of segments. This, for industrial activities, mean a hindrance to reach by road transportation other firms, as local *to-movement* structures do not lead to local areas, but to main regional road-circulation networks.

Alvorada-Viamão ID (Figure 1) and *Gravataí ID* (Figure 3) both exhibit linear-based morphologies, differing on linearities number and internal disposition. *Alvorada-Viamão ID* (Figure 1), is constructed over an avenue with direct access to a regional highway (east), forming a long continuous segment group that represents both *centrality core* (Figure 1.2) and *preferential route structure* (Figure 1.4). From this *core-structure* branches of long linear segments give access to where most of industrial sites are placed. It can be noticed that few regular blocks are formed, as roads are often discontinuous; *Gravataí ID* (Figure 2) is built on three linearities, two (north & east) are regional highways continuities that constitute *centrality cores* (Figure 3.2). From roundabouts placed on these *cores*, branches of short road-segments lead to enclosed industrial sites placement areas. It can be observed that these enclosed areas seldom form continuous regular blocks, being characterized as *cul-de-sacs*. Connected to the national highway (south), these regional routes form complex's *preferential route structure* (Figure 3.4). It is important to remark that, although *Gravataí ID* *preferential routes* inner-morphology seem to constitute a *ring-road*, there is no direct linkage between segments other than the southeast interchange, being the northeast road a bypass, which is extended from a secondary highway service road.

Cachoeirinha ID (Figure 2) differs from the remainder industrial complexes since it possesses an orthogonal-grid inner-morphology, formed by apposition of several different sized regular grids. Although characterized by this regularity, *Cachoeirinha ID* exhibits a clear division constituting two areas with diverse features. Southmost area represents the complex first iteration, concentrating most industrial sites. Constructed over a bifurcation of two urban avenues, this area is crisscrossed by roads forming regular blocks and a central *ring-road*. It can be observed, however, that a few of these roads form *cul-de-sacs*, comparable to those found in *Gravataí ID*. Nevertheless, the emerging enclosed structure is accessible from multiple directions (Figure 2.1). South of central *ring-road* structure locates another *ring-road* encompassing an expanse of undeveloped land, that houses a few numbers of agroindustries unconsidered for this research. The central *ring-road* and regular grids form an overlapping *centrality core* (Figure 2.2) and *preferential route structure* (Figure 2.4), that extends towards northmost emplacements, where recently urbanised sectors of *Cachoeirinha ID* are located. Consisting of small unoccupied groups of blocks (east), and several long linearities (west) that occasionally form blocks with sparse industrial sites occupation, this area is connected to the neighbouring municipality of *Canoas*. Compared to remainder of the complex, this sector possesses a distinct linear-based morphology, with features similar to those depicted on *Alvorada-Viamão ID*.

A first overview regarding road-network centralities distribution is possible when Complexes' Configurational Attributes are analysed (Table 1):

Cachoeirinha ID (Figure 2), even though possesses the highest number of road segments, exhibit the lowest NAIN (Maximum & Mean) values found in selected industrial complexes, an indication that connectivity may have a wider distribution within its road-system. This alludes that there is no single segment that overly concentrate *closeness centrality*, feature that is depicted in Figure 2.2. The opposite logic is observed in *Alvorada-Viamão ID*, which, despite the lowest number of segments, exhibit the highest values for NAIN & NACH (Maximum & Mean) denoting movement and flow concentration tendencies in a single group of long segments, as depicted on spatial iconography (Figure 1.2 & 1.4). *Gravataí ID* (Figure 3), regardless of a linear-based morphology, exhibit values closer to *Cachoeirinha ID*, denoting that simple Configurational Attributes analyses are not enough to unveil all characteristics about centralities distribution, aspect that is better observed through Synergy Correlation Analyses (Figures 1.5; 2.5; 3.5; Table 3).

Correlations amid selected complexes Industrial Sites and NAIN & NACH values reveal

strong correlations amongst urban centralities and Industrial Activities Placement (Table 2), with all complexes attaining Paretian Significances (Over 80%) for NACH, and all but one for NAIN:

Alvorada-Viamão ID (Figure 1) is the only industrial complex that does not abide to established significance threshold for NAIN (Figure 1.1), as 59,2% of its industrial sites (93) are located within 500m from a top 20% centrality core (Figure 1.2). This result is explained by the urban grid morphology, depicted on Figure 1.2, as urban centralities concentrate on a single long linearity that does not reach the most internal placed industrial sites. The correlation for NACH, however, has statistical significance, with 82,8 % of the industrial sites (130) being placed within established range of a *preferential route* (Figure 1.4). It is noticeable that NACH is mostly concentrated in the same linearity as NAIN, and that these segments correspond for majority of complex *to and through movement*.

Cachoeirinha ID (Figure 2) possesses the highest correlation between Industrial Sites Placement and NAIN & NACH values. 92,8 % of the industrial sites (361) are located within 500m from a top 20% centrality core (Figure 2.1), while 98,9% of the industrial sites (385) are placed at same range threshold for a *preferential route* (Figure 2.4). Industrial sites are concentrated in areas

Table 1. *Selected Industrial Complexes Configurational Attributes.*

Nº	Industrial Complexes	Alvorada-Viamão ID	Cachoeirinha ID	Gravataí ID
-	Number of Road Segments	128	726	509
NAIN				
1.	NAIN (Max.)	1.556	1.089	1.139
1.	NAIN (Mean)	1.029	0.749	0.809
NACH				
3.	NACH (Max.)	1.591	1.559	1.536
3.	NACH (Mean)	0.659	0.606	0.630

Table 2. *Selected Industrial Complexes Total Number of Industrial Sites, Number of Sites within 500m from a road-network segment of NAIN (1.) and NACH (2.) restrictions of 20% (2. & 4.); and Sites Placement Correlation.*

Nº	Industrial Complexes	Alvorada-Viamão ID	Cachoeirinha ID	Gravataí ID
	Industrial Sites Total	157	389	208
NAIN				
2.	Industrial Sites Total (Restriction)	93	361	178
2.	Industrial Sites Placement Correlation	0.592	0.928	0.856
2.	Placement Correlation (%)	59.2	92.8	85.6
NACH				
4.	Industrial Sites Total (Restriction)	130	385	184
4.	Industrial Sites Placement Correlation	0.828	0.989	0.885
4.	Placement Correlation (%)	82.8	98.9	88.5

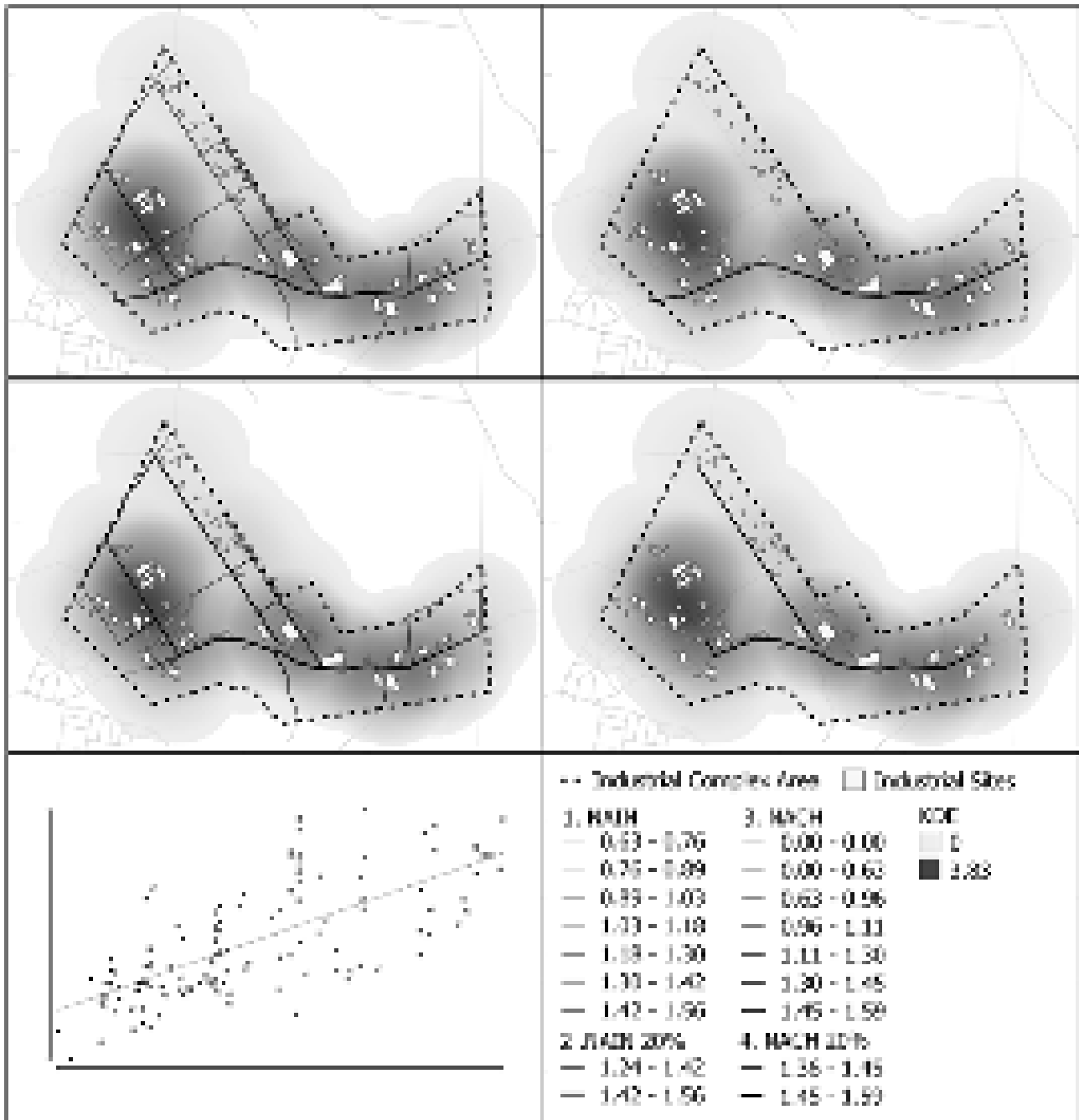


Figure 1. Alvorada-Viamão ID spatial correlations between Industrial Sites Placement (KDE), and inner-complex road-network centralities represented by NAIN (1.1) and NACH (1.3) restrictions of 20% (1.2 & 1.4); and Synergy Correlation graph between Integration R_n and R_3 values (1.5).

that dispose of more options of *to* and *through* movement, around the two main axes with higher closeness and *betweenness* centralities values. It is noticeable that, contrarily of what happens on Alvorada-Viamão ID, the regular and *ring*-based morphologies promotes higher connectivity, even to expanses around *cul-de-sacs*, giving access to more areas than branched single linearities. This feature not only can explain the observed higher occupation degree, when compared to other ID's, but also its own internal industrial organisation differences.

Although possessing a linear-based morphology comparable to Alvorada-Viamão ID, Gravataí ID correlation results differ, unveiling Paretian significances amid industrial placement

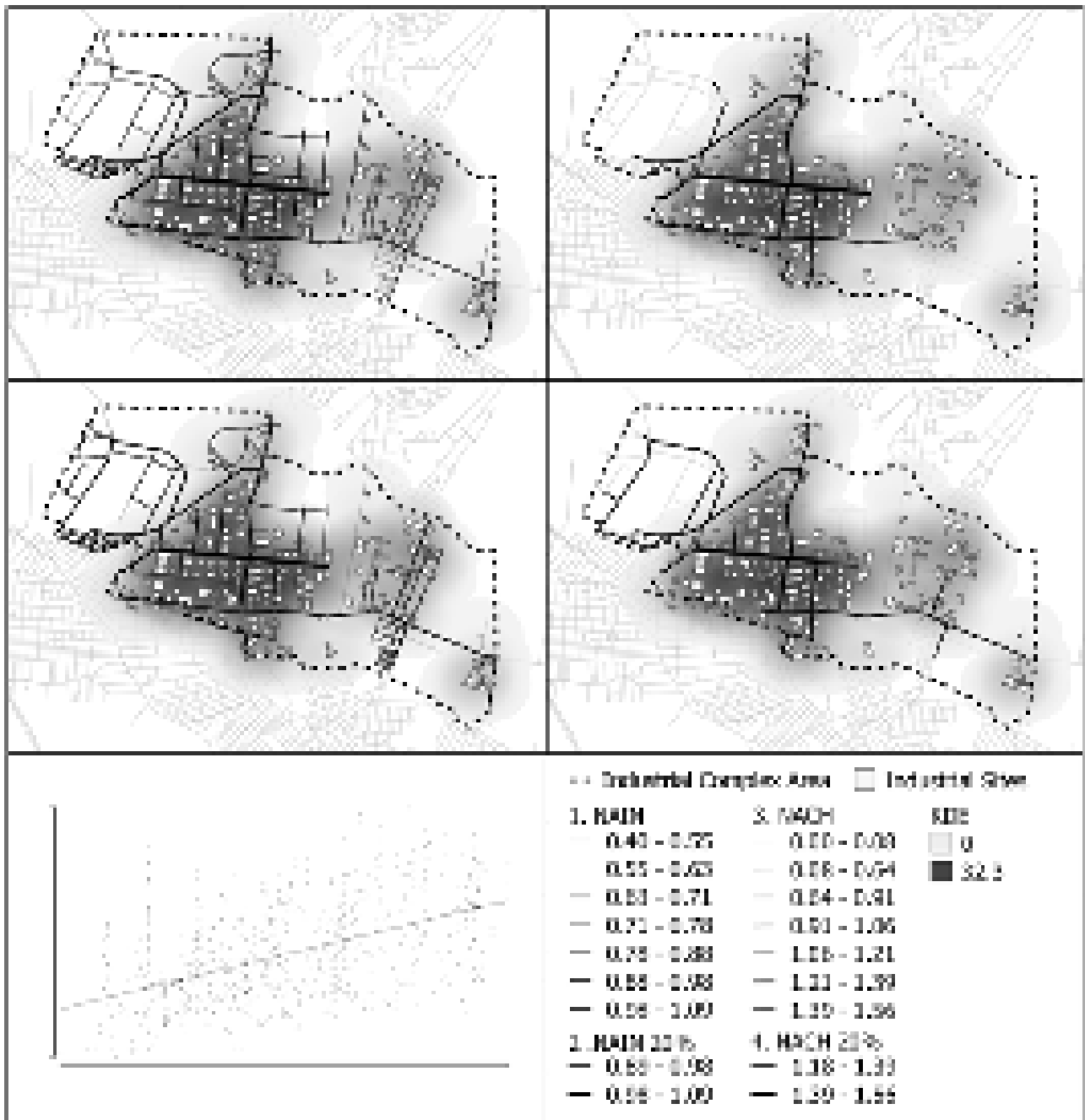


Figure 2. Cachoeirinha ID spatial correlations between Industrial Sites Placement (KDE), and inner-complex road-network centralities represented by NAIN (2.1) and NACH (2.3) restrictions of 20% (2.2 & 2.4); and Synergy Correlation graph between Integration Rn and R3 values (2.5).

and road-circulation networks for both NAIN & NACH. 85.6% of its industrial sites (178) are located within at least 500m from a top 20% centrality core, while 88.5% of its industrial sites (184) being place at the same range from a 20% preferential route. Once again inner-complex morphology explains attained results. Even though core-structure segments do not extend to areas where industries are place, these segments short lengths make placement areas closer to the main centralities structures, feature reinforced by the quasi ring-road. In terms of logistics,

inner-complex transportation needs to move through less depth to access other areas, resulting in a more accessible system.

Comparing Synergy Correlation values (Table 3) for industrial complexes it is observed that *Cachoeirinha ID* (Figure 2.) exhibit far lower values for R^2 than the remainder of selected PMAR complexes. This indicates a low correlation among global (R_n) and local (R_3) central-

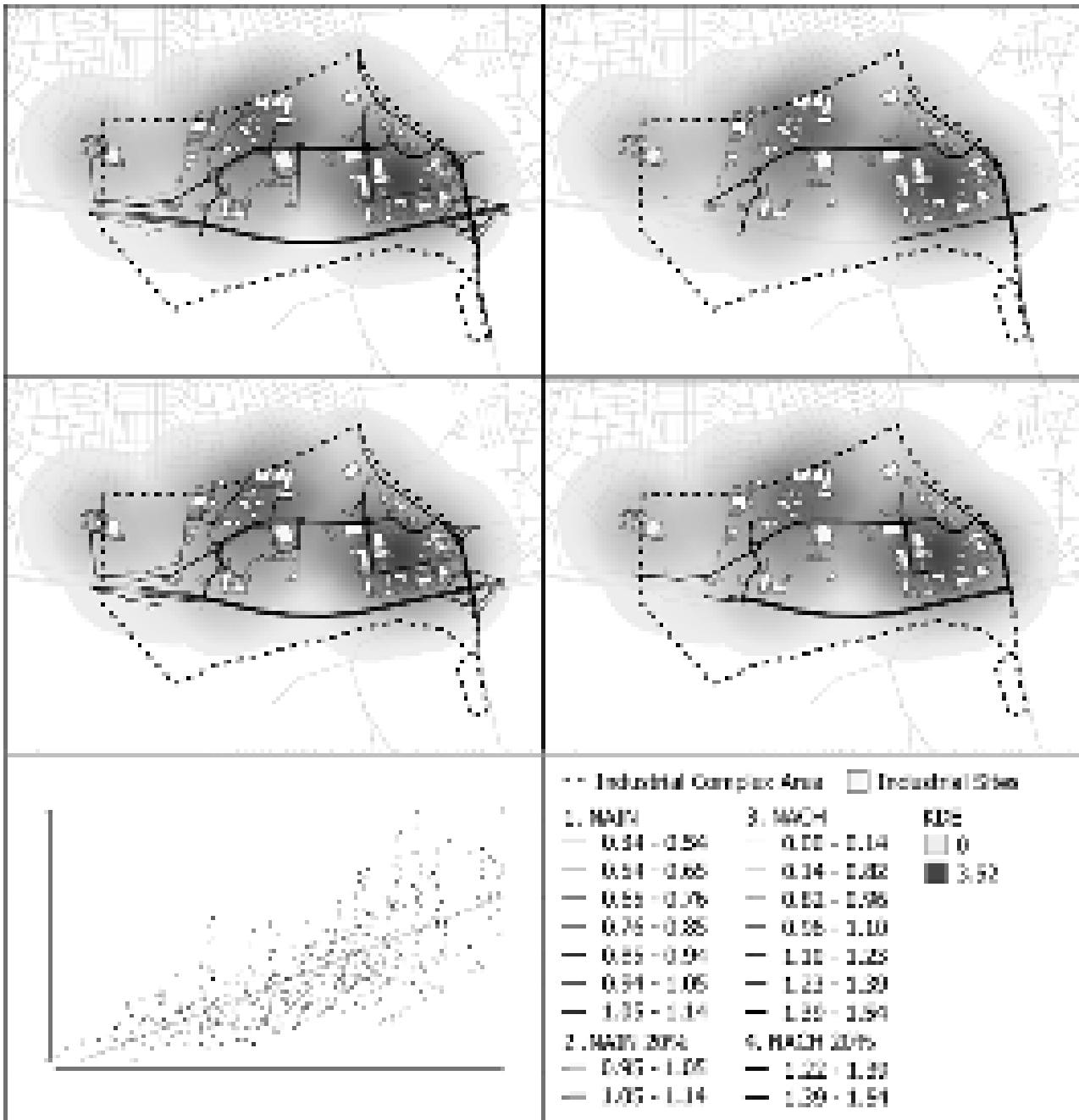


Figure 3. Gravataí ID spatial correlations between Industrial Sites Placement (KDE), and inner-complex road-network centralities represented by NAIN (3.1) and NACH (3.3) restrictions of 20% (3.2 & 3.4); and Synergy Correlation graph between Integration R_n and R_3 values (3.5)

ities, hence, convey that their movement potentials are more segment-wise distributed in the whole system. Once this is valued alongside configurational analyses (Figure 2.1 & 2.2) it becomes noticeable that this complex possesses a road-circulation morphology that allows better movement distribution along the road-network, as orthogonal grids and the *ring-road* structure form a higher number of non-hierarchical connections – segments with low angular integration differences – and create additional options of *to-movement* routes. Such morphological features ensure a greater degree of accessibility and spatial connection amid inner-complex firms, which may explain industrial complex' higher occupation rate (9.49%) as indicated by the built area proportion (Table 3). KDE measures (Table 3) reinforce this assessment, as they demonstrate that *Cachoeirinha ID* (Figure 2) have a considerable degree of industrial sites agglomeration (32.30), far higher than those found in the other complexes. Sites are placed, above all, in the *ring-road* structure inner and bordering areas, close to segments that represent centrality cores (Figure 2.1). Despite local connections, the orthogonal grid set located north of the complex exhibit lower agglomeration of industrial sites, which can be explained due to its relative *segregation* from the centralities system formed by the *ring-road*, as it is accessible through one route only (Figure 2.2) resulting in a distinct hierarchical differentiation amid these areas. Nevertheless, this area agglomeration degree is on par with those found for the remainder PMAR industrial complexes, suggesting that orthogonal grids can promote better movement conditions for industrial placement. Although only verified qualitatively, these results regarding patterns of industrial activities agglomeration and morphological properties advocate that there are relations between closeness to urban road-network centralities and densification.

Synergy correlation values (R^2) (Table 3) for the industrial complexes of *Alvorada-Viamão ID* (Figure 1) and *Gravataí ID* (Figure 3) are far higher than those observed for *Cachoeirinha ID* (Figure 2), attesting that these systems have greater correlations between global (R_n) and local (R_3) centralities. This denotes that movement potentials are concentrated in few same segments that form long non-hierarchical connections in the system, a trait that becomes clearer when results are confronted with complexes' configurational analyses (Figure 1.2 & 3.2). It can be distinguished then, that movement potentials are concentrated in linearities, which act as main linkages among the industrial complexes' expanses, restricting *to-movement* options and *segregating* whole areas, reachable only through less-integrated secondary road segments which branch from the main centrality core. These morphological features engender sparse groups of low-hierarchical spaces or "*Enclaves*", where industries are to be placed. Such characteristics also disclose an outer-complex-oriented industrial dynamic in *Alvorada-Viamão ID* and *Gravataí ID*, as firms have a close connection to the main linear structures

Table 3. PMAR's Industrial Complexes total area, total built area, built area proportion, Synergy Correlation Values (R^2) and KDE (500m) highest values for agglomeration.

Industrial Complex – PMAR	Total Area (km ²)	Total Built Area (m ²)	TBA/TA (%)	Synergy ($R^2 - R_n \times R_3$)	KDE (500m)
Alvorada-Viamão Industrial District	3.50	191,388.75	5.46	0.485685	3.83
Cachoeirinha Industrial District	10.98	1,042,870.50	9.49	0.257894	32.30
Gravataí Industrial District	3.73	329,296.02	8.82	0.530853	3.52

of global centrality – which represents a regional preferential route – but disconnected amid themselves due to the “*Enclaved*” nature of complexes’ inner-morphology. This may, as well, elucidate the low degree of Industrial Complexes’ occupation visualised for *Alvorada-Viamão ID* (5.46%), as industries have limited ideal placing locations alongside the highest road-network centrality values, that are concentrated in a single linear structure. The assessment that industrial sites tend to be clustered close to road-centralities is backed by KDE measures (Table 3). It can be observed that on *Alvorada-Viamão ID* the agglomeration patterns tend to extend along the main linearity towards an “*Enclave*” with higher agglomeration, reached only by a preferential route (Figure 1.2 & 1.4). A similar logic can be witnessed for *Gravataí ID*, where industrial sites are agglomerated along the main centrality core, with higher agglomeration being verified inside the low-hierarchical spaces, accessed through secondary lower integrated routes (Figure 3.2). The “*Enclaves*” internal structures in this complex differ from the *Alvorada-Viamão ID*, being closer in form to an orthogonal grid, supporting the statement that this morphology indeed favours industrial agglomeration.

4. Conclusions

Urban Planning and Economics ought to ponder about quintessential tendencies of current and forthcoming industrial complexes spatial organization. Urban form – and the distribution of centralities that emerge from road-circulation networks configuration – as proven by the results, is a factor that can favour or disfavour interactions amid firms and production chains. Since logistics implications tend to increase due to requirements of “*integrated industries*”, an (in)efficient spatial design can lead to industrial straightforward decay or to its resilience and long-term sustainability. Hence, industrial complexes morphology should be onwards regarded on pair with most often approached questions of Industrial and Urban & Regional studies.

Evaluation of inner-complexes spatial structure, as herewith proposed, depicted how urban morphology can influence industrial sites distribution. It was statistically confirmed that these economic activities tend to locate closer to areas exhibiting higher degrees of road-circulation network centralities, due to externalities related to transport efficiency and endogenous connectivity. Linear-based morphologies, while may favour industrial interactions with regional and nationwide territories, can diminish possibilities of ideal industrial placement, as these linearities tend to concentrate centrality in single groups of segments. This may hinder inner-complex transportation efficiency, as well, impair firm-to-firm relations, and due to such accessibility constrains, lead to agglomeration diseconomies. It was found that orthogonal-grid morphologies, as regular blocs and *ring-roads*, promote better inner-movement distribution, through the diffusion of local centralities, opening more possibilities of ideal industrial placement, which have positive effects on industrial agglomeration, as displayed by KDE measures. Hence, integration, connectivity, proximity to preferential routes, and spatial distribution of centralities contribute to even firm’s locational choices, creating a built environment capable of promoting efficient interactions among different industrial activities and their material networks.

Henceforth, the diffusion of *smart manufacturing* on current and forthcoming 4.0 industrial complexes will require application of strategies focusing, not only on economics and logistics, but that, as well, on practical and conceptual dimensions of spatial morphology and urban design.

5. Acknowledgements

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001, and in part by the Università di Pisa.

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Urban Industrial Zone Renewal and Spatial Game in China

A case study of Eastern Suburb Industrial Zone in Chengdu

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Keywords: urban form, urban landscape, industrial renewal, spatial game, morphological frame.

Abstract: The change of system constantly reshapes the urban form of China after 1949, among which the renewal and transformation of industrial zones is a typical phenomenon in the changing process of urban landscape in recent years, which centrally reflects the development characteristics of contemporary Chinese cities under new social background. From the perspective of spatial game, this paper studies and interprets the changes of urban form and the causes of these changes in the renewal process of industrial zones on the basis of the existing morphological frame and material landscapes, so then shows the particularity and complexity of the process of urban spatial reconstruction with current Chinese characteristics.

1. Introduction

Different social systems and economic development levels determine the pattern of urban development, and thus bring out different urban forms and urban landscapes. Industrialization was the main construction and development mode of PRC after 1949 when it was founded with planned economy. In order to consolidate the socialist regime and change the backward productivity in China as soon as possible, the state has systematically laid out the overall objectives for the development of industry, especially heavy industry, and has formulated key city construction systems in accordance with the nature of cities and the proportion of industries (Tab. 1). During the first *five-year-plan* of 1953-1957 and the *third-front movement* of 1964-1980, it was the peak period for the state to concentrate on investment and construction of industrial projects, which significantly improved the level of industrialization and urbanization in China. This short 30-year process has laid an important material and institutional foundation for China's current modernization direction. At the same time, the spatial form and social structure of traditional Chinese cities have undergone rapid and tremendous changes in this process. Industrial zones, as a new type of urban landscape, have centrally emerged.

After 1978, China started its period of Reform and Opening-Up as well as market economy which led it entered into rapid development. The state-owned enterprises, which were still under the old organizing as well as management system, generally encountered difficulties in operation and development. Through constant policy exploration and adjustment, the state has vigorously reformed the management system and mechanism of state-owned enterprises, enabling some enterprises to gradually establish modern enterprise system into the market ranks,

Table 1. *Key city systems formulated in 1952.*

Type	Nature of cities	Characteristics and proportion of industry	Cities
I	Key city	City with heavy industrial (8)	Beijing, Baotou, Xi'an, Datong, Qiqihar, Daye, Lanzhou, Chengdu
II		Reconstructing city with large proportion of industry (14)	Jilin, Anshan, Fushun, Benxi, Shenyang, Harbin, Taiyuan, Wuhan, Shijiazhuang, Handan, Zhengzhou, Luoyang, Zhanjiang, Urumqi
III		Old city with small proportion of industry (17)	Tianjin, Tangshan, Dalian, Changchun, Jiamusi, Shanghai, Qingdao, Nanjing, Hangzhou, Jinan, Chongqing, Kunming, Neijiang, Guiyang, Guangzhou, Xiangtan, Xiangfan
IV	General city	Non-industrial city	Cities other than the 39 cities mentioned above

while others have withdrawn from the historical stage; at the same time, with the rapid growth of the tertiary industry, industrial construction has ceased to be the dominant mode of urban development; the establishment of the urban land market and the introduction of capital have led to the replacement of the use of urban land based on land price. These comprehensive factors triggered the retreat, transformation and renewal of the original urban industrial zones, and then led to intense spatial reconstruction, which gradually changed from homogeneous industrial landscape to heterogeneous and diversified urban landscapes.

2. Definition and application of the concept of spatial game in this study

The original meaning of the word *game* is playing chess. It can be extended to a process in which one or more people or teams with absolute rational thinking using their own permissible behaviors or strategies to fight or compete with each other and implement them, and then obtain corresponding results or benefits from each other under certain rules. The fundamental reason for game is the limitation of resources, and the fundamental motivation is to maximize and rationalize people's interests. Spatial game is a game based on certain resources or forces in a certain space. It is a wider phenomenon and exists among different groups in various aspects of human survival and activities, such as politics, economy, military and even biology.

In this study, the definition of spatial game is as follows: it is a process of land redistribution and rebuilding of a specific built environment into a new and stable spatial state of urban form characterized by town-plan, land use, architectural texture and so on, led by new space participants with new interest demands which would take different ways and forces of action and are restrained or supported by the existing urban morphological frame and material landscapes foundation so that morphologically make breakthroughs, continuations or adaptations to the original space, under the change of social, economic, cultural and other background factors.

It can be seen that spatial game is a causal process in which people interact with physical environment as well as the new interact with the old, so that specific results are produced. Therefore, it includes three levels: participant level, force level and landscape level. In the process of reconstructing the industrial area, the new spatial participants, under their interests, compete with the original spatial form which has a certain restrictive role through different forces, and ultimately lead to different forms and landscape representations. Only from these three levels can we fully understand the particularity of urban form change in the reconstruction of built environment such as industrial zone renewal, and then recognize the characteristics and laws of contemporary urban development in China.

3. The motivation of spatial game in Eastern Suburb Industrial Zone

3.1. Background of Eastern Suburb Industrial Zone

The construction of Eastern Suburb Industrial Zone has undergone an important historical process in contemporary China. In 1953, Chengdu, one of the 8 heavy industrial cities, began its planning and construction of industrial zone with machinery, electronics and instrumentation as the main components. In 1955, with the approval of the central government, industries were arranged along the Sha River in the eastern suburb of the old urban area, as the starting point of Chengdu's modern industry (Figure 1). Since then, Eastern Suburb Industrial Zone has experienced expansion: during the *third-front movement* from 1960s to 1970s, a number of key military enterprises moved into this area; in the 1980s, during the period of adjustment and transformation of the *third-front*, a large number of enterprises moved in again, and the industrial scale of Eastern Suburb reached its peak in history, becoming an important industrial area in southwest China. More than 200 large and medium-sized enterprises and scientific research institutes have been gathered in Eastern Suburb, with hundreds of thousands of employees. By the 1990s, the total output value of this industrial zone accounted for 52.4% of the city's industry and 75% of the city's state-owned industry.

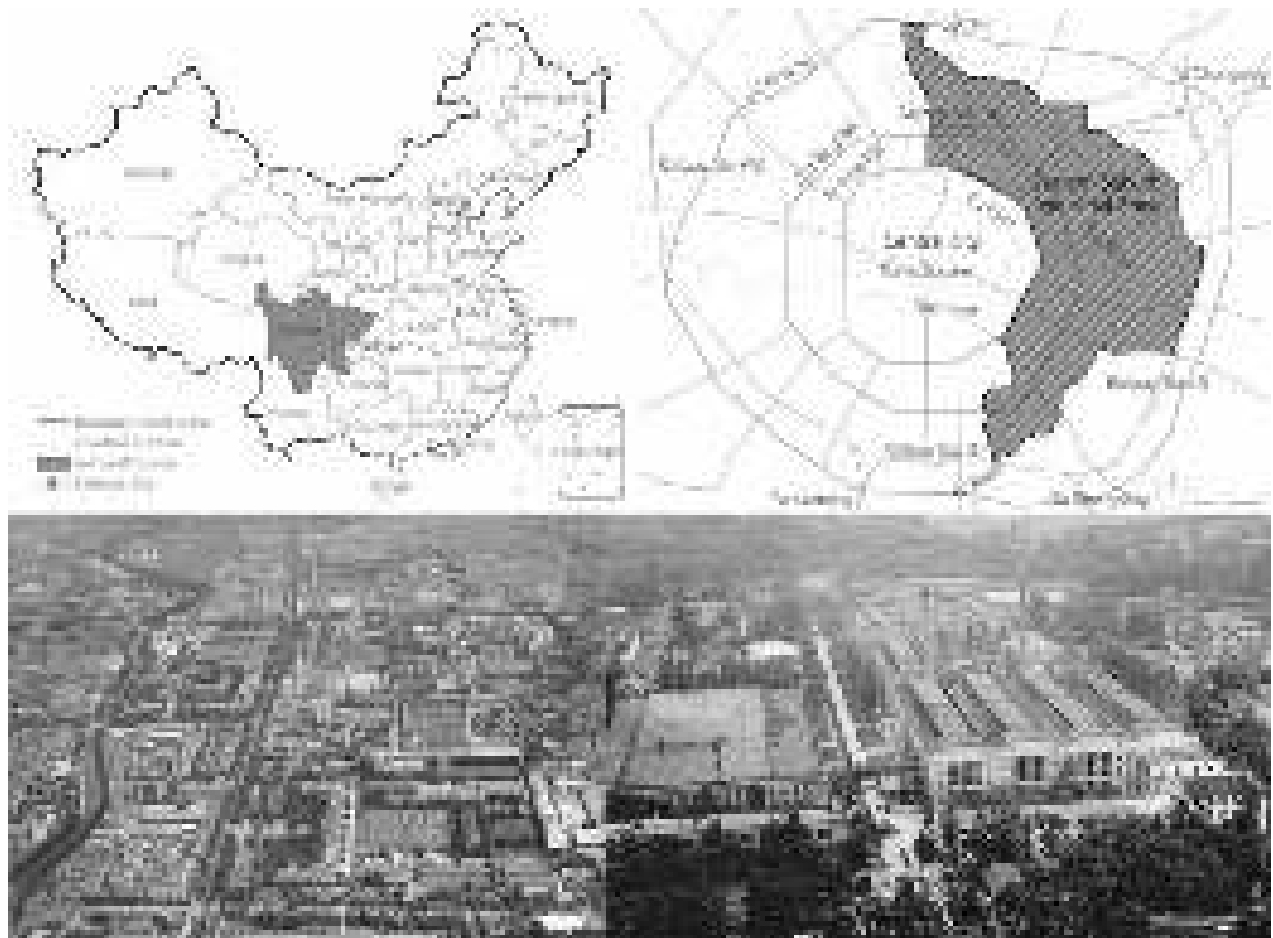


Figure 1. Geographical location and historical images of Eastern Suburb Industrial Zone.

3.2. Reasons for the renewal of Eastern Suburb Industrial Zone

Since the 1990s, with the establishment and continuous improvement of the socialist market economic system, China's society, economy and culture have entered a new stage of development, and the structure and organization of the national economy have undergone institutional changes. The change of system has caused the change of urbanization process and pattern, and also changed the fate of urban industrial zones. Specifically, the objective factors to promote the renewal and transformation of Eastern Suburb are as follows.

A. Social institutional factors

The state-owned enterprises established under the traditional planned economy system depend on state investment, which is not only the social production unit, but also the important social organization and the supply unit of living welfare. In the process of deepening the market economic system, this so called *danwei* (the unit) system has been gradually broken down, and profit has become the sole purpose of enterprises. Due to the gradual withdrawal of state supply, a large number of state-owned enterprises in Eastern Suburb were difficult to adapt to this new social system and market environment, and many enterprises got into a loss predicament or even bankruptcy. This forces the government to adjust the local industry as a whole and reform the system of state-owned enterprises.

B. Urban economy and development factors

Since the establishment of market economy, various types of capital have appeared one after another, and various forms of tertiary industry, especially real estate industry, have become the leading force of the economy and development of an urban. At the same time, the system of compensated use of urban land enables capital to acquire the use right of specific urban land through bidding, thus forming the characteristics of urban spatial evolution in which land value determines the form of land development. Obviously, the old industrial land with centralized, continuous and inefficient output hinders the capital input, affects the development of urban economy, and greatly limits the direction of urban expansion. At the same time, the aging infrastructure has aggravated the imbalance of urban development. These factors prompt the government to relocate the original enterprises and replace the original industrial land, that is, urban renewal. Especially in recent years, with the opening of Chengdu East Railway Station and the proposal of the strategy of *expanding eastward*, the land value of the industrial zone in Eastern Suburb has been rising, which has accelerated the pace of urban renewal and capital injection.

C. Environmental and residential factors

The negative impact of industry on the urban environment has begun to be paid increasingly attention, to control industrial pollution has become an inevitable trend. In addition, the surge of urban population also promotes the improvement of living environment. Since 2001, the urban population of Chengdu has risen rapidly from 10.2 million to 16.33 million in 2018, people's requirements for living environment and quality have been continuously improved. This requires the government not only to relocate industries, but also to restore ecosystems and to

provide green space, while improving and upgrading urban infrastructure and living services facilities.

D. Cultural factors

Eastern Suburb Industrial Zone is associated with important historical events, forming a number of industrial heritages with the characteristics of the times. Owing to common and special production and living experiences, ordinary citizens or workers in old industrial zones have specific collective memory and historical feelings towards Eastern Suburb; for the government, Eastern Suburb is also the cultural symbol of urban civilization and the propaganda tool of urban image; for the capital involved in this area, the historical trace is the embodiment of land value and cultural connotation in some cases. These cultural factors play an important role in the process of renewal of industrial zones in Eastern Suburb.

It is against these backgrounds, that in 2001, the city government of Chengdu initiated and led the industrial restructuring strategy of the whole city, which was driven by the transformation of Eastern Suburb, and carried out the overall relocation and transformation of enterprises in the eastern suburb. Over the past few years, more than 100 enterprises have moved to farther suburbs, accompanied by the reform of the enterprise system, while other enterprises with backward production capacity have been eliminated. At the same time, the government brought Eastern Suburb Industrial Zone into the overall development pattern of the city and re-planned it. All kinds of forces entered it one after another. Thereafter, the spatial game began and changed the urban form and landscape of this region greatly in just over 10 years.

4. Patterns and results of spatial game in Eastern Suburb Industrial Zone

In fact, spatial game is a process of spatial reconstruction in which participants with new spatial demands overcome the existing built environment with certain particularity and complexity. Restricted by the limited land and the existing morphological frame, different participants participate in the spatial game in different forms according to their own needs, and thus produce different shape results in the process of land redevelopment, so as to achieve the final balance of the game.

4.1. Participants in spatial game

In the spatial game, the groups that play an important role in urban form are mainly composed of three parts: the managers, owners and users of urban land, whose behaviors run through the whole process of decision-making, management, sell, development as well as use of urban land and so on, and directly or indirectly determine the morphological results of the spatial game.

A. Managers of urban land. The government is the decision-maker, promoter and leader in the whole process of industrial zone renewal, and also the provider of land and the formulator of land development rules. Through the formulation, implementation and control of planning, the utilization of urban space is balanced in the most optimal way among various stakeholders, with relative public welfare, fairness and authority. In China, nothing is more powerful than the government.

B. Owners of urban land. Including the government and its affiliated social institutions and various types of capital subjects, which correspond to two different ways of land acquisition,

namely, government agencies' land acquisition through the allocation of higher government; capital subjects under different forms of ownership, such as state-owned enterprises and private enterprises, acquire urban land through selling by government. These two different ways of land acquisition determine the different contents and requirements of land development. Land owners with government agencies as the main body pursue the public welfare of land, while land owners with capital as the main body pay more attention to the profits brought by land development. At the same time, the relationship between different government agencies is synergistic, while the relationship between different capital is more competitive. These are also the main forces that decide the changing intensity of the original spatial form and landscape in spatial game.

C. Users of urban land. In addition to the land owner's own right to use the land, the public is the largest group of urban land users, and also the direct group-oriented public attributes of the city, so it has a demand for the service and public welfare of the city. Because of the private nature of capital, in the development and use of urban land, public demands are often checked and balanced with capital, with the intervention of the government and relevant laws and regulations.

4.2. Morphological result of spatial game: an investigation at different levels

The renewal of industrial zones in Eastern Suburb is not only a process of reconstructing the urban landscape in a local area, but also a process of reconstructing the relationship between the local and the whole city. Through the analysis of the participants and their demands in spatial game, and based on the current situation of urban landscape, this study makes a textual research on the characteristics of urban form at different spatial levels such as city, land and building, which can interpret the different forms and characteristics of spatial game in the renewal of industrial zones, and then judge its impact and role on urban development.

A. Morphological frame and characteristics of overall plane

The important position of Eastern Suburb Industrial Zone in the development of Chengdu City has laid an important influence on the urban form, which also determines the particularity of the spatial game process. It was built on the basis of the countryside adjacent to the city. Besides the river system, there were fewer constraints. In planning and construction, *danwei* was used as land use unit (which is divided into production area and living area) to organize space together with each other, and gradually formed a morphological frame with roads, *danweis*, railway lines and natural river courses as the main elements. The industrial zone was roughly the area outside (to the east of) today's 1st Ring Road, the boundary. In order to connect the life of factories with the life of cities, and to place the production part relatively far away from the city center as well, most factories' production areas and living areas were separated. With today's 2nd Ring Road as the demarcation line, the production areas of factories were centralized outside the 2nd Ring Road, while the living areas were arranged outside the 1st Ring Road and inside the 2nd Ring Road.

Therefore, there are distinct differences in land use and urban landscape between the inner and outer parts of the industrial zone. The plots inside the 2nd Ring Road are smaller and more regular in shape; the roads basically follow the chessboard road network structure of the old urban area; the residential buildings organized by courtyards are the main texture of the city; and the urban landscape is the continuation of the old urban area. Outside the 2nd Ring Road,

according to the different nature and scale of industry, the size and shape of plots are quite different; the main roads are divergent and assume the function of regional connection channels outside the city; the texture is medium and lower density industrial buildings; because the area has not been fully developed, the outer the more dominated by mixed rural landscape. This difference in the morphological frame will have different impacts on the way of urban renewal.

B. Urban/area level

At the urban level, with the large-scale relocation of enterprises in this area, urban infrastructure led by urban roads invested by the government has been rapidly introduced. Especially since 2011, with the opening of East Railway Station, the largest transportation hub in Chengdu, the location conditions in the eastern part of the city have been fundamentally improved, and at the same time, it has also led to the speed of renewal. In 2017, the city government put forward the strategy of *expanding eastward and southward, controlling westward, reforming northward, and promoting the middle*, further clarifying the main development direction of the city towards the south and the east including Eastern Suburb, in the form of official will. This objectively improves the location advantage of East Suburb Industrial Zone in transforming to the capital-centralized land types of commerce, commerce and residence.

In urban form, the first change is the change of the morphological frame to a certain extent: the road system of this area especially in the production area, is constantly improved, and the road network is more closely linked with that in the urban central area, and a number of main roads are built to radiate to the urban periphery; the original undeveloped rural land is gradually introduced into the urban road and becomes the undeveloped land; some of the railway lines and freight yards used for transporting goods were dismantled. With the introduction of multiple metro lines, the east-west direction of the city has been connected by rapid traffic; high-density commercial and residential land gradually replaced the previous industrial land, and diversified urban functions and landscapes gradually penetrated into the east (Figure 2). From a macro point of view, in the past decade, the decision-making and implementation of the overall development of Eastern Suburb led by the city government have achieved immediate results. Such results are not only driven by the objective law, but also inseparable from the strong political foundation and power guarantee of the local government.

C. Block level

The replacement and implantation of new urban functions and the original plots of this area have produced different degrees of game and caused spatial reconstruction. Because of the overall relocation of production areas, the changes are more thorough, while the living areas are less affected because they mostly continue the residential functions of the original workers. The way and strength of reconstruction are related to 2 factors: the original morphological framework characterized by trunk road system restricts the new types of land blocks, and the changes of land blocks mainly occur on the side of non-trunk roads; at the same time, they are related to the conformity of new and old land blocks in land use scale or shape. In addition to those unchanged plots, the common forms are the segmentation and merging/recombination of the original plots and the accompanying enhancement of development strength as well as replacement of land types (Figure 3).

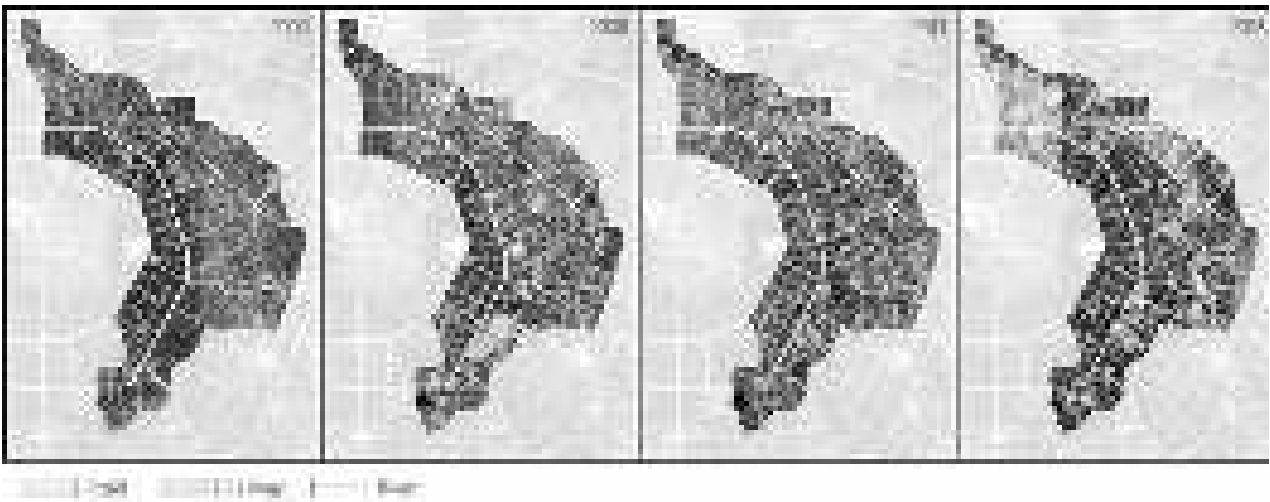


Figure 2. *Evolution at the urban level.*

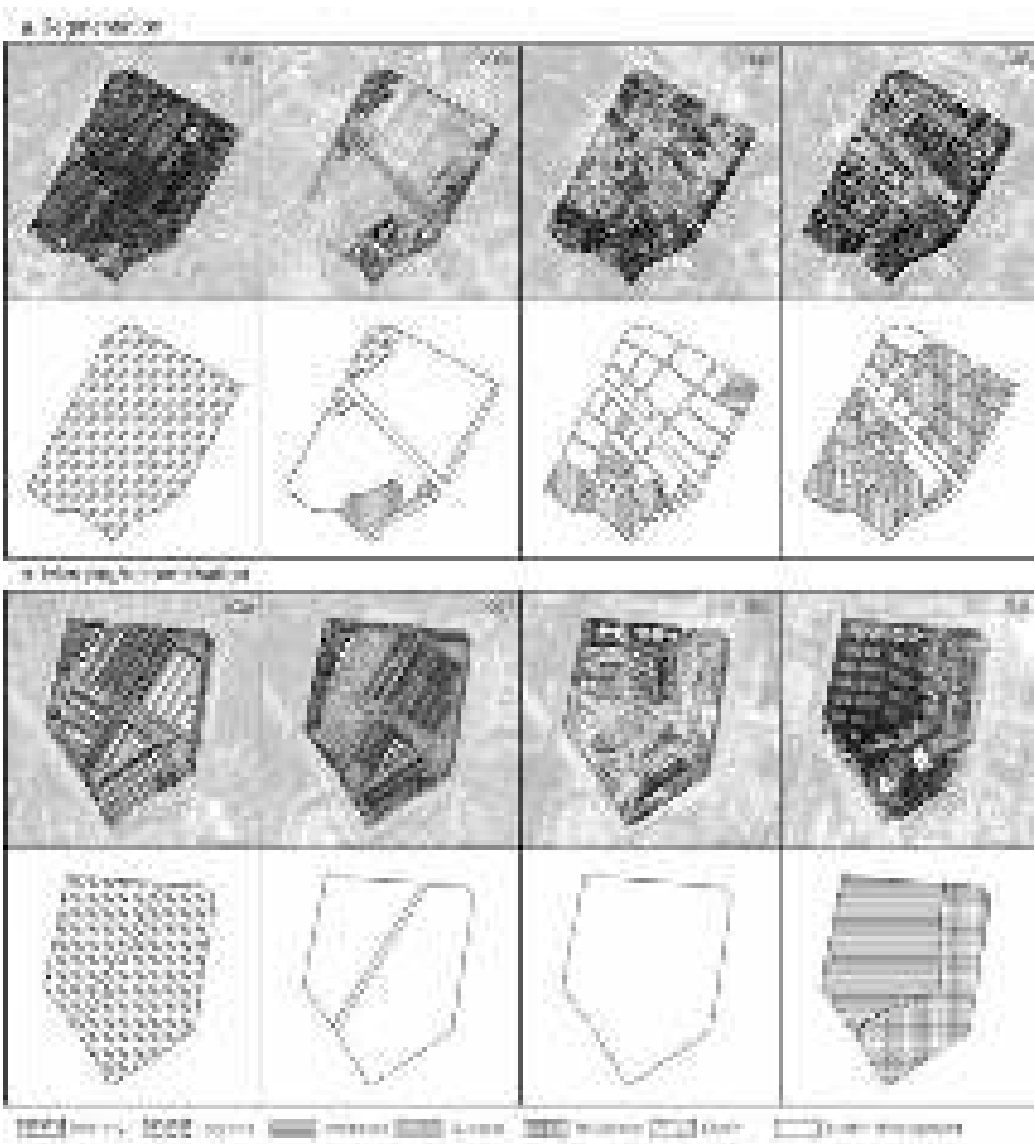


Figure 3. *Evolution at the block level (a. Segmentation; b. Merging/recombination).*

a. Segmentation

This is the most common situation in the spatial reconstruction of industrial zones, which generally occurs in a large production or living land, i.e. *danwei*, which belongs to the same property right subject. Due to the transfer of all or part of the functions within the original plot and the substitution of other functions, in order to organize transportation, equalize the scale of land and facilitate the selling of land, the original *danwei* plots have been taken different forms of segmentation. On the one hand, block segmentation needs to be combined with the organization of surrounding roads, especially with high-grade roads. On the other hand, it sometimes follows the road or space division within the original block to a certain extent, because the factory has a certain logic of space utilization in its space organization. The most typical example is the former Chengdu Seamless Steel Tube Plant.

b. Merging/recombination

Contrary to segmentation, some fragmented areas need to be integrated to form new ones of moderate scale and easy to use. Because the original plots in the industrial area are generally more regular and large-scale, this situation is less. Typically, the demolition of the railway line is characterized by the fact that the plots originally located on both sides of the railway line can be merged into one plot, or occasionally occur between two plots divided by roads. After merging, a new unit of space utilization has been formed in the original land with different ownership, the reorganization of the interior space of the plot will be more thorough.

D. Building level

Compared with the change of plot, because of the different demands of different participants, the change at the building level is more significant, and there are several forms, such as substitution, transformation and preservation. Overall, the areas outside the 2nd Ring Road are more thoroughly replaced, while the areas inside the 2nd Ring Road are more retained. There may also be both ways of substitution and transformation within the same plot, which depending on the value of the original plot's internal buildings and their value in the new land development (Figure 4).

a. Replacement

As the most typical type of way, it is also the most direct result of industrial zone transformation. Industrial buildings in the production area are generally demolished and replaced by institutional, commercial or residential buildings, also, landscapes have been updated. There are fewer substitutes for buildings in living areas. Some commercial buildings originally belonging to factories and serving the family members of workers are purchased and rebuilt by external capital. The development intensity of buildings after substitution has been generally increased a lot compared with the past because of the need for profit-seeking of capital, which reflects the directive force power of capital in the space game under certain space conditions, and achieves the game results that are most conducive to the realization of profits.

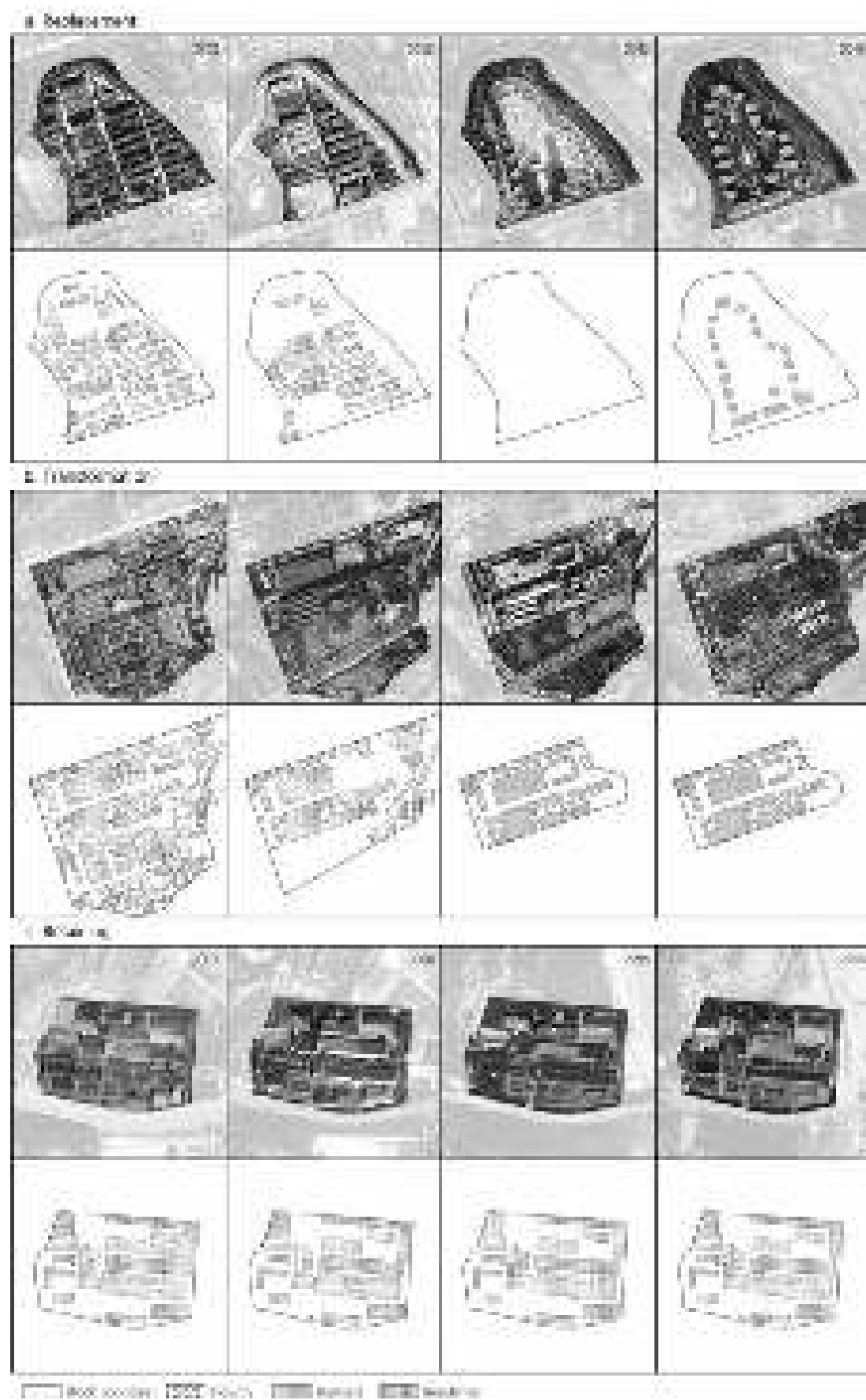


Figure 4. Evolution at the building level (a. Replacement; b. Transformation; c. Retaining).

b. Transformation

Some of the original buildings with better quality have certain use value because they are consistent with the interests of land development. They are not demolished with the relocation of industrial zones, but transformed into commercial services under the function of capital. Most of them are office public buildings. In addition, under the influence of public demand for collective memory for Eastern Suburb, some industrial buildings have been preserved and protected by the government as historical buildings. At the same time, they have been transformed and utilized by injecting commercial capital, making them monumental public spaces serving all citizens, and realizing the public welfare transformation of the functions of the original industrial buildings. Such examples include the theme park of *Eastern Suburb Memory* transformed from the former Red-light Electron Tube Factory.

c. Retaining

Only a few enterprises did not relocate because of some special reasons such as policies, production nature and conditions. They remained in the original site to engage in production as a whole or in part, while slowly realizing self-renewal. In addition, in the living areas inside the 2nd Ring Road, due to the high cost of relocation of residents, the workers' residential buildings originally belonging to the factories are generally retained, but they are separated from the original factories in the management system and become part of the urbanization management. Although the building itself has not changed much, the landscape and social structure of these large number of workers' living areas are gradually approaching to the city core because the existence of the relationship between the construction and organization of the original *danweis* has been no longer existed, and then the alienation of the industrial landscape unit to the urban landscape unit is manifested in the form.

5. Summary

From the perspective of the driving mechanism of the development and evolution of urban landscape or cultural landscape, all human construction activities are carried out in order to achieve a certain need, and a specific space and landscape phenomenon is inevitably generated. The form of human material environment construction is directly related to the social system and development pattern in a specific period. In order to realize the continuous development of human civilization, the current construction behavior constantly struggles with the nature and its past, and finally achieves balance and progress in the historical process of negation of negation. Due to the limitation of space resources, with the expansion of population and urban scale, new construction activities are increasingly affected by the past, that is, the historical built environment.

Spatial game is a spatial phenomenon produced by the combination of realistic needs and historical products. It includes the forms of obedience, superposition and subversion of realistic activities to the historical environment. It is finally presented by the urban form and landscape features with special characteristics of the times, which reflects the different cognitive, intervention and competition behaviors of human beings under different realistic purposes and dominant forces to the environment. It contains the basic philosophical dialectical relationship of human development.

Spatial game is a common phenomenon in China, which is experiencing intense social and economic transformation. In the past few decades, Chinese society has achieved many turning points and made tremendous progress. Accordingly, a large number of traces of construction belonging to different historical periods have been left in the material space. Nowadays, new development and transformation are continuing. As a large developing country with a large population, it is bound to have a long process of collision and game with the historical environment, and constantly review and remodel the built environment of the past. From the past to the present, the driving force of spatial game relies on strong government decision-making and capital operation. In the future, new driving forces will inevitably emerge along the road of social and urban development in China, and new urban morphological characteristics will be brought again.

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Morphological Comparison Study of Mainland Industrial Port Area of Island Cities

Marghera in Venice And Haicang District in Xiamen

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Keywords: Island city, urban morphology, port city, comparison study.

Abstract: The paper studies Marghera and Haicang District, both are the industrial port areas on the mainland of Venice and Xiamen, two of which are both island cities. Venice is an important port city in the Mediterranean, and the city is mainly situated on an island. With the development of the city, the existing ports on Venice's main island are gradually incapable of servicing large modern ships. As a result, by 1917, the Italian government had decided to develop an industrial zone and state-of-the-art port at Marghera on the mainland opposite the main island of Venice. Xiamen is an important port city in China, and the main body of the city is also an island. With the construction of large numbers of infrastructure, since the mid-1990s, the urban space has shifted from basic saturation of the main island to spread to the mainland, gradually forming the urban spatial form of the gulf group. Haicang District has gradually developed as an important industrial area and port. In the history of development, both cities have a long history of development, and both of the development processes are from the main island to the inland expansion. The article makes a comparative and graphical analysis of the two port areas from three aspects: development history, urban morphology and architectural typology. In conclusion, the author compares the impact of social factors on the two port areas in different historical stages, which provides guidance and reference for the development of island cities.

1. Introduction

Venice in Italy and Xiamen in China are important port cities, and the main body of both city are island. The island cities will spread out of the island after their continuous development has reached saturation. From the perspective of historical evolution, Marghera in Venice and Haicang District in Xiamen are both land-based industrial port areas formed by urban expansion outside the island. From the functional point of view, both of them include three major functions: industry, port and residence. From the perspective of development planning, both of them are closely related to policy regulation. Marghera's garden-city plan and Haicang District's geometric residential land are the result of policy regulation.

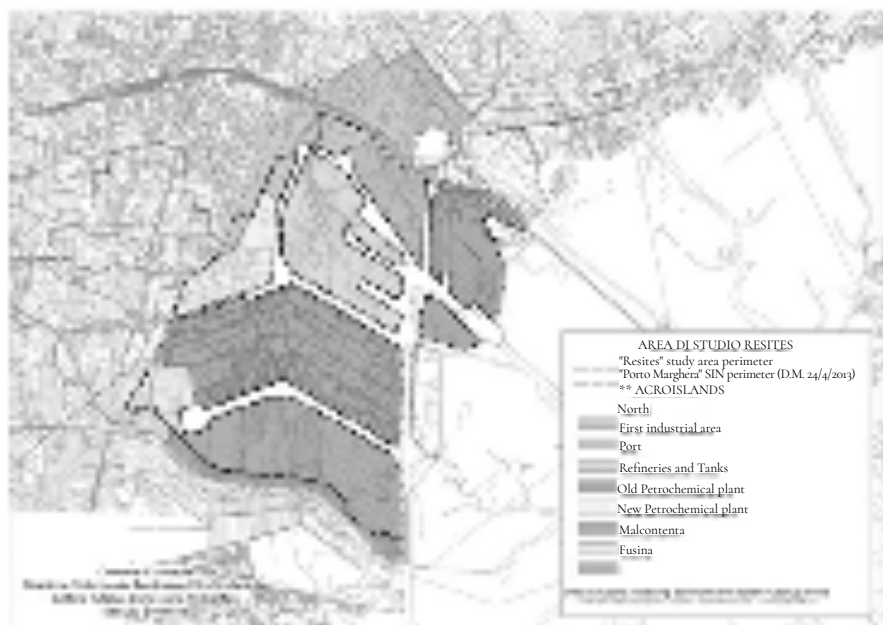
In a word, both of them have high similarities in terms of development history, function and influence of planning and regulation. Therefore, this paper hopes to provide some new enlight-

enment for the development of similar island cities by comparing and analyzing the urban form of Marghera and Haicang District.

2. The Development of Land Industrial Port Area Outside Island City

2.1. *The Development of Venice's Land Industrial Port Area, Marghera*

Venice is an important port city in the Mediterranean, and the city is mainly situated on an island. Marghera (formally Venezia Porto Marghera) lies on the stretch of mainland within the Venice lagoon. The name comes from Venetian and actually means: where the sea was (Marghera); it is dried up tideland. Since the 14th century successive rulers have carried out huge



1.1.



1.4.



1.2.



1.5.



1.3.

Figure 1. Historical Map of Marghera (1.1. Programme distribution of Marghera; 1.2. The design of the new port of Marghera, 1923; 1.3. The Lagoon before the construction of Porto Marghera, 1900; 1.5. Old and new petrochemical area, 1960).

drainage and regulation projects on the mainland, which was the hinterland of the largest sea power of the Adriatic.

The village of Marghera itself had disappeared during the XIXth century, when a fort-still existing and bearing the name of Forte Marghera- was built in its place, successively under Venetian, French and Austro-Hungarian rule.

With the development of Venice, the existing ports on Venice's main island are gradually incapable of servicing large modern ships. As a result, by 1917 – during the First World War – the Italian government had decided to develop an industrial zone and state-of-the-art port at Marghera on the mainland opposite Venice and near the town of Mestre. This is the first industrial zone. This plan was supposed to fulfil three aims: an industrial port, the creation of an industrial zone and building a new residential area on the mainland in order to relieve the lagoon area.

Development commenced in 1920, and for 10 years dredging of shipping channels, excavation, and land reclamation took place. A residential area was also constructed for the zone's workers. In 1923 the first chemical factory commenced production. By 1940 more than 60 factories were established at Marghera, and as a result during World War II Allied bombers targeted Porto Marghera.

In 1919, in order to reduce the chronic overcrowding of the island city's most run-down districts and to create a residential neighborhood near the new industrial pole of Marghera, the engineer Pietro Emilio Emmer who was inspired by the model of "garden city" elaborated by Ebenezer Howard planned to build a *città-giardino* ("garden city") next to the industrial area of Marghera. The building site was inaugurated in 1921, following the strict rules indicated by Emmer's plan: the houses should not be higher than three floors, the surrounding private gardens should be four times as large as the houses themselves, the streets were large, planted with trees and converging on roundabouts.

But Marghera's development was not as rapid as expected, which along with lack of investment, and after WWII housing emergency caused the plan's rules to be neglected both by public actors and private contractors. However, Marghera in the 1930s never become the industrial suburb the authorities had envisaged, because the workers continued to live in the villages of the province: at Mirano, on the Brenta coast, near Castelfranco and Chioggia, within a radius of thirty to forty kilometres – the distance that could be covered by bicycle. The comprehensive garden-city plan was only partially realized and it is still appreciable in a large portion of the main district of Marghera, on both sides of the central axis.

Year 1955 marked the beginning of the second phase of Porto Marghera's development: the new city plan established the expansion of the port and the construction of the second industrial zone. The building of a second industrial zone in 1950s was intended to secure control over the local proletariat and to create work and curb emigration. The new factories in Marghera included the *Petrolchimico* (the petrochemical plant). But the industrialisation of Italy took place with total disregard for the environment or workers' health. The Italians arranged the factory, which should have been away from the city, two kilometers from Piazza San Marco in Venice.

The building boom of the 1960s and 70s allowed for the rampant growth of the town of Mestre without regard for any kind of urban planning, all the more so because the local council was busy concentrating on Venice old town. For a long time the periphery around Mestre was a dormitory town almost entirely without infrastructure.

In the 1960s the development of industry in Italy lay far behind that of England, France or West Germany. The next economic boom relied solely on the introduction of new exploitation methods of long work time and a lot of overtime. In Italy strike waves blocked the increase in

productivity for almost two years. The Hot autumn in 1969 ranks as one of the most intensive collective mobilisations in the history of class struggle. Italy's social class gap is wide, and the long-term dissatisfaction of the working class has triggered a struggle for the working class, with frequent strikes. In Italy strike waves blocked the increase in productivity for almost two years. The Hot autumn in 1969 ranks as one of the most intensive collective mobilisations in the history of class struggle.

During the post-war period the growth was so fast that in 1960 there were about 200 companies with over 30,000 people employed. Considering the huge development in the area, the project for a third additional industrial area was set in motion, but later abandoned.

The new project included the excavation of a new channel in the lagoon and the creation of new landfill areas in the lagoon to host further development. The project would have had heavy consequences on the extremely fragile hydrological equilibrium between the lagoon and the sea, already under substantial pressure from the anthropic activity. These drawbacks were not considered until then and the damage was already done. However, in 1966 Venice experienced a terrible flood, causing extensive damages. This disaster sparked off a movement of the public opinion for the safeguard of Venice.

The construction of the two industrial zones and the excavation of the navigation channels and inlets in Marghera has caused irreversible damage to Venice's environment. Since 1960s, Marghera's industrial, residential and port areas have maintained steady development. Today, the islands of Venice have about 70,000 residents, steadily decreasing, while about 270,000 people live in Mestra-Marghera. Marghera remains Venice's main land industrial zone. It is responsible for the development of Venice's cities.

2.2. The Development of Xiamen's Land Industrial Port Area, Haicang District

Xiamen is one of the only two prefectural and municipal administrative regions in China, which are mainly composed of Xiamen Island, Gulangyu Island, the northern inland part and the adjacent islands. Haicang District is one of the six districts in Xiamen City. Haicang District is situated in Haicang Peninsula, across the sea from Xiamen Island. Haicang District is located in the west of Xiamen Island, south of the Jiulong River estuary, west of Zhangzhou Taiwanese investment zone and north of Jimei Peninsula. Haicang District is an important port for sea-opening trade in southern Fujian Province and the main state-level Taiwanese Investment Zone in mainland China.

Haicang District used to be a barren small fishing village. It was inhabited around 200 B.C. and once belonged to different countries. After that, Haicang District experienced changes in Tang, Song, Yuan, Ming and Qing Dynasties. Haicang in Tang Dynasty began as a seaside settlement, surrounded by the sea on three sides, called Haikou. Later, it was renamed Haicang, which had the meaning of being wealthy near the sea. There were famous rivers in its jurisdiction. In the Republic of China, there were Cangjiang Town and Haicang District; in the 1950s, there were Haicang District, Haicang Township and Haicang Commune.

The construction stage of the modern city embryonic form of Xiamen Island is from 1908 to 1949. From 1949 after the founding of New China to 1979, Xiamen Island was in the stage of expansion of urban administrative areas and steady development of infrastructure. After the 20th century, Xiamen Island has not yet reached the saturation of urban development and need not expand. Haicang District outside the island is still developing slowly in the form of seaside villages.

Until 1989, with the approval of the State Council, Xiamen formally established Haicang Taiwanese Business Investment Zone. Haicang Investment Zone has a planned development

area of 100 square kilometers, with the goal of building a new industrial zone, a new port area and a new urban area in Xiamen. Since then, Taiwan-funded enterprises have been stationed continuously. The general planning of Taiwanese Investment Zone in Haicang District of Xiamen follows the principle of developing time and sequence. Generally, it adheres to the development strategy of extending from east to west and from West Sea to inland.

The rapid development stage of construction and urbanization of Xiamen Economic Special Zone was from 1980 to 2003. However, Haicang District and Xiamen Island are geographically separated from the sea. The cross-Straits mainly rely on ships, which is relatively inefficient.

On 30th December, 1999, Haicang Bridge was completed and opened to traffic. Haicang Bridge connects Haicang District and Huli District in Xiamen island. The construction of Haicang Bridge has effectively improved Xiamen's westward traffic to and from the island and greatly promoted the cross-island development of Xiamen. It has profound historical and practical significance for Xiamen's economic and social development. In 2003, Haicang District became an administrative division of Xiamen. Since then, this former small fishing village has embarked on the road of rapid development. At the same time, Xiamen has gradually moved from an island city to a bay city.

The construction of a bay-type city is also an overall urban development plan that Xiamen put into practice during the period of the Tenth Five-Year Plan from 2001 to 2005. Its core idea is to step out of the island and into the bay, giving full play to the advantages of Xiamen's port and bay resources. Through the expansion of development space, we can achieve the expansion of total economic output, the extension of economic hinterland, the optimization of economic structure and urban layout. In order to enhance the city's service function and radiation capacity, and enhance the city's comprehensive competitiveness.

Today, Xiamen has basically completed the transformation from an island city to a bay city. The main island is closely related to the inland. On the basis of preserving the natural villages left over from history, Haicang District has built a new industrial area and a new residential area. The natural villages left behind have been transformed into urban villages. The newly-built industrial and residential areas squeeze each other with the villages in the city. The texture of the city presents a fractured duality.

3. Urban Morphology and Architectural Typology of Industrial Port Area on Land

Macroscopic urban morphology includes zonal, grid, circular radiation, cluster, satellite, multi-center and other modes, mostly based on the topography and the layout of the road network. The microcosmic expression of urban morphology in the region corresponds to the spatial form. Urban morphology is composed of square, road, building, other elements and other objects with their own spatial characteristics. This paper compares Marghera with Xiamen in terms of plots and architectural typology.

3.1. Plots Comparison

In the study of street plots, this paper classifies the plots of Haicang District and Marghera into three types each, and compares them horizontally and vertically according to the survey data.

Firstly, Marghera's residential area is located on the south side of Mestre Railway Station, adjacent to the First Industrial Zone and on the west side of it at the same time. In the 1920s, Marghera's residential areas were planned according to the concept of "Garden City". Therefore,

the shape of plots is basically geometric, which is the result of policy orientation. Marghera's first industrial zone is distributed along the railway line between Venice and Mestre, both north and south. Many of the plots in industrial zones are rectangular, which is very common in the planning of industrial zones. The industrial streets plots along the coast are mostly divided into irregular shapes according to the coastline. In the 1950s, a second industrial zone was built, located to the east of the first industrial zone, adjacent to lagoon. The shape of the plot is similar to that of the First Industrial Zone, which is mainly rectangular. However, the size of the plots in second industrial district is much larger than that of the former, which is also the result of the rapid development of post-war industry.

The author divides the plots research of Haicang District into three parts: urban village, residential zone and industrial zone. The village in the city originated from the earliest inhabitants of Haicang District. This is a spontaneous village. Today, the urban morphology of Haicang Dis-

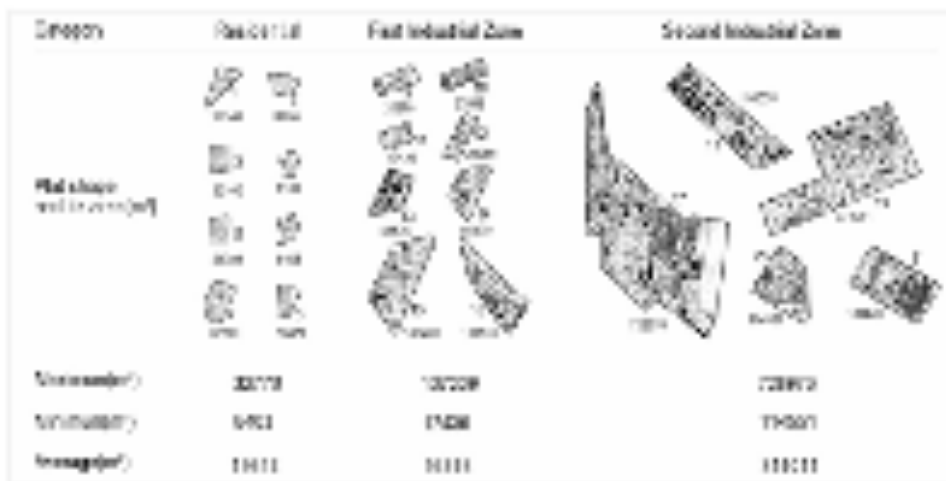


Figure 2. Plot study of Marghera.

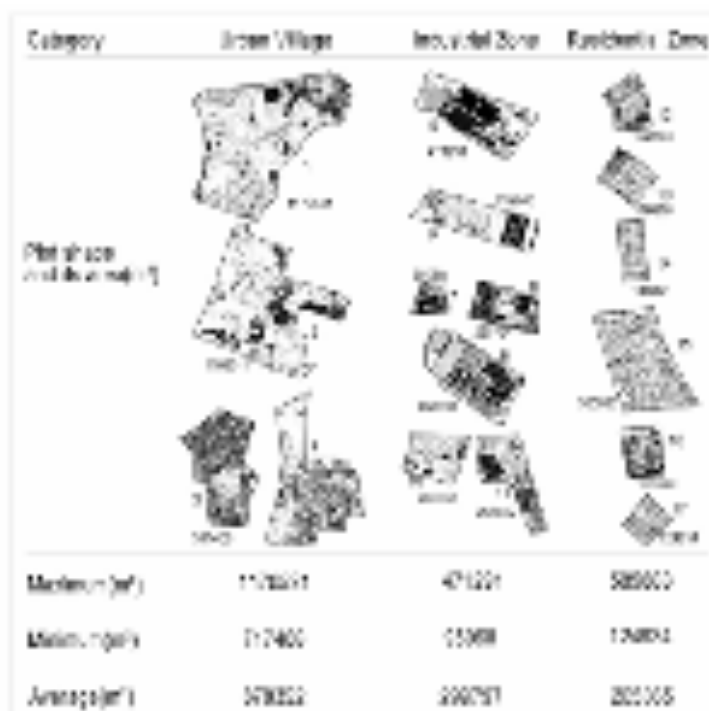


Figure 3. Plot study of Haicang District.

trict is that villages in the city are scattered in clusters between industrial and residential areas. The plots shape of villages in the city is irregular in natural form. Residential areas are mainly distributed along the eastern coastline, and their plots shapes are basically geometric, which is also the result of planning guidance. The outline of an industrial plots is always similar to a geometry. Because industrial zones need to avoid existing villages in the process of planning, it is necessary to make some fine-tuning for the geometric plots of industrial zones.

From the data point of view, Marghera and Haicang District have huge differences in plot size. Haicang's residential plot is much larger than Marghera's garden city. Because Xiamen has a high population density, the density of residential areas is much more than that of Marghera. Residential buildings and plots outlines will take on completely different scales. By contrast, the gap in the size of industrial plots is not such wide.

3.2. Building Interfaces Along Streets and Architectural Typology Comparison

After investigation, the author summarized and sorted out the building interface along the street of Marghera and Haicang District, and summed up three types respectively.

In Marghera's garden-city residential area, the buildings are basically 3 to 4 stories high, and a few buildings are 6 to 7 stories high. There is a matrix arrangement of buildings in a street. These buildings are basically similar in form and can form a continuous building interface. The layout of residential buildings is also relatively loose or tight. Because of the abundant sunshine in northern Italy, residential buildings in the Veneto area generally do not need to be strictly oriented, so there is also a street interface formed by the crisscross arrangement of residential

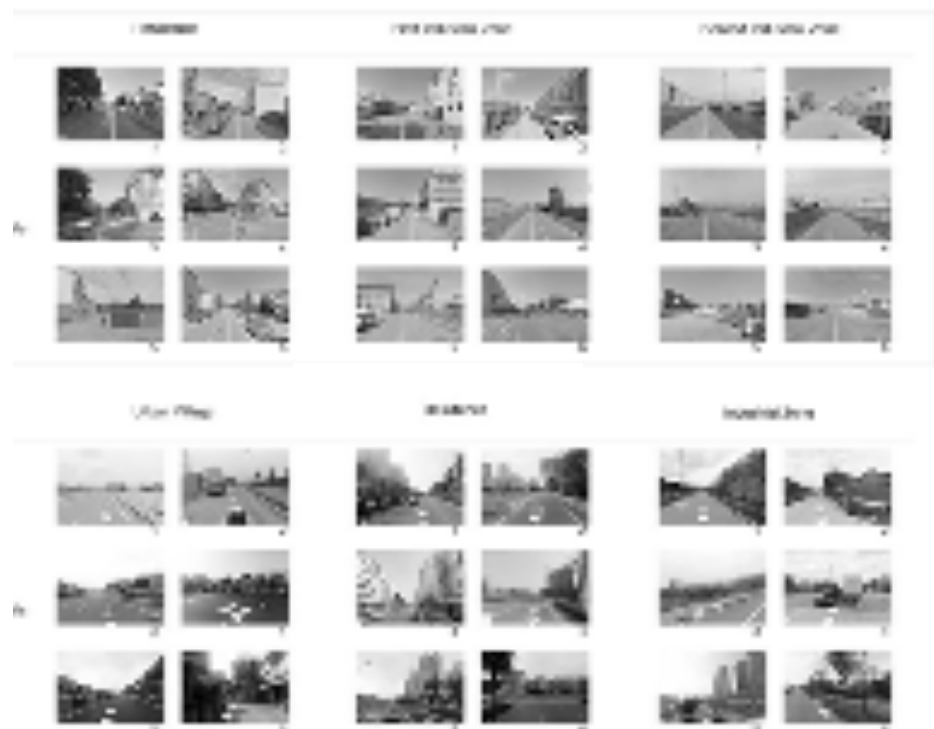


Figure 4. Interface study (4.1. Architectural interface in Marghera; 4.2. Architectural interface in Haicang District).

buildings. Marghera also has a newly developed residential area, all high-rise apartments with a cross-shaped flat.

The street interface of Marghera's first industrial district is dense and compact, but the floor height is not more than 5 layers. The scale of industrial factory buildings is quite different. Some areas are full of densely arranged small factories, and some areas are full of large factories. Another kind of workshop is the oil tank workshop of the chemical plant. Because some blocks stretch out to the sea, there are also some long strip-shaped factories with very large aspect ratio. Marghera's first industrial zone also has a centralized shopping area, including some factory stores and large supermarkets.

The factory scale of Marghera's second industrial zone is similar to that of the first industrial zone, but because of the larger Street scale and the larger spacing between the plants, the interface along the street is often loose and many open spaces can be seen.

The urban village in Haicang District has a very compact street interface, and the streets in the village are very narrow. This is quite different from the suitable scale of Marghera residential area. In Haicang District, the number of building floors in the village is basically within the range of 3 to 7 floors. Due to the lack of unified planning, the interface along the street is scattered. The size of the buildings in the village is also smaller than that of Marghera's.

The residential buildings in Haicang District are mainly high-rise buildings with a small number of buildings below 7 floors. There is only one road between some residential buildings and urban villages in the city, so the interface along the street presents a fractured situation. The scale of residential buildings in Haicang District is much larger than that in Marghera, which is also the current situation of high density residential environment in China.

In Haicang industrial zone, the layout of buildings is relatively loose, and the factory buildings are generally below 10 stories. The factory buildings in Haicang District are similar to Marghera's but the factory buildings in Haicang District have larger vertical scale. There are also some new high-rise office buildings in the industrial zone of Haicang District, which is not common in Marghera.

4. Conclusion

Marghera and Haicang District have gone through similar paths in their development history. As the land industrial port areas of island cities, they all have the functions of new residential areas and new industrial areas.

However, Marghera and Haicang also have many differences. There are huge differences between the two residential areas. The residential area of Haicang District is much larger than Marghera in terms of plot scale, architecture scale and building density. Moreover, the residential buildings in Haicang District are distributed between the industrial area and the village in the city. Although Marghera's residential area is adjacent to the industrial area, the functional division of the two areas does not mix.

There are deeper reasons for the huge difference between Haicang District and Marghera. Haicang Development Zone is one of the typical representatives of the new town industrial development zone model after China's reform and opening up. At that time, the mode of development was to build industrial zones and supporting living areas in open areas outside the old city with the rule of modernism. It is worth noting that some development zones have been successful because of the introduction of foreign capital, while others have become so-called "ghost cities" because of the disadvantage of attracting foreign investment. Unlike Marghera,

the supporting living areas in China's development zones are not just to solve the housing problems of workers. In a deep sense, this is to stimulate the real estate economy. In China's booming real estate market in the past 20 years, the residential equivalent of the new town in the development zone is very amazing. These houses are often bought not by workers in industrial areas, but by investors in old urban areas as "second houses" or simply as investments.

In a sense, these newly built residential areas have not solved the housing problem of workers. Instead, they exist for the benefit of the government's land transfer. In addition, the construction of industrial new towns has also brought "paradox of urban villages". On the one hand, the village in the city is a cash cow for the aborigines. The construction of the new town did not make them so-called "lose their homes". Because the government paid them a huge amount of demolition money, the construction made them new "multimillionaires". Therefore, they often raise the price of demolition funds in the way of "extortion", and the government's new industrial zone planning has not been fully implemented. On the other hand, the village in the city is a safe haven for workers and migrant workers. Because of the soaring housing prices brought about by capital intervention, the village in the city has become the preferred residence for workers in factories because of its low rent and prices.

In contrast, the gap between the two industrial zones in Marghera and Haicang District is not so wide in terms of plots and architectural scale.

To sum up, it is an indisputable fact that island cities need to strengthen the utilization of land resources in the process of development. The development of island cities in the future can avoid the similar problems of Magella and Haicang District and move towards a better future.

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Optimisation of Building and Road Network Densities in Terms of Variation in Building Lot Sizes and shapes

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Keywords: building, lot, road network, density, optimisation.

Abstract: Urban form at the district scale is defined as a unique combination of the following basic spatial objects: road networks, building lot patterns and building configurations. In particular, a building lot represents one of the most important basic spatial objects of urban form. In recent theoretical and empirical work from downtown districts in Tokyo, it was found that: (1) building lot sizes and frontages approximately follow a log-normal distribution; and (2) the parameters can be primarily estimated by building density (the number of buildings per unit area) and road network density (total length of road networks per unit area). The rationale for the building and road network densities presented here will be discussed by considering the variation in building lot sizes and frontages through a stochastic approach. Allowing for the smaller building lot size than minimum building lot size regulation as well as the narrower building lot frontage than minimum building lot frontage regulation (these minimum criteria being determined by Japanese building codes), the maximum building density and optimal road network density will be obtained. These findings are expected to provide urban planners with a theoretical basis to discuss the validity of these two density values (based on the deterministic approach that assumes uniform urban form) in terms of evaluating the policy effect, such as minimum building lot size and frontage regulation.

1. Introduction

Urban form is defined as a unique combination of the following basic spatial objects: road networks, building lot patterns and building configurations. The combination of road networks and the series of urban blocks (consisting of lots and buildings) that are enclosed within these road networks constitute a *district* – a collection of urban blocks and large-scale non-built areas – in a two-dimensional plane (Berghauser Pont and Haupt, 2009; Kropf, 1996; Marshall, 2009; Oliveira, 2016). In particular, a building lot represents one of the most important basic spatial objects of urban form and tends to directly connect road networks (Barreira-González and Barros, 2016; Bitner *et al.*, 2009; Legras and Cavailhès, 2016; Marshall, 2009; Moudon, 1994; Oliveira, 2016; Pont and Haupt, 2009; Shayesteh and Steadman, 2015; Suen and Tang, 2002; Vialard and Carpenter, 2012). A similar phenomenon in urban space is termed *urban syntax* (Marshall, 2009). This mutual dependence of road networks and building lots is important because the open space of road networks enables light to access buildings

and influences privacy depending on road width and building lot sizes. Wide road widths can compensate for small urban blocks and building lots and vice versa. Thus, the holism of road networks, building lots and buildings at a district scale should be central to a new definition of density (Berghauser Pont and Haupt, 2009; Dovey and Pafka, 2019).

Although a single density index is insufficient to an understanding of urban form, a method has been proposed to overcome this difficulty in classifying urban form (Berghauser Pont and Haupt, 2007, 2009): the combination of several density indices, called *Spacematrix*, which is defined as a three-dimensional diagram whose axes are the building coverage ratio (BCR), floor area ratio (FAR) and road network density (total length of road networks per unit area) of a district. Given that BCR can be estimated from building density (the number of buildings per unit area) (Koshizuka and Kotoh, 1989), *Spacematrix* can be redefined as a three-dimensional diagram whose axes are building density, road network density and FAR. Nevertheless, it has been found that: (1) building lot sizes, frontages and depths tend to follow a log-normal distribution irrespective of building density, road network density and patterns (whether regular grid or not); and (2) its mean and variance can be primarily estimated from building density and road network density (Usui 2018, 2019; Usui and Asami, 2019). Therefore, the building and road network densities of a district can also characterise the variation in building lot sizes, frontages and depths on the sub-space of *Spacematrix* (Usui, 2019). Conversely, it is expected that the variation in urban form as a set of building lots can be controlled by the combination of building density and road network density at a district scale. These findings will help provide urban planners with a theoretical framework, not only for a typology of urban form but also to discuss the rationale for present building and road network densities based on their relationship with variation in urban form.

The substantive motivation of this research is to provide a theoretical framework to discuss the rationale for present building and road network densities by considering variation in building lot sizes and frontages. According to Japanese building codes, the minimum building lot frontage criterion of two metres must be legally satisfied. However, for a better residential environment it is insufficient, and so a second minimum building lot frontage level might be proposed. Furthermore, minimum building lot size criterion can be legally determined in order to prevent the residential environment from deteriorating. Given these regulations, the upper ratio of the number of building lots that fail to meet these regulations is pre-determined as a criterion. If the ratio of the number of building lots is below a given criterion, the combination of current building and road network densities are deemed appropriate. However, the relationship between the ratio and combination of building density and road network density has yet to be investigated. Thus, urban planners tend to discuss the validity of present and future density values without examining variation in building lot sizes and frontages. Therefore, the following research question is expected to provide a theoretical foundation in determining the criteria for building and road network densities: *How can we optimise building density and road network density at a district scale subject to the ratio of number of building lots that do not meet the minimum building lot size and frontage regulations?*

The answer may contribute to delineating a feasible domain on the two-dimensional sub-space of *Spacematrix*. In setting the minimum building lot size regulation in a district (e.g., more than 100 m²), we can statistically determine the maximum building density such that the probability that building lot sizes are smaller than the regulation value is below a given criterion. Furthermore, building density criteria have been used to define

districts as densely built-up areas. In particular, a high building density, equivalent to a small average building lot size, is considered a major factor in the spread of fires and poor quality of sanitation, ventilation and privacy in Japan, rendering the residential environment worse as a whole. However, it is difficult to understand the diversity of building lot sizes and frontages in a densely built-up area (more than 60 buildings per hectare). The criteria for building density and road network density should be determined based not on a deterministic approach that assumes that all building lots are uniform in size and shape, but by considering the ratio of building lots smaller than the minimum building lot size criterion (typically 100 m²), which may need to be enlarged. Nevertheless, the rationale behind this deterministic approach has not been discussed in the literature, necessitating its reconsideration through a comparison of deterministic and stochastic approaches. Given that urban planners may encounter data limitations regarding building lot shapes, we can offer a theoretical framework to: (1) optimise building and road network densities by considering the variation in building lot sizes and frontages based on a stochastic approach; and (2) discuss the rationale for current building and road network densities compared with optimal versions.

This paper is organised as follows. Based on the probability density function of building lot sizes and frontages, the second section will derive two inequalities regarding building density and explain how building and road network densities can be optimised. In the third section, the rationale for present building and road network densities in districts in the Tokyo metropolitan region will be discussed based on comparison with optimal criteria. In the final section, we provide concluding remarks and directions for future work.

2. Optimisation of building density and road network density

In this section, we explain how to establish maximum building density through consideration of the variation in building lot sizes and shapes. First, the probability density function of building lot sizes and frontages will be explained. Second, two inequalities regarding building density will be derived. Third, building density and road network density will be optimised. Hereafter, we consider a district of area A , length of perimeter L , total road length Λ , and number of building lots n . As regards districts in the Tokyo metropolitan region, the average n is approximately six hundred. According to the Building Standard Law of Japan (Japanese building codes), in order to appropriately regulate building size and shape by BCR and FAR in its lot, a building lot basically has no more than one building, termed the rule of one building lot for one building. Thus, by assuming that the rule of one building lot for one building holds, the number of buildings is equal to n .

Hereafter, the size and frontage of building lots are denoted by s and F , respectively. According to Usui and Asami (2019), the distribution of building lot sizes is log-normal based on Gibrat's law:

$$g(s) = \frac{1}{s\sqrt{2\pi\sigma_s^2}} \exp\left[-\frac{(\ln s - \mu_s)^2}{2\sigma_s^2}\right], \quad s > 0, \quad (1)$$

where μ_s and σ_s^2 are the mean and variance of $\ln s$, respectively. These two parameters can be estimated from the following equations:

$$\mu_s = \ln \frac{1}{\sqrt{\eta^2 + 1}} \cdot \frac{\kappa(w, \lambda)}{\rho_G}, \quad (2)$$

$$\sigma_s^2 = \ln(\eta^2 + 1), \quad (3)$$

where $\rho_G = n/A$ and η are building density and the coefficient of variation in building lot sizes, respectively. In addition, $\kappa(w, \lambda)$ denotes the ratio of total building lot sizes to A as follows:

$$\kappa(w, \lambda) \approx 1 - w\lambda, \quad (4)$$

where λ denotes the road network density, Λ/A , and w mean road width. Furthermore, according to Usui (2018), building lots frontages follow a log-normal distribution:

$$h(F) = \frac{1}{F\sqrt{2\pi\sigma_F^2}} \exp\left[-\frac{(\ln F - \mu_F)^2}{2\sigma_F^2}\right], \quad F > 0, \quad (5)$$

where μ_F and σ_F^2 are the mean and variance of $\ln F$, respectively. These two parameters can be estimated from the following equations:

$$\mu_F = \ln \frac{1}{\sqrt{\eta_F^2 + 1}} \cdot \frac{\lambda(2 - w\lambda)}{\alpha\rho_G}, \quad (6)$$

$$\sigma_F^2 = \ln(\eta_F^2 + 1), \quad (7)$$

where α denotes the ratio of the number of frontages to n and η_F denotes the coefficient of variation in building lot frontages. Based on the sensitivity analysis of $g(s)$ and $h(F)$ regarding w and α , changes in the values of these parameters scarcely affect the shapes of $g(s)$ and $h(F)$. Moreover, η and η_F tend to be in the neighbourhood of 1.0 and 0.6, respectively (Usui 2018; Usui and Asami 2019). Thus, once these values are given as constant irrespective of district, and can be estimated primarily from ρ_G and λ .

Based on Equations (1) to (7), two inequalities regarding building density will be derived. Hereafter, the minimum building lot size is denoted by $s_{\min}$. By using Equations (1) to (4), the probability that a building lot size is less than $s_{\min}$ can be formulated as:

$$\begin{aligned} G(s \leq s_{\min}) &= \int_0^{s_{\min}} g(s) ds \\ &= \Phi\left(z_{\min} = \frac{\ln s_{\min} - (\ln(1 - w\lambda) - \ln \rho_G - \ln \sqrt{\eta^2 + 1})}{\sqrt{\ln(\eta^2 + 1)}}\right) \equiv \theta \leq \theta_c, \end{aligned} \quad (8)$$

where $\theta_c \in (0, 1)$ denotes the allowance for smaller building lot size than $s_{\min}$, and $\Phi(z)$ denotes the cumulative distribution function of the standard normal distribution. Since $\Phi(z)$ is the monotonically increasing function of z , we can define $z_{\min}$ and $z_{\theta c}$ as the standardisation

of $\ln s_{\min}$ and $\ln s$ such that $\Phi(z\theta_c) = \theta_c$, respectively. Therefore, Equation (8) is equivalent to the following:

$$\frac{\ln s_{\min} - \{\ln(1-w\lambda) - \ln \rho_G - \ln \sqrt{\eta^2+1}\}}{\sqrt{\ln(\eta^2+1)}} \leq z_{\theta_c}. \quad (9)$$

Thus, the maximum building density that satisfies Equation (8) is derived as follows:

$$\begin{aligned} \rho_G &\leq \frac{1-w\lambda}{\sqrt{\eta^2+1}} \cdot \frac{\exp[z_{\theta_c}\sqrt{\ln(\eta^2+1)}]}{s_{\min}} \\ &\equiv \rho_G(\lambda; s_{\min}, \theta_c), \quad \text{for } \lambda \in (0, 1/w). \end{aligned} \quad (10)$$

According to dimension analysis, the inverse of $s_{\min}$ is equivalent to the building density based on the deterministic approach. However, the $\sup \rho_G$ based on the stochastic approach is not equal to $1/s_{\min}$ because $\sup \rho_G$ is contingent not only on $1/s_{\min}$ but also on λ , w , η and θ .

Moreover, by applying the same method of deriving Equation (9) to Equations (5) to (7), the ratio that a building lot frontage is below the minimum building lot frontage $F_{\min}$ is less than ψ_c satisfies the following equation:

$$\begin{aligned} H(F \leq F_{\min}) &= \int_0^{F_{\min}} h(F) dF \\ &= \Phi \left(z_{\min} = \frac{\ln F_{\min} - \{\ln \lambda(2-w\lambda) - \ln \alpha \rho_G - \ln \sqrt{\eta_F^2+1}\}}{\sqrt{\ln(\eta_F^2+1)}} \right) : \end{aligned} \quad (11)$$

where $z_{\min}$ denotes the standardisation of $\ln F_{\min}$ and ψ_c denotes the allowance for a narrower building lot frontage than $F_{\min}$. Thus, $\sup \rho_G$ that satisfies Equation (11) is derived as follows:

$$\begin{aligned} \rho_G &\leq \frac{\lambda(2-w\lambda)}{\alpha\sqrt{\eta_F^2+1}} \cdot \frac{\exp[z\psi_c\sqrt{\ln(\eta_F^2+1)}]}{F_{\min}} \\ &\equiv \rho_G(\lambda; F_{\min}, \psi_c), \quad \text{for } \lambda \in (0, 2/w), \end{aligned} \quad (12)$$

where $z\psi_c$ the standardisation of $\ln F$ such that $\Phi(z\psi_c) = \psi_c$ respectively. In Equation (12), $\lambda(2-w\lambda)$ is proportional to the total length of urban block perimeters in a district. Given that $\lambda(2-w\lambda)$ is a convex upward quadratic function of λ , this is maximised if $\lambda = 1/w$. If the domain of λ ranges from 0 to $1/w$, then $\lambda(2-w\lambda)$ is the increasing function of λ . In actual districts in the Tokyo metropolitan region, λ is less than $1/w$. Therefore, $\rho_G(\lambda; F_{\min}, \psi_c)$ is also the increasing function of λ . On the other hand, $\rho_G(\lambda; s_{\min}, \theta_c)$ is the decreasing function of λ if the domain of λ ranges from 0 to $1/w$. Therefore, $\rho_G(\lambda; s_{\min}, \theta_c)$ and $\rho_G(\lambda; F_{\min}, \psi_c)$ are traded off in terms of λ (0, $1/w$).

Figure 1 presents the relationship between $\rho_G(\lambda; s_{\text{mim}}, \theta c)$ and $\rho_G(\lambda; F_{\text{mim}}, \psi c)$ with respect to θc and ψc . The values of the other parameters η , η_F and α are respectively 1.0, 0.6 and 1.2. The value of w ranges from (a) 6 metres, (b) 8 metres to (c) 10 metres. The values of s_{mim} and F_{mim} are respectively 100 m² and 6 m. It was found that for any θc and ψc , (1) the relationship between $\rho_G(\lambda; s_{\text{mim}}, \theta c)$ and $\rho_G(\lambda; F_{\text{mim}}, \psi c)$ shows a trade-off in terms of λ ; (2) for any λ , the greater the value of w , the smaller the values of $\rho_G(\lambda; s_{\text{mim}}, \theta c)$ and $\rho_G(\lambda; F_{\text{mim}}, \psi c)$; (3) for any λ , the greater the value of η , the smaller the value of $\rho_G(\lambda; s_{\text{mim}}, \theta)$; and (4) for any λ , the greater the values of η_F and α , the smaller the value of $\rho_G(\lambda; F_{\text{mim}}, \psi c)$, respectively. Hence, for any pair of θc and ψc , we can obtain the sup ρ_G and optimal λ^* as the point of intersection of $\rho_G(\lambda; s_{\text{mim}}, \theta c)$ and $\rho_G(\lambda; F_{\text{mim}}, \psi c)$. As mentioned above, the values of η , η_F and α are stable. Furthermore, the change in the value of w does not affect the shape of $\rho_G(\lambda; s_{\text{mim}}, \theta c)$ and $\rho_G(\lambda; F_{\text{mim}}, \psi c)$. Therefore, in Equations (10) and (12), the values of η , η_F , w and α are regarded as constant irrespective of districts.

In addition, as shown in Figure 2 (drawn in grey domain), $\rho_G \leq \rho_G(\lambda; F_{\text{mim}}, \psi c)$ ($\lambda \leq \lambda^*$) and $\rho_G \leq \rho_G(\lambda; s_{\text{mim}}, \theta c)$ ($\lambda^* \leq \lambda$) is a feasible set of the pair of ρ_G and λ that satisfies Equations (10) and (12). Moreover, the black circle represents the coordinate of the sup ρ_G and optimal λ^* as the point of intersection of $\rho_G(\lambda; s_{\text{mim}} = 100, \theta c = 0.4)$ and $\rho_G(\lambda; F_{\text{mim}} = 6, \psi c = 0.3)$. This feasible set can be regarded as a set of appropriate pairs of ρ_G and λ because both $\theta < \theta c$ and $\psi < \psi c$ are satisfied. The criteria of s_{mim} and F_{mim} should be determined from the perspective of a residential and built environment's levels of sanitation and safety at a building lot scale. In addition, not only should a civil minimum criterion be considered in order to improve the residential environment of a district, but also a higher criterion should be used to increase its desirability. On the other hand, the values of θc and ψc can be given as a temporary desirable level (e.g., based on policy making). For instance, consider a district in which θ and ψ are 0.6 and 0.5 (shown as a black triangle in Figure 2), respectively. As the first step level, the values of θc and ψc are respectively set as 0.4 and 0.3. Furthermore, as the second step level, the values of θc and ψc are respectively set as 0.2 and 0.1 (shown as a white circle in Figure 2). This step-by-step approach is expected to provide urban planners with a theoretical basis to discuss the validity of present and future density values in terms of improving the residential environment.

3. Discussion

In this section, a framework for discussing the rationale behind current building and road network densities will be proposed on the basis of Figure 2, before applying it to the empirical study of districts in the Tokyo metropolitan region. As shown in Figure 2, the first quadrant can be partitioned into four sub-regions called regions (A), (B), (C) and (D). Figure 3 illustrates each approach to reducing θ and ψ as arrows on sub-regions (B), (C) and (D), respectively. The start and end points of each arrow represent the present and improved pair of the present building density and road network density, respectively.

In region (B), although Equation (12) is satisfied, Equation (10) is not satisfied. In other words, even though the ratio of frontages shorter than F_{mim} is below ψc , the ratio of building lot sizes smaller than s_{mim} is not below θc . Thus, if a district is categorised into region (B), the policy for decreasing building density in order for this district to be categorised into region (A) should be adopted. To reduce θ from the present $\theta > \theta c$ to θc , two approaches are available: (B1) decreasing ρ_G and fixed λ parallel to the vertical axis to the region (A); or (B2) decreasing ρ_G and λ along the curve of $\rho_G(\lambda; F_{\text{mim}} = 6, \psi < \psi c)$ to the region (A). On the one hand, by adopt-

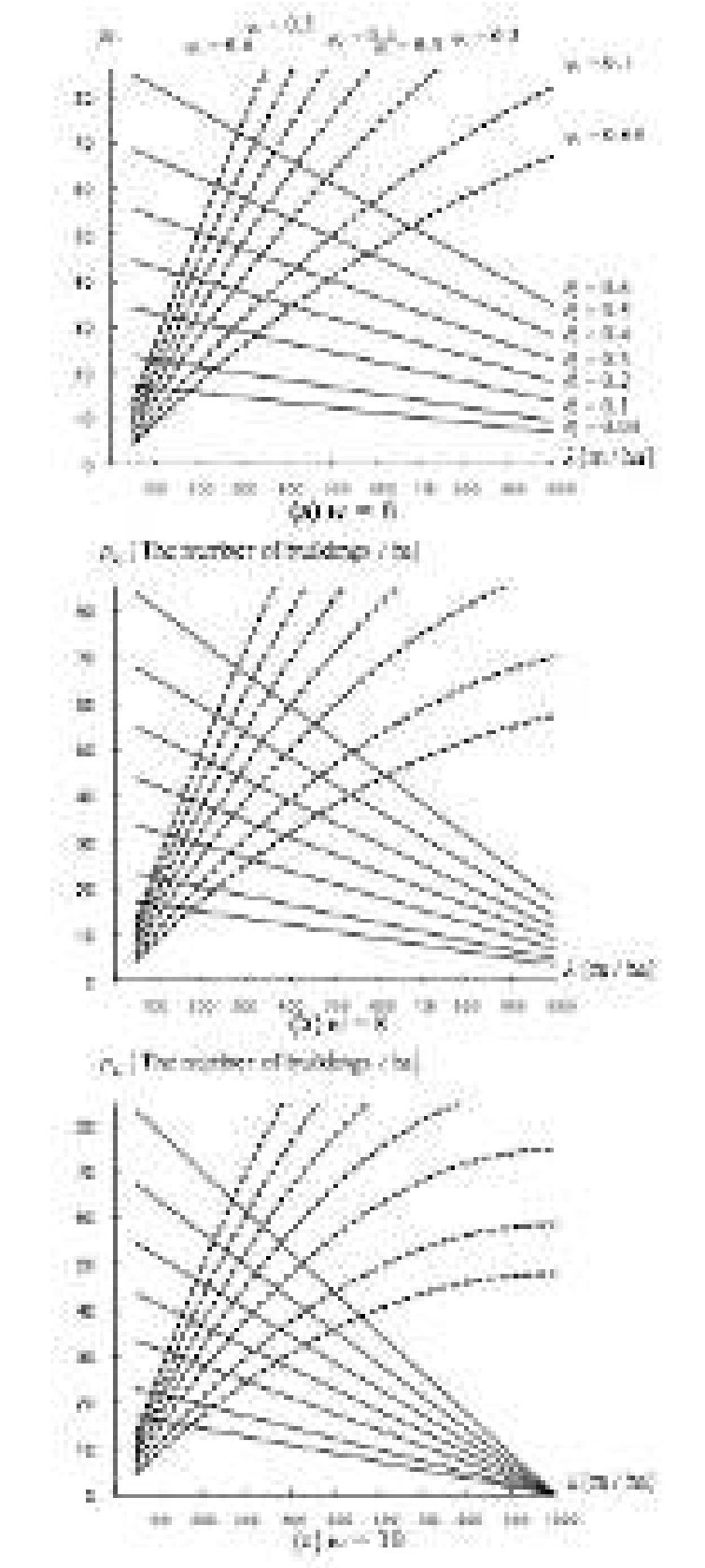


Figure 1. Relationships between the sup ρG and λ , given as Equations (10) (solid lines) and (12) (dotted lines) with respect to θ_c and ψ_c . The values of other parameters, η , ηF and α , are respectively 1.0, 0.6 and 1.2, while $s_{min} = 100 m^2$ and $F_{min} = 6$ metres. The value of w ranges from (a) 6 metres, (b) 8 metres to (c) 10 metres.

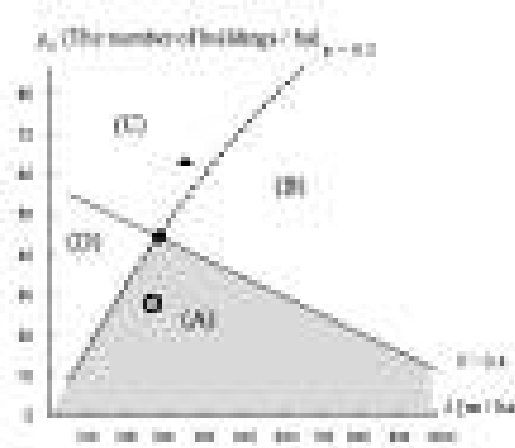


Figure 2. A feasible set of the pair of ρG and λ (drawn in grey domain). The solid line and dotted line represent the $\sup \rho G$ given as Equations (10) and (12), respectively. The values of other parameters (η , ηF , α and w) are respectively 1.0, 0.6, 1.2 and 8 metres while $s_{\min} = 100$ m² and $F_{\min} = 6$ metres. The values of θ_c and ψ_c are 0.4 and 0.3, respectively. The coordinate of the $\sup \rho G$ and optimal λ^* as the point of intersection of $\rho G(\lambda; s_{\min} = 100, \theta_c = 0.4)$ and $\rho G(\lambda; F_{\min} = 6, \psi_c = 0.3)$ as the black circle.

ing approach (B2), the ratio of building lots smaller than $s_{\min}$ can be reduced by decreasing both ρG and λ simultaneously, with ψ ($< \psi_c$) being held constant. Decreasing λ is equivalent to increasing α at the expense of the road area of a district. Thus, approach (B2) corresponds to a land readjustment project that merges small urban blocks into a large urban block, as well as improving the pattern and width of road networks in order to meet demand for large building lots. On the other hand, by adopting approach (B1), θ and ψ can be reduced without decreasing λ by merging several adjacent building lots that are narrower than $F_{\min}$ – especially *flag-shaped building lots* – into a regular building lot. Thus, approach (B1) corresponds to land readjustment projects of an urban block without altering road network patterns.

In region (D), although Equation (10) is satisfied, Equation (12) is not satisfied. Thus, if a district is categorised into region (D), the policy to either reduce building density or increase road network density so that it may be categorised into region (A) should be adopted. To decrease from the present $\psi > \psi_c$ to ψ_c , two approaches exist: (D1) decreasing ρG and fixed λ parallel to the vertical axis to the region (A); or (D2) decreasing ρG but increasing λ along the curve of $\rho G(\lambda; s_{\min} = 100, \theta < \theta_c)$ to the region (A). Whereas approach (D2) renders θ constant, approach (D1) brings θ close to 0. In terms of improving the residential environment, approach (D1) is more appropriate because it is possible to reduce both small and narrow building lot frontages. Furthermore, owing to rigid budget constraints for road construction and maintenance, approach (D1) is more practical than approach (D2).

In region (C), both Equations (10) and (12) are not satisfied. Thus, if a district is categorised into region (C), the policy to reduce building density in order that it may be categorised into region (A) should be adopted. To decrease from the present $\theta \geq \theta_c$ to θ_c and from the present $\psi \geq \psi_c$ to ψ_c , two approaches exist: (C1) decreasing ρG and fixed λ parallel to the vertical axis to the region (A); (C2) decreasing ρG and λ to the maximum ρG and λ^* , respectively; or (C3) decreasing ρG but increasing λ to the maximum ρG and λ^* , respectively. Whereas approaches (C2) and (C3) accompany either increasing or decreasing the present λ to λ^* , approach (C1) does not. In terms of decreasing the present ρG effectively, approaches (C2) and (C3) are more appropriate than approach (C1). This is because by adopting approach (C3), although additional roads are required, the reduction of ρG in approach (C3) is smaller than that in approach (C1).

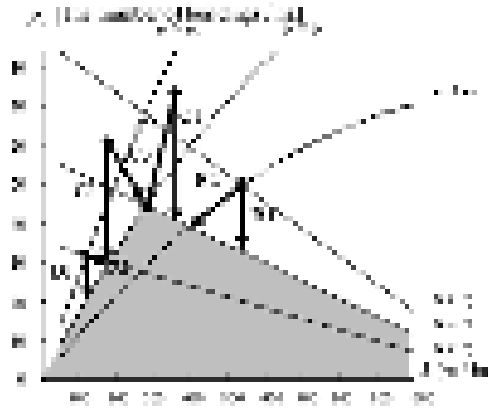


Figure 3. Approaches to reducing small and narrow building lots in each sub-region.

In order to discuss the rationale behind the present values of ρG and λ in districts in the Tokyo metropolitan region (the total number of which is 3,117), the figures are plotted as shown in Figure 4 (black dots). It was found that (1) if θ_c and ψ_c are 0.4 and 0.3 (a desirable level), respectively, almost all of the districts in the Tokyo metropolitan region are categorised into either region (A) or (B); and (2) if θ_c and ψ_c are 0.1 and 0.1 (the more desirable level), respectively, almost all of the districts in the Tokyo metropolitan region are categorised into regions (A), (B) or (C).

As mentioned in the previous section, if the combination of ρG and λ in a district is categorised into region A, it can be regarded as appropriate because both $\theta < \theta_c$ and $\psi < \psi_c$ are satisfied. Otherwise, the policy for either decreasing ρG or increasing λ in order for this district to be categorised into the region (A) should be adopted.

4. Conclusion

The substantive motivation of this research was to discuss the rationale behind current building and road network densities by considering variation in building lot sizes and frontages based on a stochastic approach. The criteria of $s_{\min}$ and $F_{\min}$ were deemed desirable, and θ_c and ψ_c were set as a temporary desirable level (e.g., based on policy making), enabling us to optimise building density and road network density at a district scale.

Optimal building density and road network density can be obtained as the point of intersection of $\rho G(\lambda; F_{\min}, \psi_c)$ and $\rho G(\lambda; s_{\min}, \theta_c)$. Furthermore, $\rho G \leq \rho G(\lambda; F_{\min}, \psi_c)$ ($\lambda \leq \lambda^*$) and $\rho G \leq \rho G(\lambda; s_{\min}, \theta_c)$ ($\lambda^* \leq \lambda$) can be delineated as a set of appropriate ρG and λ because both $\theta < \theta_c$ and $\psi < \psi_c$ are satisfied. Moreover, in order to discuss the rationale behind the present values of ρG and λ in districts in the Tokyo metropolitan region, they are categorised into the four regions (A) (appropriate), (B) ($\theta > \theta_c$ and $\psi < \psi_c$), (C) ($\theta > \theta_c$ and $\psi > \psi_c$) and (D) ($\theta < \theta_c$ and $\psi > \psi_c$). It was found that: (1) if θ_c and ψ_c are 0.4 and 0.3 (a desirable level), respectively, almost all of the districts in the Tokyo metropolitan region are categorised into either region (A) or (B); and (2) if θ_c and ψ_c are 0.1 and 0.1 (the more desirable level), respectively, almost all of the districts in the Tokyo metropolitan region are categorised into either region (A), (B) or (C). As mentioned in the previous section, if the combination of ρG and λ in a district is categorised into region A, it can be regarded as appropriate because both $\theta < \theta_c$ and $\psi < \psi_c$ are satisfied.

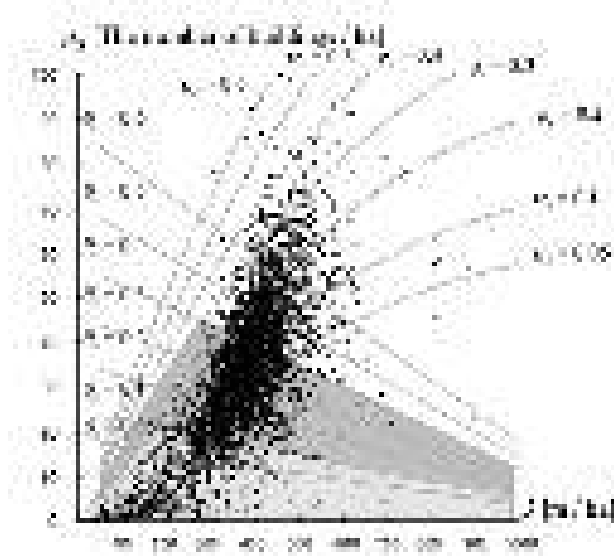


Figure 4. Building density and road network density of districts in the Tokyo metropolitan region (black dots) with $\rho G(\lambda; s_{\text{mim}} = 100, \theta_c)$ and $\rho G(\lambda; F_{\text{mim}} = 6, \psi_c)$ (drawn in solid lines and dotted lines, respectively). The values of other parameters $\eta, \eta F, \alpha$ and w are respectively 1.0, 0.6, 1.2 and 8 metres, while $s_{\text{mim}} = 100 \text{ m}^2$ and $F_{\text{mim}} = 6$ metres. The number of districts is 3,117. The regions drawn in dark grey and light grey are a feasible set of the pair of ρG and λ for $\theta_c = 0.4$ and $\psi_c = 0.3$ and for $\theta_c = 0.1$ and $\psi_c = 0.1$, respectively.

Otherwise, the policy for either decreasing building density or increasing road network density in order for this district to be categorised into the region (A) should be adopted.

As mentioned in the second section, the inverse of s_{mim} is equivalent to building density based on the deterministic approach. However, the $\sup \rho G$ based on the stochastic approach is not equal to $1/s_{\text{mim}}$ because $\sup \rho G$ relies not only on $1/s_{\text{mim}}$ but also on λ, w, η and θ . According to Figure 4, although building density is sixty buildings per hectare, various pairs of θ_c and ψ_c can be observed – e.g., $(\theta_c, \psi_c) = (0.5, 0.6), (0.6, 0.3)$ – implying that building density does not capture the ratio of smaller and narrower building lots on its own. By introducing road network density, we can understand the variation in urban form and the ratio of smaller and narrower building lots below the given criterion of s_{mim} and F_{mim} . This is a limitation of solely using building density because it does not allow us to understand the variation in urban form. On the other hand, in the districts of the Tokyo metropolitan region and given the values of θ_c and ψ_c as 0.6 and 0.3, respectively, a building density below sixty buildings per hectare enables districts in the Tokyo metropolitan region to be categorised into region (A) (appropriate).

Several points can be suggested for future research. First, variation in other dimensions such as building lot depths and building height also help characterise variability in urban form. By considering the ratio of deeper building lot depths than the maximum criterion being less than permitted, region (A) might be more restricted than when this ratio is not used. Such future work should thus explore the potential of *Spacematrix*. Second, based on the characterisation of variations in urban form on the sub-space of *Spacematrix*, the rationale for contemporary zoning regulations regarding each building lot (e.g. BCR, FAR and building setbacks) could be reconsidered to promote a better residential environment.

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The Frontage

Uncovering the Public-Private Interface through Sampling and Categorization of Micro-Morphological Solutions at Street Level

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Keywords: public-private interface, categories, micro-morphology, directed content analysis.

Abstract: This paper addresses the problem of realizing the potential of the urban experience in the detail of what we perceive as urban; the relationship between buildings and cityscape; private and public, inside and outside; through urban form in the public-private interface of street frontage. It asks how we can develop a random sampling and categorization of micro-morphological solutions at street level into fundamental knowledge of an urban typology, which work as a tool to produce urban form.

The paper describes categorisation of types through *directed content analysis*. By developing existing theories of interface typology into an initial coding scheme through a process of coding, type and pattern identification, we use a survey of photographic examples as a basis for refining and extending these and thereby exploring relationships between defined categories.

The research presents interface relationships comprising two main dimensions, *depth and spatial interaction of the threshold* and *visual and physical permeability of the façade* each including 4 main categories with variations. We define this element as *façade-threshold* through a matrix of interdependent relations with interface types providing a defined knowledge of this relationship, which can contribute to the understanding and development of better design solutions where urban micro-morphology influences our urban experience.

1. Introduction

This paper addresses the problem of realizing the potential of the *urban experience* through urban form. With urban experience we understand the content of what we, with reference to Ildefons Cerda, perceive as *quintessence for urbanization*, the relation between buildings and streets. A common expression in today's urban planning practice is "active facades" which is a reference to a lively street and facilitation for commercial activities. The frontage of a private building face the public domain, but the public-private interface at street level is much more complex, than just openings for commercial activities. Think about your street and your experience of moving through the spaces and places it comprise. How do you get from this street and in to your private home, how do you walk from the most public to the most private? How many spaces do you have to break through before you are completely inside? Our experience of this particular part of the urban morphology is firstly *visual*; we get information through what

we see. And it is *tectonic* while we sense the materials, smells and sounds. But it is also *bodily*, by how we move and feel frictions and obstacles, and it is *interpretable* by how we combine these experiences to orient in the cityscape (Figure 1). The *frontage* represents the relationship between buildings and cityscape, a negotiator between private and the public urban space and thus inside and outside. The frontages define the street and presents possibilities for encounters between different territories e.g., between home and city. These potential connections include dimensions of both material and social character. Our task is to discuss this interface as a micro-morphological urban type and to find a suitable concept that define it. .

2. The frontage as public-private interface

When Ildefons Cerda, as a part of his search for a grand urban theory in the mid19th century, described the relation between houses and streets as the *quintessence for urbanization*, he delved deeply into the origin of the streets and their tight, indissoluble relation to the buildings which they served, both as an entity connecting ways and buildings but at the same time as an economically and legally challenge of city production and financing. (Soria y Puig & Serratos, 1999). In the decades and centuries after there was a fall and rise in focus considering the characteristics and capacities of this small micro-morphological relation. Nearly hundred years after Cerda, M.R. Conzen presented a different approach to this relation through the term *Frontage*, which included an interface between *street* and *the boundary of a plot* (Conzen, 1960). As such, the *plots* defined buildings and played the important role of town development. In his seminal Alnwick study, Conzen presented the term *Frontage types* as measurements of individual plots, including the length of street line taken up by it and classified as two main Frontage types a and b with fractal variations; halves, quarters and three quarters. More recently, Karl Kropf has established a framework to combine different approaches in his *Generic structure diagram* (Kropf, 2014). This framework shows relations between micro-elements of materials and structures and macro-elements of streets and urban tissues, including buildings and plots on different vertical scales and their relation to the street. The diagram frame a discussion on the varieties and complexities included in micro-morphological research, *the frontage as public-private interface*. These three theoretical approaches has been important for our investigation of the relation between buildings and streets. In addition a range of studies on morphological characteristics of form (Kickert, 2016; Palaiologou *et al.*, 2016; Samuels *et al.*, 2012; Zoller & Wüstenrot, 2014), structure (Hanson, 2000; Hillier & Hanson, 1984; van Nes, 2008) and iconography of the public-private interface, and its correspondence to social capacities such as urbanity; liveability, walkability, use/activity (Minoura 2016), behavior and prevention for crime (van Nes, 2008) as well as perspective qualities such as experience and territory (Habraken & Teicher, 1998). As such, this relation has been widely researched and described, but very few have engaged in questioning this as a typology and thus be able to conceptualize it.

The issue we are addressing in this paper is not the *street frontage* as such, but the making of a typology comprising micro-morphological solutions of public-private interface that occur at street level and become foundations of our urban experience. The image below demonstrate how a whole range of different micro-morphological solutions in just a small part of street create the spatial conditions for our experience.

The aim of this paper is to discuss whether it is possible to *operationalize* urban experience into a tool for current design practice. The research questions posed are; How can different solutions of public-private interface at street level be categorized as types and morphological variants? Can we develop a *precise concept* that describe this micro-morphological part of the city?



Figure 1. Urban experience.

3. Methodology – sampling photos, sketching theory

We have investigated these questions in parallel and along two directions; a photo documentation and sampling of existing examples of this urban element. And a literature review of how this element is treated in urban design theory and text books in urban planning and architecture, with the aim to find an *operational theory* (Figure 2). Based on a directed content analysis of the photos and a critical reading by “sketching the theories”, we have sorted and categorized the existing examples according to the *operational theory* of urban design, the theories of typologies defining building-street relation. We randomly selected, sampled, documented and produced more than 2500 photographs of the building-street relation from real-life contexts in both Norway and abroad. The operational theory of typologies provided us with a theoretical framework that directed our research, results and analysis. We sorted and interpreted the raw data/photos through a systematic process of *coding* (through sketching) and *pattern identification* (through categorizing) with purpose of *refining* existing and *developing* new types and a typology. This approach to categorization can be described as *directed content analysis* where existing theory help establishing and identifying key concepts or variables as initial coding *categories* (Riff *et al.*, 2006). The process from sampling and sketching of categories (Figure 3), led to a matrix of types (Figure 4). A type in this matter is neither a building, nor a street. We are searching for the particular characteristics that enable us to classify them as a type by the development of a set of related but distinct categories within this phenomenon.

Our method developing the types and typology is situated in the *making disciplines* of design and architecture, bringing in an understanding of design through diagrammatic reasoning, through drawings and diagrams. This spatial knowledge production in our research comprise *diagrammatic development of types produced through relational thinking and drawing*. We have interpreted and drawn theory into visual categories that we have recognized through the empirical material. We have sorted the material and analysed characteristics of this material into diagrams of types that are synthesized into a typology. This process includes activities such as ab-

straction, connection and systems and transaction. As such, the method of using drawings has accompanied the whole process from raw to refined data comprising *sketching* of initial coding scheme, *drawing* of categories, analyzing and *developing* diagram types and synthesizing typology. While academic tradition largely produce spatial knowledge through verbal and textual accounts (with images, maps and diagrams only playing an illustrative role), a few researchers have recently called out for a more comprehensive approach including visual development and reasoning. Dovey and Pavka (Dovey & Pavka, 2019) suggest that the *language of urban thinking* also includes knowledge *embodied* in diagrams and maps central to discourses of spatial knowledge, and fundamentally relational rather than reductionist. Revealing general patterns of both sociality and spatiality, they can contribute to the description and development of morphological types connected to urban complexity and experience.

The procedure involved a seven step process of drawing out and into types: A_operational theory_creating initial coding scheme of depth configuration, B_Coding and sorting of raw data in initial coding scheme, C_Refining coding scheme based on processed data, D_operational theory_introducing levels of visual and physical permeability, E_Defining the matrix – Synthesised knowledge developing types, F_Defining the typology_diagrammatic representation of types generating an analytical tool.

4. Operational theory – Dimensions of visual and physical permeability

Our problem is that the urban element we are investigating belongs to neither the building nor the street, but overlap and relate these two main structures in the urban tissue. The literature review (Figure 2) shows at least four different typologies addressing the micro-element of the building-street relation forming the precedents for this research (Bobic, 2004; Dovey & Wood, 2015; Gehl *et al.*, 2006; Habraken & Teicher, 1998).

These four typologies focus on different aspects of the building-street relation (Figure 2) presenting opportunities to *break through* or *move along* the physical boundary of the building wall. The most detailed typology in our operational theory is Milos Bobics (2004) *entrance typology*



Figure 2. Literature review – a synthesis of perspectives addressing the building-street relation.

including 7 primary types and 40 subtypes. The typology focus on *the permeable link* between the house and the street, in the entrance and topological steps from public to private. Another typology of the permeable access, was developed by Habraken a few years earlier. He developed a multi-scale typology of entrances and gates on all scales from interiors room of a building up to nations based on how they negotiated *movement and flow* between different types of social and legal territories. This two are most concern about the movement *through*, while Jan Gehl's *façade-typology* comprising soft and hard facades, concerns the movement *along* the frontage. His design-driven typology mix aspects of morphology, psychology and value assessment in one combined approach where the building-street interface is classified along an five step axis from A_soft (social, permeable, active, small grain, good details) to E_hard (asocial, blank, large grain, no details). Dovey and Wood (2015) also developed a five-step typology focusing on the physical transition zone, the public-private interface. Their typology includes the *legal cadastral boundary* and not the physical building line as included in Bobic, Habraken and Gehl's work.

5. Defining the matrix

Our research suggest that interface relationship occurs in two main dimensions, *depth and spatial interaction of the threshold* and *visual and physical permeability of the façade*, each including four main types with numerous morphological variations.

We developed the dimension of *Depth and spatial interaction of the threshold* as a synthesis of the photographic data inspired by Bobic and Habraken and their typologies of permeable entrances. We present this boundary between inside and outside as a *threshold*, presented in the dictionary as 'a point of entry or beginning' and 'a strip of wood or stone forming the bottom of a doorway and crossed in entering a house or room.' As such *threshold* is formed of both an object and a relation, it is formed of both the spatial element of form and the active crossing through structure. This duality presented in this term highlights the morphological potential of terminology.

This threshold allows us to break through the physical wall through different steps of *depth*. The configuration of this depth includes topological and/or territorial steps from the street to the house/flat, from the public to the private. As such, the threshold is directly connected to the structure, syntactical arrangement and relation between different steps. Within this dimension, we have developed *four main types of depth and spatial interaction* that define and present structural connections and configurations between private unit/block and public space, described through *diagrams*. They include interesting sub-types that shows a range of formal types and examples of spatial interaction between form and space. Three of the types operate at micro-morphological level, describing the transition of the building on its plot in relation to the street (direct, setback, projected). The last main type operates at block-street level (integrated) and describe a deeper transition from public to private space. This deep threshold type has numerous sub-types and topological steps that can be investigated further through structure diagrams of depth configuration. The *direct* type is strictest and most clear transition between public and private space without any kind of overlaps or spatial transitions. Building, plot and territory meets in the same line facing the street directly.

The *setback* type (subtraction of building mass/space) include a zone of overlap setback from building line within the building mass. The setback creates a covered area physically connected to outdoor public space, a space that define distinct rooms sometimes with specific materiality for roof, walls and floor. It also provides longer façade length and has often been used as expan-

sion of shop windows on smaller plots. The type present a visual expansion of the streetscape from the public into the private domain. The physical subtraction of building mass can occur at street level, over or under connected by steps. Distinction and demarcation of public and private spaces is not as clear as previous type, as public and private space here share territories. *The setback type include seven sub-types: raised street, under building, colonnade, carport, loggia, alcove and niche.* The *projected* type (addition of building mass/space) include a zone of overlap outside from building line. The main building line includes a zone or a margin where building elements, permanent and/or temporary, adds on outside the line sometimes within the plot and sometimes out into the pavement and public space. The elements can be attached to the building in two ways, by projecting out into the public pavement or by creating a distance between building and public space within the private plot (example: front gardens). The type is more complex than the setback and connected to usage within or outside property – or building boundaries. It includes the whole span from spontaneous appropriation (though placements of plant and kids toys) to permanent structures such as steps out into the pavement. As such this type presents ambiguities including practice of appropriation as well as legal distinction.

The last type, *integrated*, included several layers of overlap between building and public space. The type consists of spatial connections and transitions integrated in and as a part of the urban block. It occurs though a sub-division of the urban pattern when public and/or collective space break through the urban form of the block. Buildings and entrances relate out and around a surrounded collective space like an inner street/mews, courtyard or arcade that again connect out to the street. The transitions are complex with a range of layers from public and collective to private, and can further be investigated through configuration analysis using of the generic structure diagram (Kropf, 2014) and topological investigations. It is a very common type within the Norwegian context, often presenting collective permeable entrances towards the street.

The refining process of photo material showed different degrees of visual permeability that could not be included in the dimension of physically permeable interfaces, of depth and spatial interaction. As such, different degrees of visual and physical permeability defined an additional dimension added in the analysis process. We developed the dimension of *Visual and Physical permeability of the façade* as a synthesis of the photographic data inspired by Jan Gehl's typology of soft and hard facades and Dovey & Wood's typology for the public-private interface. We present this dimension and transition between inside and outside as *facades*, presented in the dictionary as 'the front of a building' and with origin in the Latin *facia*, meaning "face". The transparency and permeability of the facade includes different degrees contact between the street and the house/flat, between the public and the private. As such, the facade is directly connected to the material performance of the façade, its form components and properties, and thereby the capacity of creating relations through visual and bodily senses. The façade is the negotiator that takes care of the two pair of capacities, *transparent/non-transparent* and *permeable/impermeable*. As such it is the clearest physical and morphological boundary between inside and outside. This dimension allows us to *move along* the physical facade through constantly changing morphological contexts, and thereby presenting opportunities for urban experiences.

Through the process of the content analysis we developed 4 distinct types of façade characteristics with different degrees of permeability and capacities. The four main types within this dimension define and present visual and physical degrees of connection between the private unit/block and public space, described through *diagrams*. Three of the types are connected to degree of visual permeability, describing different extent/amount of visual contact between inside and outside (closed, one-way transparent, transparent). The last main type describes the physically permeable façade and is closely connected to Bobic's and Habraken's approaches. The

Closed type of the facade present no visual or physical relation between inside or outside. As such it has no capacity of transition but can include tectonic experience through rich material details and/or iconographic elements such as graffiti, or ornamentation. This type of façade could be interpreted as not being able to support urbanity, however we presents this type as engaging a different capacity of socio-spatial relation. As such, the properties this morphological type presents must thoroughly be investigated to address the rich variety of urban experiences urbanity presents. The Opaque window is a type of closed translucent façade defining the transition between the closed and the next main type, the *one-way transparent type*. This type presents *one* visual relation from inside to outside, from private dwelling out into public space, and works as a way to secure private interests. This relation becomes physical through materiality, as a window with properties defining one relation known from interview rooms, or through the use of different floor levels and/or indoor furnishing such as curtains and plants etc. It is a very common way of securing private interest within the Norwegian context when built form fails to address territorial transition between public and private interests.

The next two facade types are generally included as the main types within the vague term *active facades*, currently prominent within the Norwegian context. The *Transparent* type of the facade creates visually accessible openings between inside and outside. The type include a range of different transparent elements, from a small window to a whole glass façade, presenting different possible connections and degrees of visual permeability. The properties of this type presents the capacities of relating the inner life of a building with the public life of the street. The *Permeable type* include physical openings in the facade between inside and outside. There are a range of possibilities within this category that we experience moving along the street. For example we can measure the density of permeable physical openings, the *entrance-density*, by counting the amount of doors pr. street length finding an index of permeability along the street (Palaiologou *et al.*, 2016). Knowledge of this presents probabilities for socio-spatial encounters. In addition, counting transparent and permeable types on both sides and across the street presents degrees of *inter-visibility*, a capacity relevant for an experience of safety and control (van Nes 2008). Morphological traditions in different countries presents different approaches to the connective element of the building-street interface. I Norway, the connective element is often included in and as part of the buildings and flats, stacked on top of each other. In comparison, the English terraced house use the connective element of the outdoor street where housing is stacked next to each other. The different permeable types are therefore in the first example collective and in the second individual, presenting both higher inter-visibility and entrance-density.

6. Defining the typology of façade-threshold – including a new term of synthesized knowledge

We suggest that the two main dimensions and their main types can be presented in a *matrix of types*, of combined and synthesized representation of *relations*. This matrix include both the physical boundary that define inside and outside (façade) that we move along, but also the element that allows us to break through this boundary (threshold). As such, it links different theoretical perspectives into one combined and comprehensive approach defining sixteen unique types both including facades and thresholds. This linkage we address through the development of the matrix offers a new, combined and precise concept describing this micro-morphological part of the city.

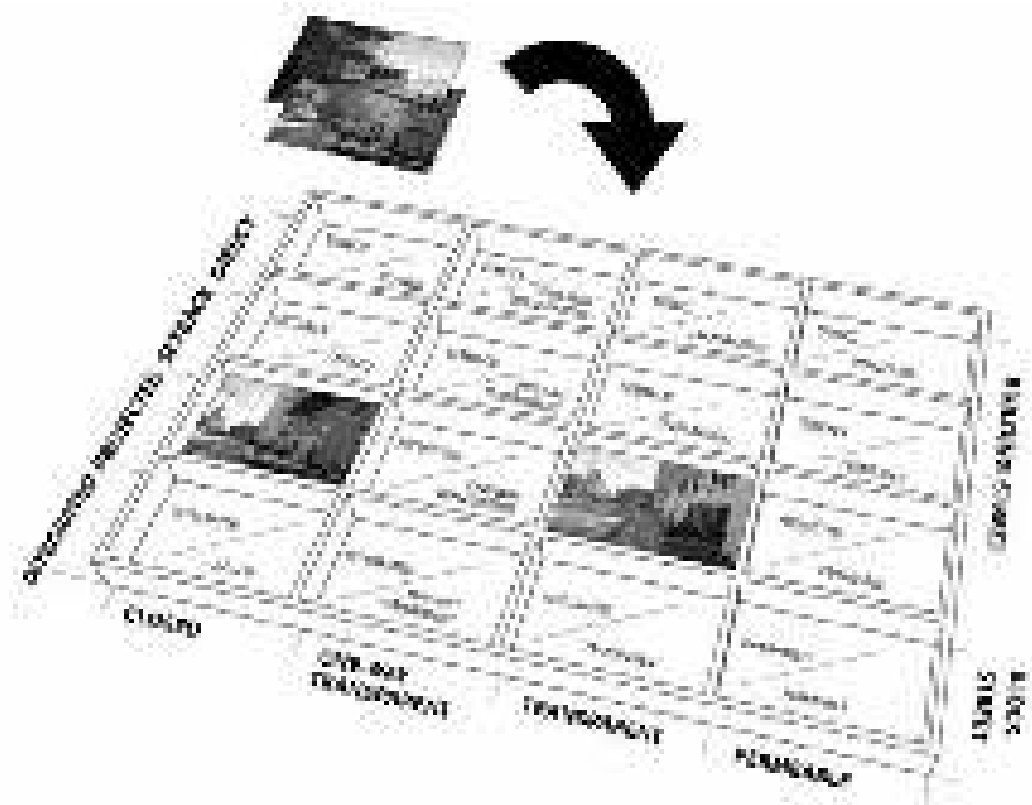


Figure 3. Sorting matrix of the two main dimensions into 16 categories.

We define this concept of interrelating types as *façade-threshold*. We have developed this term to be able to precisely address the two main dimensions of interface relationships that our research reveal. In addition it links form with structure, objects with relations. The term include and develop the dimensions of the established conzenian terminology of the *frontage* and advance the more general term of *public-private interfaces* into a morphologically clear and comprehensive proposition. The concept *façade-threshold* provides a substantial alternative to the more vague terminology of *active frontages/active facades* that currently dominate, particularly within the Norwegian context.

7. Summarized discussion

The final step in the content analysis included a reduction of sorted and categorized visual images into *typological diagrams*. We drew the main characteristics of the photographs into different types as perspective sections and placed these into the matrix of categories. This typological process reduced the different photographs into different patterns highlighted as sub-categories. Finally we refined and synthesized the characteristics into main types of relations, into a range of types of *façade-thresholds*. The process of categorization and type creation enabled us to understand the complexity of the streetscape as an unlimited combination of variations within sixteen different main types of the building- street relation. The *façade -threshold* as concept enable us to focus directly on design solutions for that particular urban element, and thus break down the often strong boundary between the building design and the urban design

We established the *typology of façade-thresholds* as presented in the matrix of interdependent

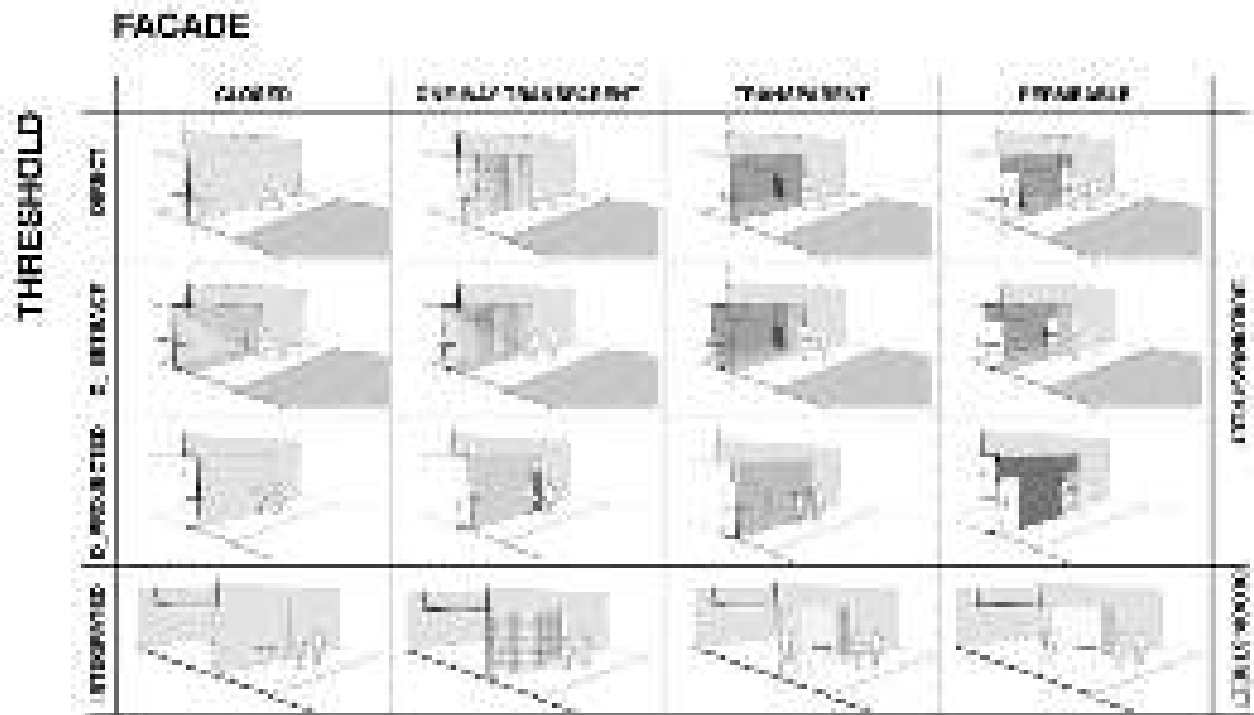


Figure 4. Typology – matrix of the facade-threshold with 16 unique types.

relations, and presented it in a catalogue of interface types that provides a defined morphological knowledge. The matrix of typologies give us the opportunity to use it as a part of *mapping/analysis*, as a part of *presentation* or as part of *thinking* (conceptual), it gives us a way to see, present and understand the world. The categories of typological variations of public-private – displays not only the range of possible solutions, but also the hidden complexity in the urban development. The public-private interface is not alike allover, but address different questions ie about property rights and overlapping spatial use and ownership and in accordance to this; several unlike economical commitments and opportunities.

The aim of this paper is to problematize the urban experience of walking in a city and to contribute to the development of better design solutions through an understanding of how urban micro-morphology influence this. Our experience of how walkable a city is relates to the building-street relation. In new project developments, infill or larger building structures, there are often demands of achieving qualities described through the vague terminology of *active facades*. This term aims to give form an agency, without being able to clearly define the characteristics that comprise it. The value-loaded term presents expectations of a future lively streetscape where buildings are developed through an intention of “*eyes on streets*”, known from Jane Jacobs’ seminal work. By introducing the facade-threshold as an urban element with its own characteristics, agency and value, we argue that this presents the first step in developing a more precise and focused discussion on how to secure this character and quality in both the building design process and the urban design and planning process. The term also presents an opportunity of making complex relations manifest in types and a typology, which again can help developing legislation and regulation affecting planning and implementation, and the

link between these. In addition it can help understanding the rights connected to both objects (land/buildings/facades) and relations (access, territory, threshold).

8. Conclusion

We suggest that the the typology and terminology developed through this research can operationalize solutions that presents good conditions for urban experience. The *façade- threshold* belongs neither to the building nor to the street, but to the city and with the word of Cerda; an element that might be understood as the quintessence of the urban.

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The Impact of Neoliberal Economy on the Urban Morphology of Rafidia Neighborhood in Nablus City-Palestine

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Keywords: Rafidia, urban transformation, morphological analysis, neo-liberal economy.

Abstract: Rafidia, the today's modern neighborhood in the city of Nablus- Palestine was a small village before 1963 when it was annexed to the city of Nablus. The neighborhood's urban morphology has transformed since that time, however the major transformation in the urban morphology of the neighborhood was after the year 2009 when the Palestinian government adapted the neoliberal economy that changed the urban landscape in the whole Palestinian cities, however this paper is going to study this impact on the neighborhood of Rafidia. The aim of this paper is to prove (analyze and criticize) the role of economy and in particular the neo-liberal economy in producing and transforming the various urban forms/morphology in the neighborhood that through the impact of the socio economic conditions managed to realize the current form of the neighborhood.

In order to read and analyze the neighborhood of Rafidia an analysis of the morphological aspects will be done so as to understand. The implemented methodology includes direct observations via site visits, fieldwork, documentation of all existing streets and buildings, and surveys of the existing literature related to the subject. An analytical approach based on the Conzenian School has been applied to analyse the urban form, spatial layout and configuration of the Neighborhood.

1. Introduction

Nablus city urban fabric is consisted of a mix of different historical and architectural layers, including the roman, Byzantine, and Islamic periods. The old center was founded during the Roman period and continued to be inhabited till now. The city went through several colonial and occupation powers since the defeat of the Ottoman empire and the start of the British mandate in 1917, followed by the Jordanian control of the part of Palestine including Nablus till 1967 when the Israeli occupation controlled the whole of Palestine including Nablus. The Israeli occupation lasted to 1994 when the Palestinian Authority was founded (Al-Nimr, 1938).

Administratively, the Palestinian lands have been subjected to a mixture of different laws and rules of different regimes such as the Turkish, the British, the Jordanian and the Israeli. During the British mandate the British city planning law including about 17 laws had been applied mainly in Jerusalem and Nablus. During the Jordanian period, however, some laws were

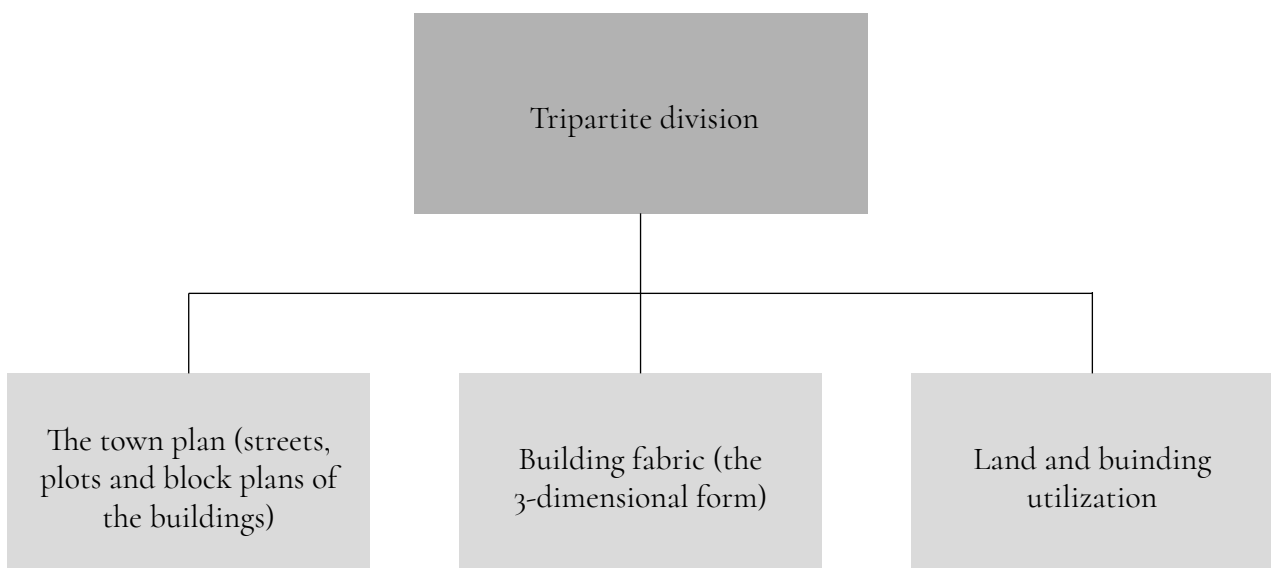
released such as the city planning law of 1933 and other laws pertaining to building planning in villages and cities. Other laws were introduced like the planning law of 1966, which is still used in West Bank with some modifications.

In 1963 during the Jordanian period, the master plan of Nablus was expanded to the east and west to include many rural areas including Rafidia village. The aim of this research paper is to investigate the urban transformations of Rafidia and its relation to the economic forces affecting the new city neighbourhood.

2. Research Methodology

The methodology for this study passed in three phases, the first phase includes a study of the urban development of Rafidia neighborhood, the second phase concentrates on morphological analysis of the neighborhood based on Conzenian morphogenetic school which put forward a tripartite division of urban morphology: the town plan (streets, plots and block plans of the buildings), building fabric and land and buildings utilization (Conzen, 1960), this phase includes analysis of the main components of the urban form (plot-street-building). The third phase discusses Rafidia morphology dialectics with context concentrating on the economic changes.

Conzen's morphological approach considers land uses, building structures and plot and street patterns to be the most important aspects and emphasises the differences in the persistence of these elements. Buildings, particularly the land uses they accommodate, are usually the least resilient elements. Whereas the street plan tends to be the most enduring element, the plot pattern changes over time, as individual plots are subdivided or amalgamated (Conzen, 1960; Carmona, 2001). In his theory Conzen developed a logical system of explanation, which can lead to an incisive and nuanced understanding of the relationship between urban communities and the physical fabric they create and recreate around them as social needs change over time (Conzen, 2009).



Graphic 1. Source: Conzen, 1960, p. 4.

Finally this paper aims to investigate the relation between the urban form and the economy, according to Oliveira (2016) most of research on the relationship between urban form and economy adopts macro scale of analysis. He refers to UN-Habitat recent report as a good example of study that offers a literature review on the economics of urban form (UN-Habitat, 2015). The report addresses two major characteristics of urban form at the macro scale, density and centrality. However, this paper will concentrate on reading the transformations of urban form at the micro level in the context of the economic changes.

3. Analysis and Findings

3.1. *Rafidia Urban Development and Urban Transformations*

Period between (1963- 1993)

With Rafidia joining Nablus municipality boundaries, more attention has been given to the roads and infrastructure. The master plan of Nablus expanded in 1963 to the east and west to include many rural areas with area of 18400 dunum, such as Rafidia (figure 1). However, only some blocks (around 6) of Rafidia were joined, while the rest of 11 blocks that formed Rafidia were all included in municipality borders by 1966 (Dawoud, 2003). Later on, the development of streets network and infrastructure to the west contributed to the growth of building movement towards Rafidia (Khalil, 2005) and connected the area more to the urban fabric of Nablus. This growth caused the up rise of more varied uses like commercial buildings especially on the sides of main street, or mixed use buildings.

Moreover, this period was the beginning of vertical expansion and the rise of high buildings in the area without supervision and regulation, and the heights were unevenly combined with each other. But this did not have a significant impact on the urban composition by then, due to the relatively low density of the building compared to the current situation, where the population of Rafidia recorded by 1961 was 922 and the change was slight until 1982 with 1200 person (Abu Hajar, 2003).

In light of the political changes of this period and the absence of structural plans and appropriate planning laws, most of the expansion was random and unthought-of, contributing to the creation of a structured environment of an unorganized nature. There was no regulation of uses so that residential and commercial uses were mixed.

However, 80s witnessed the emergence of different type of buildings, where multistoried buildings have spread over the agricultural land. 15% of high buildings in Rafidia nowadays date back to the period between 60s and 80s. After that, between 80s and 90s was the beginning of urban boom in the area, where more houses, villas, and high buildings appeared, and 60% of high buildings were constructed (Dawoud, 2003).

Period between (1994- 2009)

By following the most important events of this period, the entry of the Palestinian Authority by signing Oslo accords is considered the most influential on the development of Palestinian cities as mentioned before. The impact was evident on the urban composition of Nablus city, where economic development has been accompanied by many urban and social changes. In addition to the political circumstances and division of land into A, B, and C that resulted of

limited access to land and land scarcity. The latter issue impeded a natural horizontal expansion of the city, which forced the vertical direction and helped the emergence of high buildings.

Moreover, topography was a natural barricade in the face of the expansion that was moving towards the mountains and high slopes on both sides of the Nablus plain, making it difficult to pave the ground for construction and excavation of the mountains to create areas suitable for construction. This limitation of topography made it more economically beneficial to go towards multistoried building type, where larger number of units produced on the small area of land that needs less excavation. During the second part of the 90s, building spread in most of Rafidia, particularly in the west, south and center, and along the main street.

Most of the development was in the residential sector due to the classification of land for residential use. As pressure on land increased due to large urbanization and high prices, vertical expansion increased and high buildings were overshadowed.

In 2006, the new campus of An Najah national university was opened close to Rafidia (on bait Wazan blocks) (figure 1), which had a significant role to attract people like employees and their families, students, and developers/investors to the area. This means higher demand on residential and commercial buildings, where developers started to pay more attention for investing there and establishing high buildings to keep up with population increase. The demand increased vastly on apartments in Rafidia; accordingly prices increased 106% in 2006 from 1980 (Omran, 2008). By 2015, buildings covered most parts of Rafidia and built up area density increased.

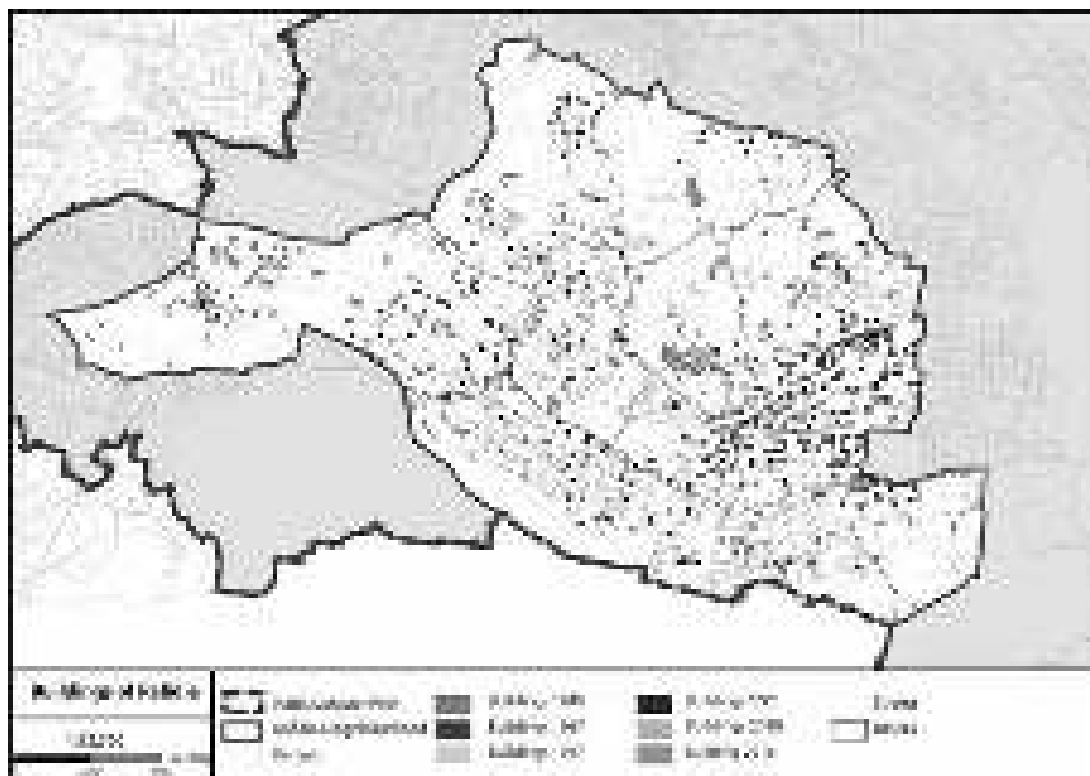


Figure 1. Rafidia buildings 1942-1967-1997-2010-2015. Source: authors based on master students filed work.

Period between (2009-2018)

In 2009, the Palestinian government adapted the Neoliberal economy; the increase of investments in the construction sector has been significant. Construction works spread everywhere in Nablus city and in particular in Rafidia Neighborhood, in an unprecedented manner and fueled a process of land speculation that affected the prices of Real Estate significantly. In the last decades of the twentieth century, real estate development in the occupied Palestinian cities was confined to individual investments when means were available to expand outside family houses on privately owned and inherited properties. Wealthy persons used to invest in buying plots of lands in central areas then construct small commercial buildings; prices of land were growing steadily but slowly. Rental housing market was quite limited due to the slow pace of urbanization and the limited influx of internal/external migration to the main Palestinian cities (Zawawi/Abu Hammad, 2019).

Small and big real estate agents started to appear in the neighborhood and worked as major transformers of urban landscape. The neighborhood lost many of its landscape features and underwent a process of socio-economic change. In this context, a speculative environment was a driving force behind a large increase in land prices. The empty plots of land became the best commodity in the city (Costa, 2009, 181), as reflected later on in the construction units' prices.

On the other hand, urban planning authorities in the Palestinian cities have had a long hand in facilitating this construction boom by easing issuing building permits without having a proper quality control or respect to the geomorphology of each city. In addition, buildings' codes and bylaws deal in the same level with all urban and rural contexts, such bylaws are derived from previous planning codes inherited from the successive different administrations (Ottoman, British, Jordanian, Israeli) knowing that these codes were mostly issued in a top down approach where the benefit of the authorities was put on top Zawawi/Abu Hammad, 2019). In addition, the successive various administrations have affected the current building and planning Palestinian system (Abdelhamid, 2006, 14) leading to create chaotic urban sprawl land areas that are accessed by specific rich groups of the society. In consequence, regulations allowed 7 floors buildings in this area after some changes in land use in 2013. This reflects the argument of Maclaran/Kelly concerning forging "a strategic alliance between urban planning authorities, the economic growth lobby and property development, reinventing both the image and reality of the city, helping to create an urban landscape which was iconographic of economic success, growth and change". (Maclaran/Kelly, 2014, 12).

The Palestinian Authority had also important contributions in shaping the physical appearance of the city of Nablus and Rafidia in particular, by changing property laws and zoning regulations to allow individual ownership of units in apartment buildings and construction of multi-story buildings (Zawawi/Abu Hammad, 2019). The skyline of Rafidia has changed dramatically in the decade following Neoliberal economy adaptation which transformed the urban morphology of the neighborhood in terms of its dimensions and plan unit. This will be discussed in the next section by discussing the transformation of urban morphology as a result of economy.

3.2. Morphogenetic analysis

The analysis of current town plan of Rafidia which is transformed as a result of neoliberal economic approach after 2009 requires to study Streets, plots and buildings as the main features of plan unit that Conzen have developed, where it deal with each element of plan unit and its relation to the same category, such as streets and their arrangement within street system, as well as other elements (Conzen, 1960).

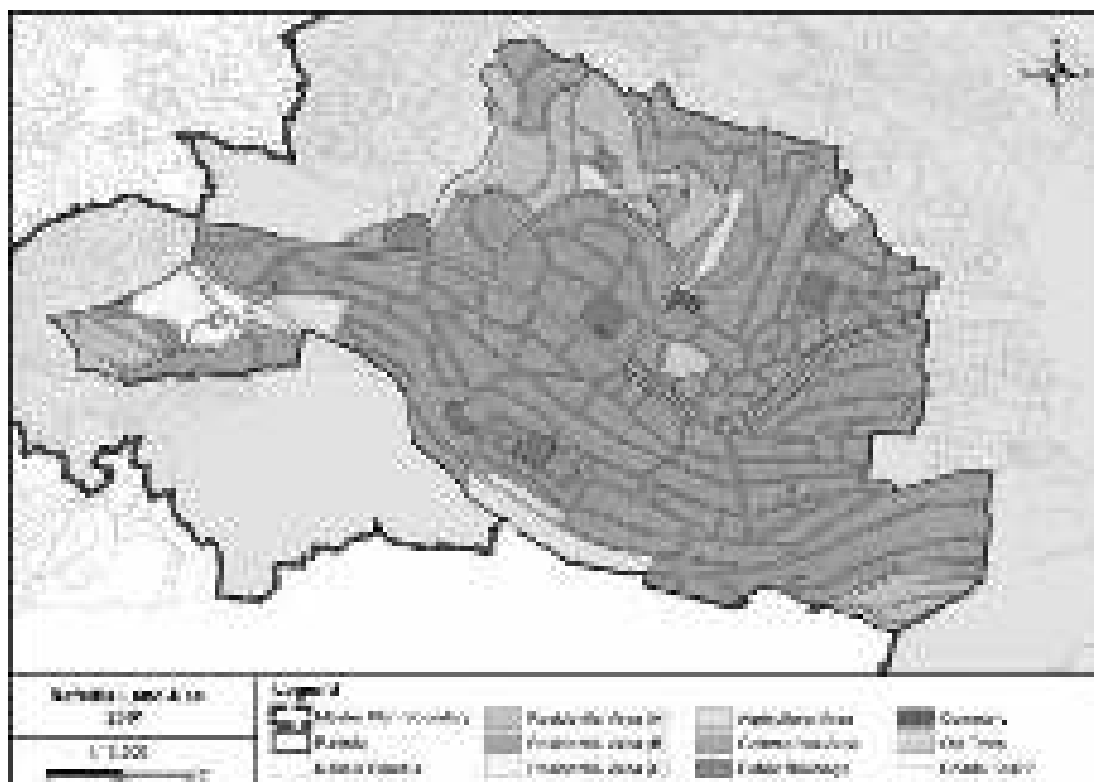


Figure 2. *Rafidia land use plan 2001. Source: authors based on master students filed work.*

Land use

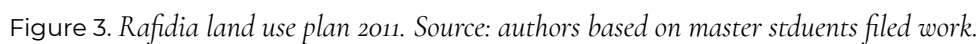
The change was noticed in the master plan of 2001 to 2011 (figure 2, 3), as some of the land transformed from residential B into local commercial that allows 7 floors and roof instead of 4, also residential A area declined (Qasrawi, 2017¹). Nowadays, Rafidia consists of 11 blocks on area of 3,021,978 m². The uses of land vary in Rafidia as the residential use dominates the uses with 48.72% of the total area based in 2015, and it's known for health and entertaining services, and the spread of commercial zones with 5.71% on the sides of Main Street particularly.

The Industrial use in Rafidia is very low and doesn't exceed 1.43%, which make Rafidia desirable for living purposes. While the agriculture use represents 28.20% of land, which is considered to be high despite the general shortage of agriculture use in the city with only 1.86% of the city total area. That refers to the origin of Rafidia as a village where people mainly worked in farming, availability of water from springs, and land fertility. In addition to the high use of land for tourism purposes that increased the area of open spaces up to 27.41% (Nablus master plan, 2013).

Street pattern

As streets are the most stable and durable element, they are the least affected by urban transformations compared to other elements such as buildings or plots (Boeing, 2017), which in turn gives them more control over other elements. This is clear in the network of Rafidia Streets that evolved over the years, where the development was based on the main streets that cross the area all the way from east to west (figure 4). Road network have spread along with the expansion of

1. Interview with municipality engineer, Azzam Qasrawi, on 9 Sep 2017.



Street system varies in the area and includes three different types based on change in plan unit. First, the old center of Rafidia, which has traditional plan unit characterized by narrow alleys, irregular shapes of streets and open spaces. This street system is known for small roads branches from the main road to provide access between buildings and blocks, and mostly it doesn't connect to other roads and has dead end (figure 4). Second, the areas along the main street and surround the old center represent transitional plan unit with more regular shapes of streets and organic road network that follows the mountain topography the most, the width of such streets increased comparing to traditional type and followed more gradual arrangement. Third, modern plan unit developed to the south and west of Rafidia, the streets in this area have a continuous and linked network of streets, with more unified widths and organized shapes. However, its continuity interrupts the buildings accumulation and creates smaller blocks separated by wide distances.

Plot pattern

The plot size and shape started to be more unified and organized in the transitional plan units, but still it was a complex of plot pattern, as the difference is obvious between old parcels within the old center blocks of Rafidia and the new parcels that were included in the newly de-

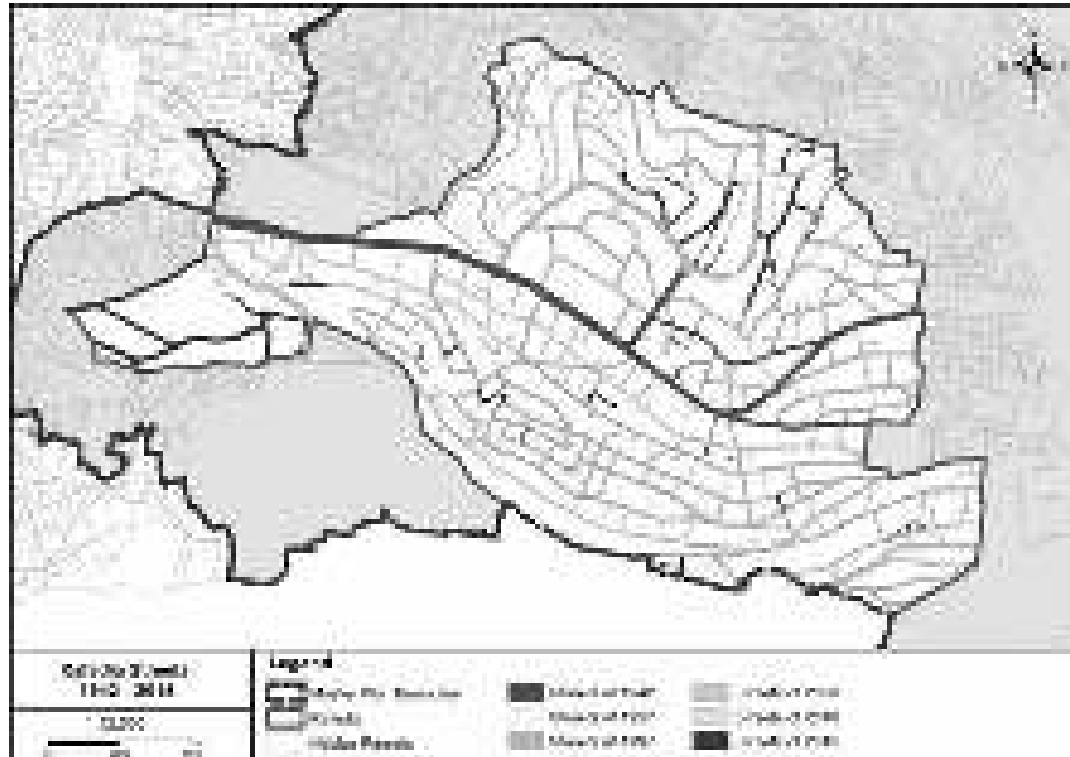


Figure 4. *Rafidia streets 1942-2015. Source: authors based on master students filed work.*

veloped blocks to the east and west. Hence that during the process of urban laws and building regulations development, some old parcels was incorporated in order to create regular forms and sizes and increase the viability of land.

Blocks plan (buildings)

The form of building in Rafidia is mostly irregular and follows different patterns of plan and architecture type, which can be referred to different factors such as change of typology (figure 6). Although it's noticed in the recent development of residential projects that building plans assume more regular shapes as well as it plots, but it's no longer an expression of a certain type. This reflects the modern orientation of individuality in building form and absence of typology.

The type of buildings in traditional plan unit in Old area of Rafidia formed in the traditional Housh system or a complex of many houses sharing some walls, where buildings are aligned close to each other randomly separated by small alleys but as a whole they form a high dense unit of neighborhood. This continuity in the urban fabric slowly disappeared in transitional plan unit and buildings were scattered and not assembled or gathered. However, the form of buildings itself changed into less complex but more plain shapes away from the traditional forms and reached higher floors.

The recent development of building type is obvious in the modern plan unit as every series of high buildings aligned in a block, its boundaries distinct by wide streets. Each building stands separately in the center of plot and mostly each block contain double series of plots. It is clear that the creation of a network of wide, open, and mostly unfinished streets has helped to dismantle the continuity of the plot series or blocks, thus creating individual and isolated buildings on these plots.

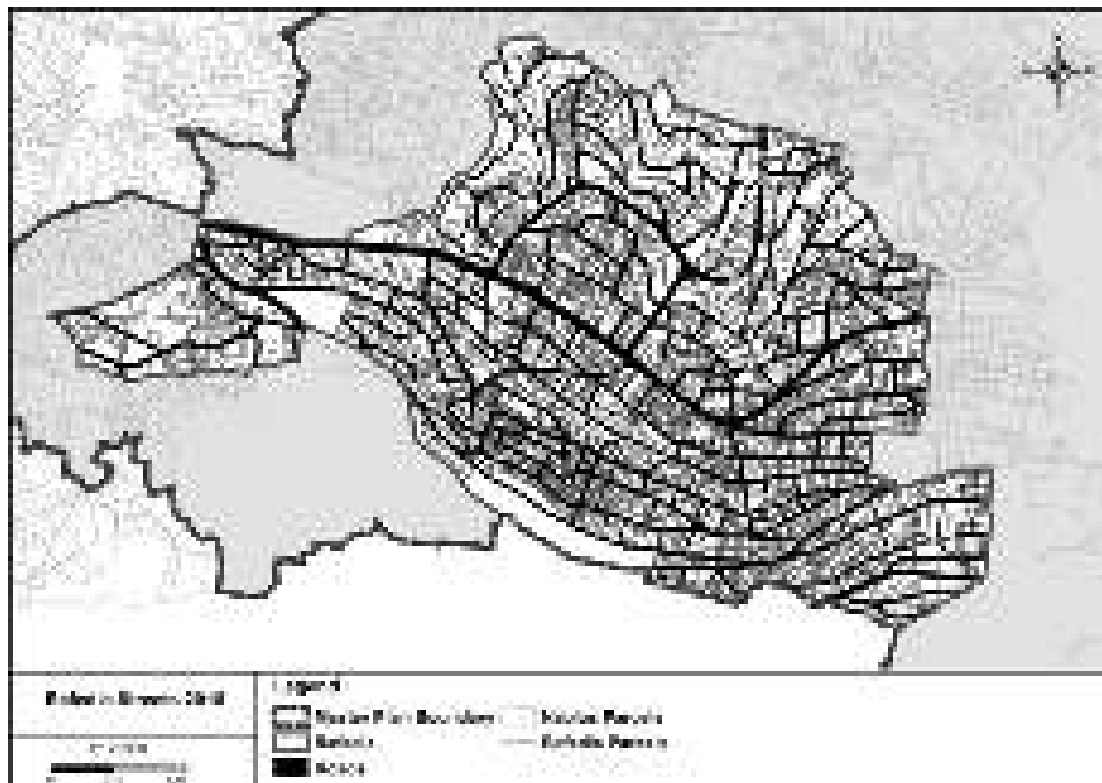


Figure 5. *Rafidia parcels 2015. Source: authors based on master students filed work.*

Despite the regular forms of plots and more organized block plans, where double lined plots are the most common form, the formation of buildings in the neighborhood or area no longer seeks to achieve harmony and balance between buildings, illustrates the different building types in the area that mostly are irregular and vary in shape. This singularity and irregularity can be observed in Rafidia through the new plan unit, which shows the relationship of the buildings to each other and with the surrounding space and the radical changes in the physical structure. The block plans are no longer responding to the plot shape and the relationship between them has weakened, where the continuity of plan in the traditional buildings transformed into point blocks.

These struggles of organizing the site features as streets, plots and buildings ,or plan unit as for Conzen, and to relate it in an proper relationship are an evident of the absence of typology and its role in developing appropriate understanding of site elements (Gutman, 1966). The analysis of the neighborhood highlights the transition from the traditional urban fabric, which characterized by continuity, compactness and the integration of buildings with the space surrounding, to the modern fabric of scattered buildings without connection of other elements. Buildings in most of Rafidia stand as large blocks separated from each other by open spaces without any link between them, and suggesting the lack of continuity in the projected area. Moreover, mutual influence between streets, plots, or buildings provides important indicators in shaping form of plan unit and contributes to the identification of certain characteristics such as openness and enclosure (Oliveira, 2016). The sense of enclosure dominates the traditional type of fabric as buildings accumulation produce open spaces and defines its borders in coparison to the modern fabric that lacks enclosures and open spaces.

So, after defining the characteristics of Townscape of Rafidia and analyze its physical ele-

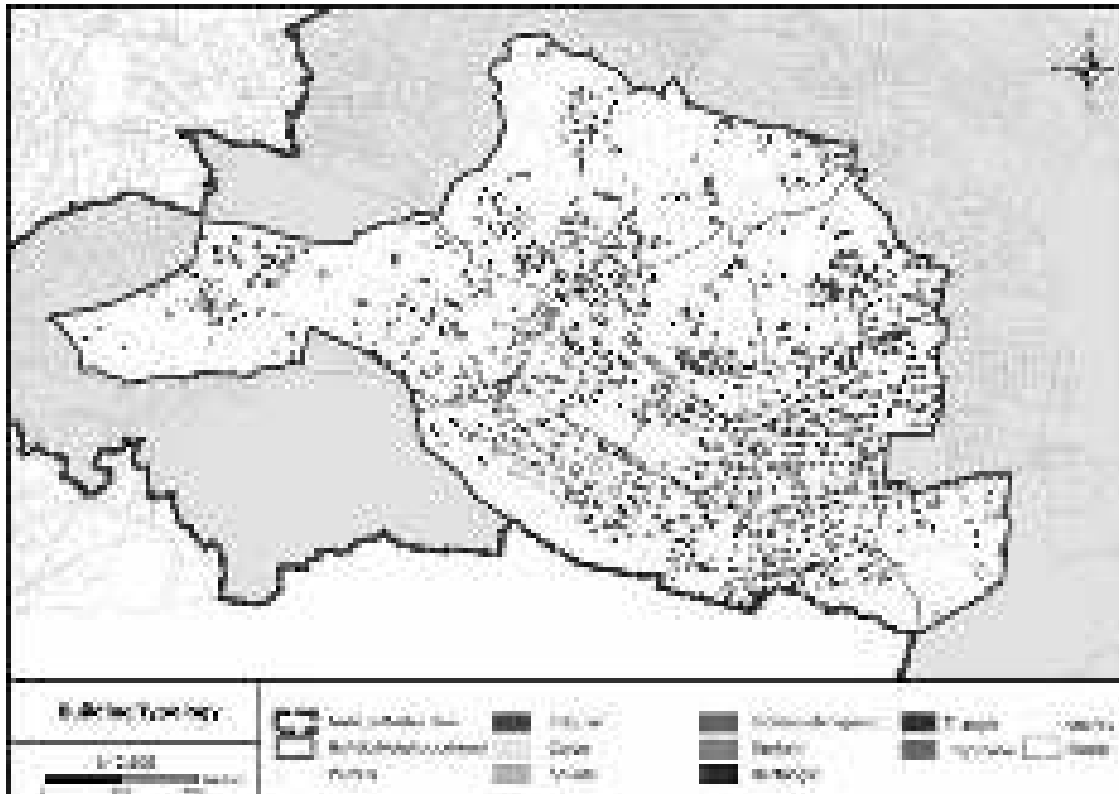


Figure 6. *Rafidia building typology. Source: authors based on master students filed work.*

ments and evaluate its performance, the next step is to reflect how these physical attributes are impacted by economy and transform the urban landscape of the neighborhood.

3.3. *Determinants of physical environment in Rafidia in relation to economy*

Density

Some researchers who advocate high density in cities defended their claim that increased density could support better and cheaper public transport, and more control over people. At the same time, high density also lead to more pedestrian injuries and the effects of urban thermal islands and waste; loss of privacy and direct sunlight. And reduce the level of physical and mental health. In case of Rafidia, the built up area density is still moderate and not considered high or highly compacted, with about 40% of its total area.

However, measuring density is not affected only by the ground floor occupancy, where vertical expansion is necessary to consider as Rafidia is characterized by high buildings. This means higher density of population in the same area of building. This has affected the area of public spaces where more people should share it, also public space portion per person is declining as Rafidia growing and building movement increasing.

Moreover, the increase in density was not combined with a mix of uses throughout Rafidia. Residential buildings are mostly existed there except for some areas such as the main street, where there are commercial and mixed use buildings. This situation creates less vibrant and active socially areas according to Jacobs (1961).

Spatial layout and physical distance

Generally, the current urban fabric of Rafidia reflects the changes that have taken place in the city, where high rise residential and commercial buildings dominated the built up area. And the response of these buildings to urban changes is revealed in the way they are organized and aligned. Buildings are being isolated in the process of modern urban development, and ignore their relation to the urban fabric that includes open spaces, streets and other elements (Trancik, 1986).

The emergence of high buildings in the urban fabric and its inclusion in residential neighborhoods was accompanied with problems resulting from the incompatibility and harmony of elements of urban configuration with each other and lack of efficiency in the design of these elements, such as undefined and lost open spaces, high buildings fragmented and isolated, or even the absence of urban character and typology.

The hard topography of the area contributed to the small plot size, which affected the footprint of buildings as they stand as high but small sizes blocks with small setbacks in between, which could provide legibility and vitality to the area, but this pattern impedes the creation of well-designed open spaces. This issue was advocated by Leslie Martin (1972), where he examined different patterns such as small and large blocks of buildings and their relation to open spaces and proved mathematically that large blocks are more capable to produce balanced built environment. The large footprint of building would allow the continuity of open space which is essential to enrich the flow of people and encourage their interaction as they explained themselves. The importance of open spaces and their design is never less than the buildings, where good urban design consider these spaces as a group connected to each other, not as random spaces resulting from buildings.

The old cities relied in their composition on the open spaces to create urban character for buildings and define the boundaries of the place. But modern urban fabric, as shown in the case of Rafidia, produce urban spaces that are not limited or specific and do not have a vibrant relationship with the buildings or contribute to the enhancement of their composition. These resulted in lost spaces rather than open spaces, as the former defined by Trancik (1986) "the leftover unstructured landscape at the base of high-rise towers or the unseen sunken plaza away from the flow of pedestrian activity in the city".

The lack of proper open spaces in Rafidia resulted from the disintegrated and fragmented urban fabric, where buildings located randomly without considering each other and other several factors, including building footprint and the difficult terrain of topography. Also these buildings lack of appropriate accumulation or grouping, "*Tall buildings can be equally appropriate grouped in clusters or located alone*" (Ibrahim, 2007). It is spreading as free standing masses without any connection or orientation. The placing of these buildings lack of gathering sense such as circulating around some space and define it as a common area for a group of buildings or clustering in a composition that would achieve enclosure and connectivity.

The weak enclosure and definition of open spaces in Rafidia results from certain arrangement of buildings as Booth (1983) illustrated the cases, such as the alignment of buildings in a long row or single building standing. On the opposite, higher enclosure could be accomplished through arranging buildings around some space or change the angle that buildings face each other. Also irregularity is a key factor of creating sense of mystery in the space, which encourages people to experience it more.

Height

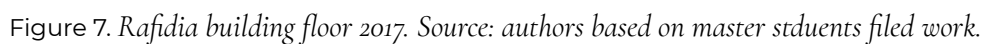
The increase of high residential buildings number in Rafidia was vast over the last decades, where most buildings have 7 floors or more (figure 7). This caused many problems; first, variety of height produced a lack of harmony in the urban image of the city and the skyline. buildings adjacent next to each other with different heights, where some high buildings of more than 7 floors stand right next to one or two floors buildings causing a gap in the landscape and imbalance in height. Also, distinguish of public and private buildings and uses has disappeared with the unlimited height of buildings, that it became hard to recognize the character of monumental buildings (Krier, 2009). This is due to several factors, including the mix of land use and the random changing of it, as well as the topography and its impact on the level of streets and buildings on either side, so that the building may rise to several floors, but all goes under the level of the street. Moreover, the effectiveness of the parcel is affected by additional factor, which is the plot ratio. In the old areas, the ratio is usually only 2:1, where the buildings were one or two floors surrounded by a public area or a garden or vice versa, such as the houses of the courtyard. This density is suitable for humans, unlike the change of the current ratio of more than 7:1, where high buildings that rise for more than 7 floors. This means less shared public space per person and more compacted buildings with large masses because of height.

In response, in 2007 the municipality created a system to limit the heights to a certain extent using the law of floor ratio (Qasrawi, 2017). As mentioned previously, most of Rafidia land is residential B, commercial, and some transformed into local commercial. The regulation allows raising for 4 to 7 floors in residential B, depends on street width. In case of 15m street, 7 floors is the maximum height and floor ratio should not exceed 320%, and with streets less than 8m, 4 floors allowed but floor ratio not to exceed 190%. And if the number of basements exceeds 3 floors, the vertical building line is moved to be with a depth of 12 m until reaching four floors above the level of the upper street (Nablus municipality, 2006).

Local commercial use allows a floor ratio of 300% at the maximum and height of 7 floors with a front setback of 4 m. And the commercial use in Rafidia Street allows 350% with a 3 m front setback. In the case of streets with a width of 20 meters and the area of the parcel is less than 2000 meters, it allows to rise to twenty floors and a floor ratio of 500%. These regulations have contributed to the reduction of building heights and thus reduce the size of the resulting problems to some extent, and forced investors and urban developers to reduce the number of floors to not exceed the floor ratio. But most of the high buildings in Rafidia existed before passing these laws, which makes it hard to change it².

However, this development and acceleration of urban growth in Rafidia had consequences on the old buildings. In recent years, there has been a marked decline in the number of old buildings that were spread on both sides of the main street or in the surrounding areas. Rising land prices, coupled with increased demand for housing, have attracted investment and urban developers, stimulating many older residents to sell their homes to the private sector to replace it with high buildings.

2. Appendix 1: Nablus municipality setbacks and floor ratio regulations.



In general, Rafidia has been in stages of growth and development but has produced a low quality physical environment, which is characterized by high density of people and buildings, lack of building typology, ignorance of buildings organization and their relationship to each other, creating scattered open spaces and lost spaces, and spread of high buildings that lack proper social spaces. In crises area the urban form is not dictated by the planning framework only. Political, economical and demographic forces are main players in the construction of urban form, they mainly lead the urban transformations.

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Houseboat Communities as Floating Neighbourhoods for Degrowth

How Living Afloat is Reshaping the Urban Morphology of European Metropolises

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Keywords: houseboat, community, housing, degrowth.

Abstract: Houseboating is an interesting model of housing for degrowth, that provides accommodation to thousands of people in Europe.

London, Paris and Berlin, are examples of the different development of this bottom-up phenomenon. All these cities are adapting themselves to the rising number of houseboats but they are struggling with the absence of dedicated infrastructures, the lack of attention to the needs of the boaters and the connections between the existing neighbourhoods and the new floating ones.

These ‘liveaboards’ belong to different generations and lifestyles, but they mainly live in communities, tied together by a genuine sense of sharing and need of each other’s experience. They have organised themselves into “associations” to make their life on water easier and to face local authorities in order to claim their rights, being stronger together.

This research enlightens the strength of these communities and how they are taking an active role in urban development. The aim of this work is to illustrate how this dwelling contributes to rediscover values such as the sense of belonging to a neighbourhood and the responsibility for waterways, bringing back waterfronts to its city.

1. Introduction

Houseboats are boats designed or adapted for the purpose of dwelling. Many of them remain static and are moored to a fixed location and often linked to land to provide utilities in order to be used as permanent homes. These kinds are more correctly called “floating houses”. Others, instead, are autonomous units, capable of navigating and producing their own energy. Houseboating is a very popular recreational activity around the world involving people of all ages, culture and social backgrounds.

Modern houseboating had its main kick-start after World War II, when working-class families, who could not find affordable accommodation on land, decided to settle on board disused working boats. This original dwelling grew in popularity during the ‘60s and ‘70s with the city’s counterculture and hippie movements. It is in those times that many houseboats started to be equipped with proper sanitation and luxury fixtures, becoming like regular houses, but afloat. However, it was only at the end of the past century that a significant number of Europeans started taking up residence on water. This phenomenon has continued to grow in recent years

and journalists started to talk about a “mini-boom”, mainly caused by the increasing housing costs and the technological advances that make life on board easier and more comfortable than ever before.

After extravagant artists, bohemian architects, retired couples and students trying to save money, many more people started to buy and restore boats instead of renting more expensive tiny studios in suburban areas. In fact, this trend looks very appealing for many Gen Xers and Millennials as a reaction to the real estate crisis in the most expensive European cities like London, Paris or Berlin. In fact, living afloat – even if still considered *naïf* – seems a reasonable way of investing in “floating estates” and, for many, the only possibility to own their house, reaching a sense of achievement and freedom from long-term loans and mortgages.

Nowadays, this phenomenon has become so popular that finding a berth in those “houseboat friendly” cities is getting more difficult, transforming the life afloat almost into a luxury. Canals and rivers are congested and the waiting list for a place in a marina seems endless. The waterfront of those cities is facing a constant change since the riverbanks become the connection between the existing urban areas and the new floating ones. Meanwhile, prefabricated houseboats spread in the market and gain big popularity on Airbnb, giving birth to new scenarios that now involve new actors not necessarily related to the world of boating, if not for a weekend.

More recent movements such as the “tiny houses”¹ and “degrowth”², surely played an important role in the diffusion of this bottom-up phenomenon, sharing their core values with the ones of many houseboaters.

2. Methodology

The aim of this paper is to present different approaches to deal with this bottom-up phenomenon that is shaping the waterfront of many cities, presenting houseboat communities in London, Paris and Berlin as case studies.

Academic literature about history and management of inland waterways is not enough to understand this complex phenomenon nowadays. Indeed, not only houseboating is relatively recent but also it is still growing and evolving. This is why the research methods are a combination of documentary sources – such as press articles, forums on dedicated websites, annual reports of the main agencies about inland navigation, statements collected after conferences, meetings and surveys made by the associations of houseboaters – as well as field observations and interviews. The results of this data collection are the main actors’ portraits and the definition of the current scenario, trying to give shape to a possible near future.

1. In 1997 the architect and designer Sarah Susanka, wrote the book “The Not So Big House”, that is considered a sort of manifesto of the ‘small houses movement’. The movement is based on the value of quality materials and reduced volumes with an essential design. In a few years this philosophy attracted more and more people. Jay Schafer is the co-founder of Tumbleweed Tiny House Company, the first company dedicated to Tiny Houses from the design to their construction. He claims that the key to living in a tiny home is smart design and attention to detail. Aesthetics aside, Schafer also believes that people can discover a sense of freedom in living with less, though at the base of the “less is more” lifestyle.

2. ‘Degrowth’, a type of ‘post-growth’, that is becoming a strong political, practical and cultural movement for down-scaling and transforming societies beyond capitalist growth and non-capitalist productivism to achieve global sustainability and satisfy everyone’s basic needs.

3. Analysis/Results

London, Paris and Berlin: are case studies about how this practice is taking place challenging the actual urban schemes and local authorities, showing how communities of houseboaters are working together to defend their rights and achieve a better life quality.

3.1. *London*

The UK has old traditions about inland waterways; in fact, during the Industrial Revolution many canals were built to allow commercial carrying narrowboats to navigate around the country. These systems of waterways counted rivers and artificial canals since the eighteenth century and it is with the arrival of the railways that many of the artificial navigations closed. However, even if this was a common destiny for many other countries, the UK has been one of the first to reinvest in the inland waterways for recreational use. Most of the navigable canal system survived thanks to the work of several charities³ that in the last fifty years have rediscovered inland navigation, mainly devoted to tourism and leisure activities.

The city of London has more than 100 miles of waterways, not counting the Thames River (other 42 miles). Communities of houseboaters in London have always existed but nowadays there is an unprecedented growth of canal goers. In fact, British canals are living a second golden age and they are more popular than ever.

London has the highest average property prices in the UK and with soaring rents, life on the water seems like a good compromise to many Londoners – if not the only possible alternative – to keep living in the city. According to the Canal & River Trust (CRT), which manages the canals of England and Wales, the boat numbers in London has increased by 57% between 2012 and 2018. “The Trust offers two types of licenses for boaters: permanent moorings [...], and ‘continuous cruiser’ licenses, which are around £1,000 a year, but require the boater to find a new location every 14 days – the latter have increased in number by 153% to 1,615 boats since 2012” (Monks, 2018).

Another article published in December 2017 was reporting that, according to the CRT data, “the number of boats in London rose from 2,326 in 2012 to 4,001 in 2017 – representing a 72% increase [...]. Of those, the number of boaters without home mooring more than doubled from 638 in 2012 to 1,880 in 2017” (Agbonlahor, 2017). To solve the problem, the CRT is working on new mooring rules and it is proposing higher fees. In fact, in 2018 the Trust has proposed to restrict some of London’s mooring spaces and start charging for others. Boaters are fighting against the authority managing Britain’s waterways since mooring fee increased of up to 89% between 2017 and 2018 and they feel being “priced off” their properties. Most of the people accuse the Trust to prefer leisure cruisers rather than permanent houseboaters, making impossible for them to stand the new fees, as a result of gentrification (Manzoni, 2018).

In June 2018, after months of consultations with boaters and other stakeholders, the CRT released a mooring strategy for London to deal with the increasing number of boats on canals

3. In UK there are several charities operating in different ways to preserve canals for pleasure boating, recreation, and industrial archaeology. First of all there was the British Waterways (BW), a statutory corporation owned by the government. It served as the navigation authority for the majority of canals and a number of rivers and docks. In 2012 all of British Waterways’ assets and responsibilities in England and Wales were transferred to the newly founded charity the Canal & River Trust (CRT). The CRT cares for and brings to life 2,000 miles of canals and rivers across England & Wales. In Scotland, British Waterways continues to operate as a standalone public corporation under the trading name Scottish Canals. Other charities are, for instance: the Inland Waterways Association (IWA) and Waterway Recovery Group (WRG). All of these organizations were born thank to passionate houseboaters that started working together restoring and then managing their parts of canals.



Figure 1. *Narrowboats in Little Venice (London), Péniches in Paris, floating houses in Berlin.*

and rivers. The London Mooring Strategy press release document says: “While a number of trials have been carried out and there have been some positive changes, it is clear that a plan of action that covers all aspects of London moorings, developed with waterway users, is necessary to make a significant difference”.

Matthew Symonds, CRT boating strategy and engagement manager, concludes: “London’s waterways are some of the busiest in the country and we need to manage the finite space effectively. We need to face the challenges head on, as well as taking advantage of the opportunity to develop a really world-class water space that people will be able to visit and enjoy. [...] We believe waterways have the power to make a real difference to people’s lives and that spending time by water can make us all healthier and happier. By bringing communities together to

transform their local waterway, we are creating places and spaces that can be used and enjoyed by everyone, every day”.

3.2. Paris

The River Seine was once an important commercial waterway, plied by cargo-carrying barges, the *péniches*. As it happened for narrowboats in the UK, when the inland waterways gave way to the railroads, barges declined in importance. Today, most of them have been converted into floating restaurants or river cruisers, while some others have been transformed into floating homes or BnB.

Parisians know the houseboating phenomenon since more than a hundred years, when some painters and writers like Robert Louis Stevenson⁴ decided to move on board. Not only artists preferred a *péniche* to a house on the land, but also important personalities of their time, like Marshal Joseph Joffre, who lived there during and after the Great War, setting up his office, which he even linked by a telephone line. These original characters inspired the wealthy and aristocratic population of Paris; most of them equipped their boats of all comforts. Almost all of these boats had a generator and running water, stored in tanks on the roof. Meanwhile, ashore, only a few people had this type of comfort at that time.

After World War II, it was the turn of the Americans who remained in Paris, including actor Sterling Hayden⁵, to settle on the banks of the Seine.

The generation of ‘68 was also tempted by the non-conformism of houseboats, the “*bateaux-logements*”. Architects discovered the possibility of exploiting the zenith light and creating an innovative interior design according to the spirit of the loft.

In 1975, Parisian barges created associations to defend river habitat in order to resist their expulsion, but it was only twenty years later that they obtained some recognition and status. The number of berths was regularized and new facilities favored the installation of residential and entertainment barges along the Seine.

In the ‘80s and ‘90s, French personalities belonging to the show business as well as diplomats and many others were seduced by the life on the water. The crisis of inland navigation and the soaring price of real estate had prompted many landowners to buy a commercial barge to be converted into a residential boat. This formula made it possible to have a large living space in the heart of Paris for a derisory price. Indeed, buying a barge in Paris can be more accessible than a traditional apartment, since the cost per square meter can be up to 40% lower than that of Parisian real estate. This is why this phenomenon still has not lost its charm and is expanding even more rapidly than before in Paris as in the rest of France. Nowadays the inhabitants of rivers and canals come from all walks of life. Between them reigns a cohesive atmosphere, where the experience of the elders is often useful to the novices of the community, increasing the dominant spirit of sharing.

According to the latest estimates made by *Voies Navigables de France* (VNF) and the *Port Autonome de Paris*, there are more than 1,150 houseboats only in Île-de-France. According to some associations of houseboat inhabitants, the number is more likely to be around 1,500. The majority of them are stationed in Paris and in the departments bordering the capital.

Over the past ten years, the green water of the river has become clearer and the banks clean-

4. Apparently the first draft of the *Treasure Island* – published in 1883 – was written aboard Stevenson’s Parisian barge, called *Les onze mille vierges*.

5. Sterling Walter Hayden (1916–1986) was an American actor. His most famous role probably was General Jack D. Ripper, in Kubrick’s *Dr.Strangelove* (1964). Once back in the US, he joined the houseboats community of Sausalito in California.

er thanks to public policies for waterfront development and re-naturalization of the waterways. Shops, restaurants and sport centers are approaching the now rediscovered riverbanks and the inhabitants of the river, while appreciating these new features, fear to be deprived of their environment. Since the mooring places are rented and cannot be bought, boaters are starting to add value to the décor, becoming part of the attractions offered by the waterfront and so indispensable in the cityscape.

As in Amsterdam or London, owning a boat in the age of sharing economy can represent a good investment by simply renting a guest-room or the whole boat episodically or regularly on Airbnb. Some boat dwellers are starting to develop different operations to justify their presence surfing on the wave of unusual places to be rented for private parties or special events.

Houseboats are anchored in little ports all over Paris, but there is a long waiting list for an available spot allocated by the VNF, *Ports de Paris* or the *Mairie de Paris*, that together are operating in the city. However, because of the increasing number of boaters, the authorities are delimitating the areas dedicated to the houseboats. There are more than 30 “ports” and they take their names from a nearby street or the closest monument. Most of them are on the Seine and can be few hundred meters to few kilometers long. Apart from the famous *Port des Champs-Élysées* with a nice view of the Tour Eiffel, other residential ports have been designed for long-term as well as short-stay moorings along Parisian canals, protected by locks. Located at the foot of the Place de la Bastille, *Port de l’Arsenal* welcomes more than 170 boats all year round⁶ since the ‘80s, when it was converted in a marina after its past as a commercial port. Much smaller than the Arsenal port, *Port de la Villette (Halte Nautique de La Villette)* is located in the north of Paris.

3.3. Berlin

Berlin is the most fascinating and contradictory case study. Berliners have always been known for living in uncommon places: while rents are constantly rising, more and more people have avoided conventional houses, but even the unusual life models adopted so far, such as squats, living in Bauwagen (van or construction wagons), houseboats, tiny houses and even Tipi tents are now under pressure.

Berlin has rivers, canals and lakes that together make up around 6.5% of the city’s surface that is equivalent to about 60 km² – not even Amsterdam is so rich in water (52 km²). Despite this huge surface available, there are only a few communities of boaters and none of the city authorities that manage permits for boat moorings can estimate the real number of houseboats. In 2011, only 25 berths were registered with the Berlin Water and Shipping Authority (WSA) but there were about twice as many unregistered houseboats in the city. According to the WSA, nowadays this number is around 60 boats. About ten boats have been docked – some for decades – in the flood canal of the Tiergarten lock, in the affluent residential area of Charlottenburg. According to many, this is the oldest houseboat community in Berlin. Its water residents have recently developed a taste for modern luxurious prefabricated houseboats; protective fences and intricate pathways and hedges have appeared and they have started to pay significantly higher mooring rents. Another dozen are moored in the Plötzenseer Kolk near Spandau. The formerly fourth Berlin residential floating colony at Treptower Park disappeared completely after about twenty years of permanence when the owner of the area revoked the permissions to the boaters. Only five boats have found a way to join the other existing colonies.

6. It is curious to note that in this port to live on board permanently is technically forbidden, but an unspoken deal with the port authorities guarantees to the residents that this rule is not enforced.

A few new berths were set up in Niederschöneweide for some of the Treptower Park movers, while part of this former colony probably joined those who, according to WSA, are moored in that unknown number of other city's banks.

In Berlin there are no designated berths for residential houseboats, owners have to make suggestions to the authorities themselves and be prepared for a long march through institutions and sub-institutions, because unlike in London or Paris, there is no central "houseboat commissioner". Spots directly adjacent to the water are often designated as purely commercial areas in which residential homes are not permitted. Other hurdles are boat traffic, tidal range or nature conservation issues. For all of these reasons the berth must be approved by the respective district, which examines demands and, in individual cases, must also give its consent as the owner of the riverside property. The licensing procedure for houseboat moorings is still new territory for the authorities, so the issue is often handled carefully and with great restraint. Because of the complexity of the procedure, the WSA in the first place recommended consulting an expert with experience in the relevant administrative law when searching for a location and applying for a berth. Despite many enquiries from interested parties, this immense demand does not change the insufficient supply. Apparently, the easiest way to get a houseboat in Berlin is to wait for another owner to sell their boat with its approved berth. However, in order to be allowed to moor in marinas, most of the houseboats are officially licensed as recreational boats – and not as first permanent residents.

Living permanently afloat in Berlin is still something for a few enthusiasts, and authorities do not seem to work in favor of the fast development of houseboating. However, this attitude does not reflect the interests of the flourishing business of pontoon houses and floating homes that is taking place in the whole Germany, with Berlin playing a key role in it. In fact, the annual expo "*Boots und Fun*" in Berlin is more and more focused on the market of houseboats, with brand new shipyards presenting their houseboat projects every year. It was the first nautical expositions with a whole pavilion dedicated to the world of houseboating in the whole Europe.

According to the several platforms of houseboat renters, Berlin has a lot to offer in terms of attractions, with its kilometers of navigable waterways and its marinas surrounded by nature only a few minutes away from the city center. A couple of examples are the Rummelsburg City-marina in eastern Berlin or the most recent "Humboldt Island" on the banks of Lake Tegel, that offers floating homes as part of an exclusive lakeside new suburb.

With the exceptions of *péniches* and Dutch barges, which have a habitable surface around 100 m², most of the houseboats – with narrowboats⁷ as the best example – are considered as floating tiny houses. On the other hand, if tiny houses undoubtedly represent a housing solution for degrowth, houseboating deserves to be taken into account as an interesting model for even more reasons.

"Degrowth ('*decroissance*' in French) was launched in the beginning of the 21st century as a project of voluntary societal shrinking of production and consumption aimed at social and ecological sustainability" (Demaria *et al.*, 2013).

Living afloat on converted old working boats, abandoning the mainstream housing narratives (Nelson, 2018), enriches the cityscape with colourful inhabiting waterfronts. First of all, houseboating gives a second life to non-recyclable big and complex objects, as boats are. Even when boats are no longer available for cruising, their hulls can be used as "floating" basements

7. British narrowboats were never wider than 2.13 m (7 ft) while their maximum length is 21.95 m (72 ft). Anything wider or longer will be unable to navigate most of the British canal network (to access the entire network the maximum length is 17.37 m – 57 ft).



Figure 2. A 'Schark' built on the hull of an old Dutch barge, Amsterdam.

for new arks or better “scharks”⁸, avoiding the economic and environmental costs of divestment and the ones related to the construction of a new square hull in concrete. This specific kind of arks is often turning out into very original and beautiful exemplars.

Most of the time, the boats that are now converted into houseboats are part of a local historical heritage that needs to be protected and preserved, keeping both the boats and the waterways alive. The last original narrowboats belong to the Industrial History of Great Britain and, on the contrary of most of yachts, their value may increase with the years, representing a true investment for their lucky owners.

Next to restored working boats and their replicas, prefabricated houseboats spread in the European market, giving birth to new scenarios that now involve new actors not necessarily enthusiasts of historic boats. Indeed, new pre-fab pontoon boats are representing a sustainable option, by requiring less work and construction materials of any similar-size building on the land. Fully equipped with the last “green” technologies such as hybrid or fully electrical engines, solar panels and so on, these new floating houses are often following those values of the ‘Tiny House Movement’, such as living with less according to the “less is more” philosophy and leaving a low impact in terms of consumes and pollution.

London based architect Carl Turner has developed the design for a prefabricated floating living-unit leaving the plans available to download via the open-source architecture platform, Paper Houses. Described as “Part-house and part-boat”, it was thought as a solution to the global prob-

8. Arks are floating houses rather than houseboats since the ‘hull’ on which they are constructed is often not motorised and the superstructure resembles houses on the land. This kind of craft is typical of the Netherlands. However, some arks are simply hulls of old ships used as empty shells. These kind of arks are friendly called ‘schark’(‘ship’ + ‘ark’) as explained on by the Houseboat Museum of Amsterdam.



Figure 3. *Floating House* prototype, Carl Turner, *DIY houseboat* example by Claudius Schulze.

lem of flooding and thus it was designed to deal with any flood-prone site. The design comprises a simple lightweight structure, which could be constructed on traditional pile foundations but could also be built over a concrete hull that would allow it to float. According to Turner's philosophy, anyone can access the project, being able to build his own DIY floating house.

A similar concept is at the base of tiny house movement, where designers offer the possibility to buy only the project, leaving the construction to the DIY fans. Shanty houses, the American floating houses, are quite often DIY experiments and there are several websites offering projects, tutorials and advice. Of course, this sharing behaviour helped to create communities of passionate people with the same values and ideas about these alternatives housing possibilities. Down-sizing the houses' volumes and taking care of the construction in terms of quality and quantity of materials and workmanship, makes this kind of dwelling more sustainable from different points of views and so perfectly compatible with the Degrowth ideals.

4. Discussion/Conclusion

The fact that living on board is still an emerging trend is shown by a new urbanization wave of European waterways and the following gentrification of their waterfronts. Nowadays, houseboats are a permanent presence in many neighbourhoods in London, Paris and Berlin, as well as

many other cities in Europe and they surely represent a new flourishing business characterised by several potentialities. All these cities are adapting themselves to the rising number of 'live-aboards', people simply looking for more sustainable and closer to the nature ways of settling, without leaving the city-life. Despite these houseboaters belong to different generations and lifestyles, they often create local communities tied together by a genuine sense of sharing and need of each other's experience in order to deal with the daily maintenance and reparation works on board and with the authorities on land.

Houseboating is a bottom-up phenomenon, but even if the first settlers were mainly spontaneous users, with the rising number of boaters a change in the European metropolises started to take place, including important top-down actions. New services and facilities arrived on the waterfronts, simplifying life for boaters.

Houseboats are a cultural enrichment not only in terms of living examples of a nautical tradition. In fact, many little communities of enthusiasts helped their own suburbs to gain popularity, as tourist attractions, inviting the curious to witness this charming lifestyle. After an initial reluctance, "landowners" had to admit that the presence of houseboats is actually making certain areas safer and more enjoyable, assuring from both sides a re-appropriation of the waterfront, with an improvement in terms of quality of life for the whole neighbourhood.

It must be remembered that the firsts to move onboard were very passionate people, with a strong desire to protect their waterways and preserve the right and the ability to navigate them. Doing so, these urban pioneers were contributing to safeguarding canals and riversides, improving their accessibility for all. Nowadays those who decide to live afloat are more often pushed by the idea of owning an alternative dwelling, possibly leaving a low impact on the planet, rather than being simply attracted by life on water. Since its rebirth, during the reconstruction after World War II, houseboating was not only a simple glamour phenomenon, but it represented a more complex settling choice defined by several factors.

"Some actors working on the development of alternatives argue that the change of individual values and behaviour should be the main target of degrowth. This is manifest in the lifestyles of people who practice voluntary simplicity, living better with less, downshifting and slowing down life's pace" (Demaria *et al.*, 2013). According to this statement, many houseboaters -often unaware- are the authors of a positive change, a virtuous example able to make the difference in cities like Amsterdam, which nowadays makes part of her fortune on houseboating. On the same article, it is explained how a "degrowth approach" works once a 'diagnosis' is made. "The diagnosis consists of identifying the causes of a social problem. Degrowth as an interpretative frame diagnoses that disparate social phenomena such as the social and environmental crises are related to economic growth. Degrowth actors are thus 'signifying agents' engaged in the production of alternative and contentious meanings which differ from the ones defended by the mainstream (i.e. mass media, most politicians, economics professors and financial experts and industry CEOs)" (Ivi).

Living afloat is a kind of dwelling that cannot be ignored as an insignificant market niche anymore. While designing the cities of tomorrow it is now impossible not to wonder about the needs of this kind of settlers, representing a new challenge for architects, designers and urbanists. According to a report on the urban planning potential of living on water, the BBC recently interviewed Koen Olthuis, the founder of Waterstudio, an architecture firm specialized on floating homes, and co-author of the book *Float! Building on Water to Combat Urban Congestion and Climate Change*. "For some time now, Olthuis explained, he has observed that the original defensive attitude of city authorities has turned into support. "They're [houseboats] becoming more interesting to municipalities, because they're treating



Figure 4. *The Chichester on Chichester Canal in southern England, Baca Architects, 2016.*

them as real estate, which generates property taxes”. Olthuis envisions a buoyant future for water living as urban congestion increases and climate change brings on stronger rains and more flooding. [...] In addition, Olthuis contends [...]: “Cities will need to brand themselves and make themselves more interesting, and water living will be just the thing to attract young, high-net-worth individuals... and floating communities will only increase the functionality and flexibility of cities” (Wysocky, 2016).

Experts say that by 2020 at least 60,000 new dwellings will have to be built in Berlin, and they doubt whether the massive demand for new buildings can be met at this rate. Moreover, in the 2018 Revision of World Population Prospects, the UN reports that 54% of the world’s population lives in urban areas – and that figure is expected to increase to 66% by 2050, so it is clear that many metropolises are meant to acquire new citizens. Considering that in the city of Amsterdam there are about 5000 people living on board their 2500 houseboats, and more than 8000, in London, the need of living space can be solved – even if only partially – colonising waterways. In a city with limited space, residential boats can satisfy the “right to the city” (Nelson, 2018) of new inhabitants offering, at the same time, a good opportunity to create exclusive domiciles, playing a key role in medium-term urban development planning.

In 2015 London-based Baca Architects has developed a floating prototype with British company Floating Homes, for a housing competition to seek solutions to London’s housing crisis hosted by think-tank New London Architecture (NLA). According to some interviews, the prototype, named ‘the Chichester’ had been inspired by the design of canal boats and houseboaters lifestyle. Moreover, Baca Architects has developed a number of concepts that aim to move growing urban populations into floating communities. These concepts follow the recent surge of interest in floating buildings, which respond not only to the rising sea levels but also to the lack of housing solutions on overcrowded cities. This boxy floating house, characterized by a replicable design, was installed on Chichester Canal (southern England) in 2016 as a demonstra-

tion of how it could be widely exploited across London's waterways. The project aims to install prefabricated floating housing on disused space along rivers and canals in London. According to the Baca Architects press release, the scheme could deliver up to 7,500 affordable homes – at £150,000 for a two-bed unit – in the city center.

As a consequence of the development of inland waterways navigation systems promoted by the European Community and the spread of the so-called tourism “fluvestre”⁹, houseboating – not only as a fancy form of slow-tourism – will keep on rising its popularity in the name of the “Little Venice”¹⁰ dream... and it will play a key role on the future urban design of European waterfronts.

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9. It is a form of integrated tourism, sharing the same values of slow tourism. The term “fluvestre” is a French neologism made by the words *fluvial* (riverine/fluvial) and *terrestre* (land based).

10. Little Venice, Westminster, is a neighbourhood of London, nowadays famous because of houseboats presence.

Watershed: the Transformation and Interrelationship of Urban Tianjin and its Water Environment in China's Planned Economy Era

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Keywords: urban form, water environment, Tianjin, the planned economy era.

Abstract: Much has been written about cities in China's planned economy era from 1949 to 1978. Most of them focus on political and economic background, urban-rural relationship, land policy, and residential registration system to gain a general understanding of the time, while some, by choosing typical components or important projects, reveal characteristics of urban development. With a few notable exceptions, little is known about the relationships between built and natural environments of a city at that time. Mao, who had terminated the long time unrest status of the nation, gained unprecedented power to mobilize the masses. This power, facilitated with the traditional eager of water ruling and modern water conservancy technology, made a radical shift on the water environment. What was easily overlooked is that this change not only influenced irrigation, navigation, flood control, and hydropower generation, but also affected the development of cities along the rivers.

This article focuses on the city of Tianjin, which is located at the mouth of the Haihe River, to examine the interrelationship between the city and its water environment at that time. By investigating water conservancy works in and beyond the city, comparing several versions of urban master plans, and depicting the evolving urban forms and structures, the paper argues that the transformation of the water environment along the river deeply impacted the urban development, set the foundation of transforming the river-based trade city into a plain-based industrial city, and tore the city into an urban-harbor dual structure.

1. Introduction

The idea is generally recognized that the development of a city is inseparable from the environment in which it is located. If we define a city in “adequate environmental terms” and place it within “the larger framework of the physical world”, we may get a better understanding of its evolvement (Melosi, 1993). This method is especially necessary for the study of Chinese cities, especially with regard to urban and water environments. Water plays an important role in culture, society, and governance of China. “Many of them are likely to remain strange, opaque or alien unless their connection with water is understood” (Ball, 2016). There is a big amount of excellent research on the issues of cities and waters in China. And some of them discuss the role of water in the evolution of urban forms, mainly in ancient time. But for the planned econ-

omy period, research on such issues is rare. In fact, with the development of modern technology, human beings have become more capable of transforming nature. The changes in the water environment and the city have become more intense, and their connections and interaction have become stronger. In this regard, Tianjin, located at the mainstream of the Haihe River, as a case demonstrates the enormous impact of changes in the water environment on urban form in China's planned economy era. This paper tries to bridge the research of urban planning, water conservancy, and related socio-political background through a historical perspective to build a holistic and multidisciplinary approach to understand the city's development and transformation at that time.

2. Waters and urban form of Tianjin

The city of Tianjin emerged in ancient time for the sake of its location, which is the intersection of the Grand Canal and the Haihe River, and played a role of trade terminal that serving the imperial capital Beijing and the river basin. The topographic and climatic factors cause frequent flooding in this area. The low-lying terrain in the downstream plain and coastal area is full of wetlands and ponds. Cities and villages can only construct in limited highland, which formed a unique physical form and living conditions.

This stable situation changed when the colonizers come at the end of the 19th century. The environment condition cannot meet their need to build a modern port city (figure 1). A large number of management projects had been made to transform the rivers and surrounding environment, which became a foundation for the city's prosperity. Before the Communist China established in 1949, the city of Tianjin transformed from a trade settlement with 200 thousand



Figure 1. An aerial view taken by the French military shows topography along the Haihe River around 1900.

people to a modern port city with a population of 1.8 million, the second largest city in China at that time. The Haihe River and its tributaries presented crucial roles of navigation, industrial, domestic and irrigation water supply, waste water and flood discharging. The river became a veritable mother river in the city.

During the planned economy period, Tianjin and its water environment experienced tremendous changes. The built-up area (BUA) rapid grew by 1960, from 61skm in 1949 to 146skm in 1960, and then entered a long-term stagnation period (only increased 15 skm for 16 years). The urban population grew from 1.79 million in 1949 to 3.02 million in 1964, and then fell back to 2.72 million in 1976. The linear form along the rivers that shaped before 1949 gradually evolved into a sprawling pattern surrounding the old city (figure 2).

The following paragraphs will review and compare the initial versions of the urban planning scheme, investigate the water conservancy projects carried out in the same period of the Haihe River Basin and the resulting changes in the water environment and the impact on Tianjin. The paper argues that the water environment and its changes have played a much more important role than usual understanding in the formulation of the plan, the development of the city and the evolution of the urban form.

3. Urban planning: visions of the city and its waters

On March 13, 1949, the Second Plenum of the 7th CCP Central Committee was held in Xibaipo Village, on the northern bank of the Hutuo River, an important tributary of the Haihe River. This meeting was widely regarded as an important meeting for drawing the blueprint for future national construction. The meeting put forward the main tasks to transform China from an agricultural country to an industrial country. It also pointed out that only by restoring and developing the production in the city, and transforming the consumer-oriented city into a production-oriented city, can the people consolidate their regime. The editorial of the People's Daily subsequently pointed out that the old cities with modern industry like Tianjin still has the nature

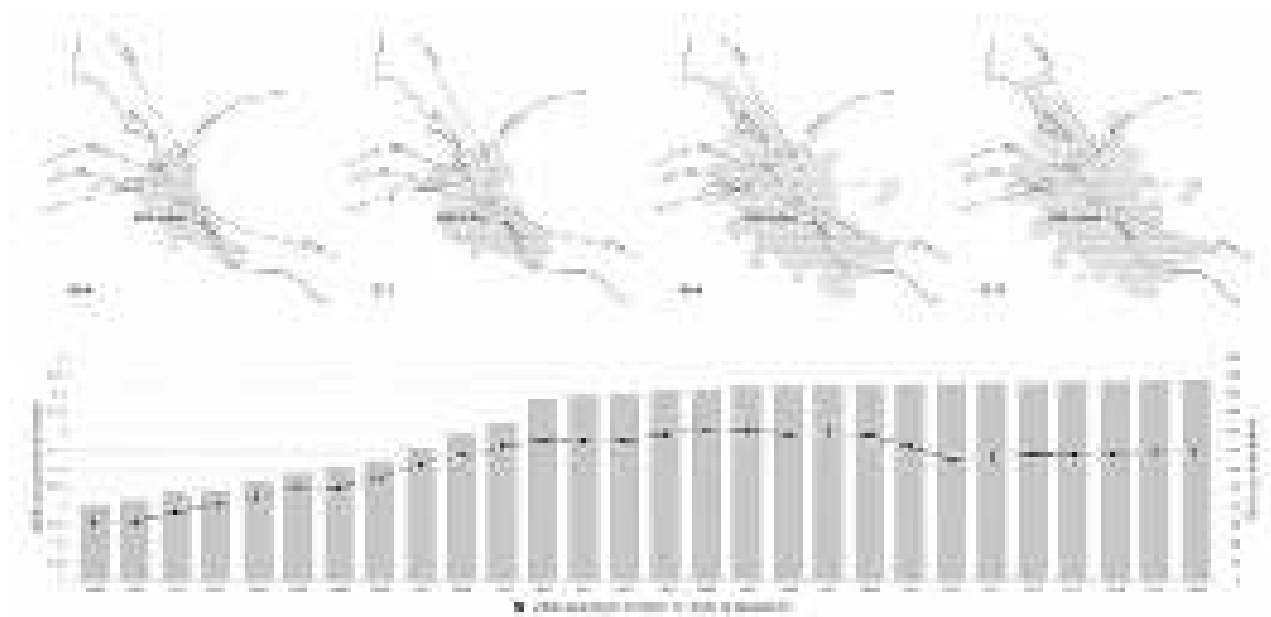


Figure 2. Urban form of Tianjin in some key years and urban population and built-up area from 1949 to 1976.

of a consumer city. Its prosperity is based on the exploitation of workers and the exploitation of villages. “We want to eliminate this phenomenon,... It is necessary to quickly restore and develop production”. “Building a production-oriented city” had laid the basic policy for China’s urban construction in the following 30 years. Under the influence of frequently changing international and domestic situations, political lines, economic and urban policies, urban planning during this period also frequently changed. The development of the “old city” such as Tianjin was mainly centered on “reconstruction” and always reflected the consideration of its water environment.

4. The will of developing along the river

In the first three years after 1949, known as the period of national economic recovery, industrial and agricultural development had grown rapidly. A large number of rural people had entered the city. The population of urban area of Tianjin had increased from 1.79 million in 1949 to 2.01 million in 1952, while the area of built-up area (BUA) had only increased from 61skm to 71skm. The tight condition of construction land shortage had not improved. Since 1951, the Tianjin Construction Committee (TCC) had considered the expansion of the urban area and strives for more land for construction. In 1952, TCC proposed the Plan for Expanding the Built-Up Area (1952 Plan).

The plan believes that Tianjin’s urban construction is strongly restricted by the surrounding low-lying terrain, resulting in densely populated areas in the BUA. In order to provide land for new industrial projects and supporting facilities, it is necessary to choose an appropriate direction to expand the building area. The plan was deeply influenced by *the Greater Tianjin Metropolitan Plan* during the Japanese occupation period. It broke through the restrictions of administrative divisions at that time, especially strengthening the role of the Haihe River as the axis of urban development, and focusing on the development of the lower reaches of the river. The linear form establishes the connection between Tianjin urban area and Tanggu and the seaport. It intended to give full play to the support of Haihe to industrial development. Two districts were planned along the river, and the industrial zone was arranged on the bank to take advantage of the river’s transportation, water supply and sewage disposal. The residential land was placed inland (figure 3).

The low-lying topography around the BUA was both the premise for this plan and the primary problem that must be faced in the subsequent construction. A big portion of the planning text was used to demonstrate the land reclamation plan in detail. According to the plan, over 30skm land will be filled for an average of 1.5 meters high in three years. The soil was from the mud dredged from the Haihe River and the rural area outside the embankment in the southwest. The total cost of land reclamation was nearly 95 million yuan, which was close to the total amount of all infrastructure investment of Tianjin in 1952. Such a huge investment is a burden on a new regime at that time. Later, two more versions of filling scheme were discussed to scale down or extend the schedule to reduce the cost. At last, the height of filling was reduced and the whole project was divided into ten phases.

5. Reconsidering the direction

In September 1952, the Central Financial and Economic Committee (CFEC), the most important administration of the planned economy, held the first national urban construction conference, requiring cities to formulate urban planning, especially the master plan to guide the construction of the city. For the first time, the Chinese cities were classified into four categories ac-

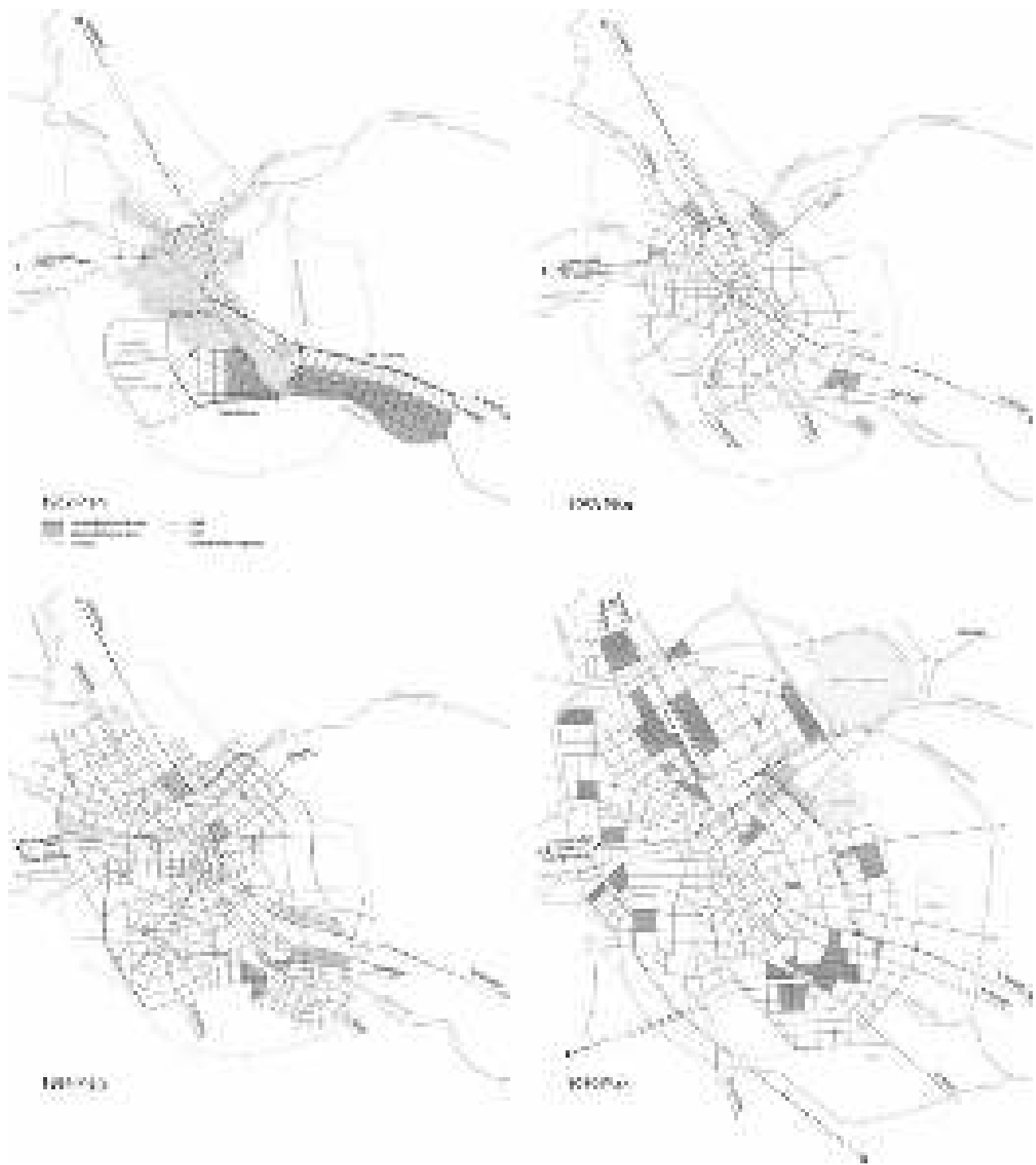


Figure 3. The layout of several versions of urban plan in same scale. The current outer ring road is drawn to help compare.

cording to the proportion of heavy industry that planned to be developed. Tianjin ranked in the third category, that is, the proportion of industry will not be increased in the future, and no priority will be placed on development. At the same time, a large number of Soviet experts participated in the construction of the country and gave professional guidance.

In this context, Tianjin's first urban construction preliminary plan was born in January 1953 (1953 Plan) (Figure 3). The plan replaced the linear structure of the 1952 Plan by establishing a mono-centered structure. A hierarchy system with "one city center and ten district centers" and a "three-ring and eighteen-radiant" road system were set up as the skeleton of the city. Research

on historical sources suggests that the reasons for this major shift may include: 1. The strong desire of the authorities and planning practitioners to change the old city's unconformity structure caused by the large number of concessions and the separation of Chinese and Foreign districts. 2. And the deep influence of Soviet expert Muchin who visited Tianjin in October 1952 and suggested that urban planning must reflect the superiority of the socialist system, reflect the infinite care for the working people and create comfort environment for them. A socialist city should make good use of rivers, so that the people can enjoy the natural scenery along the banks. The city must have a city center, and there must be a cultural and educational area, etc. It is clear that the 1952 Plan, which placing industrial areas on the riverside with the purpose of facilitating production, and the absence of urban centers for its linear structure will inevitably be opposed by Muchin. In the 1953 Plan, the urban centers was highlighted, and the four industrial areas selected were no longer occupied the riversides, but left the space to the workers' houses.

The First Five-Year Plan began in 1953, marking the full debut of China's planned economy. Mao Zedong proposed that the general line of building socialism is to gradually realize the socialist industrialization of the country. The focus of the First Five-Year Plan was to carry out industrial construction focusing on 156 projects aided by the Soviet Union and establish a preliminary foundation for industrialization. Soviet experts put forward that "urban planning is the continuation and implement of the national economy", and urban planning should be coordinated with industrial projects. Urban planning following the pace of economy plan and the factory site selection became a rule in the following years. This rule, on one hand, embodied the central position of industrial land in the city, and it also indicated that the long-term plan follows the short-term economic goals may cause great uncertainty.

In June 1954, another conference of urban construction was held by the Ministry of Construction and Engineering (MCE). Under the guideline of giving the priority to develop the key cities and attention to the expansion of existing industrial cities, the conference put forward a new category of the cities, in which Tianjin accelerate its class than before and got the allowance to "use the old urban area as much as possible, construct a new urban area in a planned way, and combine it with local reconstruction in the expansion to serve the new industrial area".

In this context, the TCC formulated the 1954 Plan based on the modification of the 1953 Plan, clarifying that the city is an industrial city. The planned urban population increased from 2.5 million to 3 million. And the mono-centered structure, hierarchy system, and the ring road network were retained while the planned district centers increased to 15. The planned urban area expands evenly comparing the former one and the area increased to 230s km. The road system has been more classically beautified, highlighting the composition of the city center and the axis (Figure 3). In this plan, the role of the Haihe River as the axis of urban development has been neglected, but countermeasures have been proposed for the low-lying situation to meet the needs of urban expansion and maintain the mono-centered urban structure. It is recommended to fill or concentrate the puddles, excavate artificial lakes, and use the soil scooped out in urban construction.

Due to the consideration of an upcoming war, CCP proposed a strategic contraction of the coastal areas in 1955. Only rational and effective use of coastal cities will be carried out to support the construction of the interior. The no. 115 factory of the 156 aid projects originally planned to be built in Tianjin moved out of the city. The shrinking industrial scale also means a reduction in urban area. Hence, the new plan (1955 Plan) reduced the planned urban population to 2 million.

Only one year later, Mao Zedong published his famous *Ten Major Relationships* and made a dialectical interpretation of the relationship between the coast and the interior, that is, it is

necessary to carry out reasonable development of coastal cities in order to better support the construction of the interior cities. At the same time, the central government headed by Zhou Enlai advocated a frugal movement on the increase of production and the practice of frugality. In the field of urban construction, it was reflected in the compression of non-productive construction. Under the contradictory policies from the top level, the revised urban plan (1957 Plan) restored the population size to 3 million, while urban area was compressed to 158.82 skm (30% less than the 1954 Plan). Compared with the mono-centered expansion of the 1954 Plan, the consideration of land conditions in this version was much more practical. The Soviet experts had especially played a crucial role in this revision.

In August 1956, after their field trip in Tianjin, the chief adviser of the MCE, Sarisev, and other Soviet experts deeply felt the restrictions on the development of low-lying terrain. He suggested to make a new comparison plan with a linear layout that fully consider and take advantage of the relative high topography along the Haihe River, especially in the northern part of the city. He also pointed out that the Haihe River as the main axis of the city should be emphasized. Subsequently, economic comparisons were made between the two layouts from six aspects, such as filling and municipal construction. It was calculated that the layout of an oval form could save an investment of 30.37 million yuan compared with the mono-centered round form. Meanwhile, in order to save arable land along the lower reaches of the Haihe River, the city was planned to expand to the northwestern along the river.

6. Placing the city on a water network

In 1958, China entered the Second Five-Year Plan and officially took the step of the Great Leap Forward. In the same year, Tianjin became the capital of Hebei Province, and its area was expanded to more than 30,000 skm. The 1957 Plan cannot provide sufficient land for huge industrial investment and needs to revise. The urban population of the new plan reached 3 to 3.5 million, and the land area expanded to 370 skm, more than two times of the 1957 version. According to the layout principle of “scattered in large and concentration in small”, combined with policy of building urban people’s communes, the urban area was divided into twelve production and living groups. Each group has its own industrial area, living area and service facilities to achieve self-sufficiency within the group and reduce transportation between different groups. The urban form comprehensively considers the opinions of the previous versions of the plan, avoids the low-lying areas in the northeast and southwest, and develops to the highland in northwest, forming an oval shape along the direction of the Haihe River. At the same time, in order to implement the requirements of “controlling big cities and developing small cities”, and considering the low-lying conditions around Tianjin, the plan proposed to develop several industrial satellite towns around the urban area and at Tanggu.

The layout of such a large urban structure and a big number of industrial zones was placed on an efficient traffic system. In addition to newly built or adjusted railway lines, it was mainly based on an urban river network. The network, taking the Haihe River as trunk and making full use of the channels and ponds in the city, planned to construct a river transportation system around the urban area, and connect the warehouses and factories in and beyond the city. (Fig. 3) Meanwhile, through the construction of the Beijing-Tianjin Canal and the Tianjin-Tangshan Canal, and the restoration and expansion of the old channels, the waterway communication with the whole river basin will be realized to meet the urban positioning of “North China Water and Land Transportation Hub”. This plan was carried out under the guidance of the Min-

istry of Communications' proposal for the construction of a river network, and the "Planning for Urban River Networking" of Tianjin. And both of river network ideas were based on the Haihe River Basin Plan compiled by the MWR in 1957 and the improvement of various adverse conditions in the Haihe River after river basin management.

7. Waters in tremendous changing

7.1. *Haihe River Basin Plan: waters for an ideal world*

At the end of 1957, the Ministry of Water Resources (MWR) completed the preparation of *the Haihe River Basin Plan (Draft)*, and believed that the main means of comprehensive management of the basin is to fully control and regulate water resource. The plan takes flood control as the primary task. A large number of large and medium-sized reservoirs are planned at the exits of Taihang and Yanshan Mountains to regulate floods and control runoff. There are also several distributary channels in the coastal area that planned to reduce flood when needed.

The plan considers that the total amount of water, 9.678 billion cubic meters, cannot meet the full development of irrigation, navigation, hydropower, and industrial and domestic water demands. It is necessary to divert water from outside the basin. It is planned to divert 23.45 billion cubic meters from the Yellow River through the Sanmenxia Reservoir and 1.15 billion cubic meters from the Luanhe River. In the future, it can also transfer 25 billion cubic meters of Hanjiang water through the Danjiangkou Reservoir. Based on these idealized figures, MWR finished the plan of the Haihe River Basin and distribute these water resources in a top-down way. In addition to renovating and providing water for 165 million mu of land suitable for irrigation in the whole basin, the plan also planned a network of waterways in the basin to promote the transportation, industrial and agricultural development. It included the Beijing-Tianjin Canal, Tianjin-Tangshan Canal and 9 more major waterways in near-term plan and canals that link the basin to the Yellow River, Huaihe River and the Yangtze River in long-term plan. In addition, a hydropower development program has also been formulated for upstream rivers.

7.2. *The Haihe River Transformation Project: A Sign of Warning*

Just as people yearn for the ideal world, the facts send an early warning. In the early years after 1949, the central government took "building water conservancy projects to develop agriculture" as an important national policy to implement. On the one hand, it encourages farmers to build "small water conservancy" spontaneously, and on the other hand gradually increases investment in water conservancy projects. The eager of farmers to improve farming conditions through the construction of water conservancy projects out of control to some extent. According to the People's Daily, the total amount of water conservancy projects during the First Five-Year Plan was huge, equivalent to the construction of more than 40 Great Walls. This kind of booming scene was essentially the competition for water resources in various regions. In the absence of systematic planning and coordination, these projects have had a tremendous impact on Tianjin that located in the lower reaches of the Haihe River.

The North China was arid from the winter of 1957 to the spring of 1958. There was very little water coming from the upper reaches of the Haihe River. By April 20, the flow of the

Mainstream was only 4.2 cubic meters per second, almost equal to the amount of wastewater discharged into the river. The Tianjin Municipal Government held a meeting to discuss the issue of urban water use. It is believed that with the development of the economy, the fresh water required by the city will increase exponentially, but the amount of water in the Haihe River is not abundant, while the amount of water used for irrigation in the upstream is also growing. The amount of water coming upstream will keep decreasing. Therefore, in order to solve the problem of water use in Tianjin, the government decided to reconstruct the mainstream of the river so that the water source can reach the standards for industrial and domestic using.

The project includes the construction of a hub project in the river mouth to separate freshwater and seawater and the reorganization of the urban sewer system to avoid discharging sewage into the Haihe River. The investment amounted to 80 million yuan, almost 1.3 times to the total investment in municipal construction during the First Five-Year Plan. Two newly built gates at the river mouth cooperated with the ship-lock built in 1946 proof the seawater and make the Haihe River a freshwater storage channel with a total storage capacity of 80 million cubic meters. In order to quickly resolve the situation of water shortage, the municipal government mobilized the public to participate in voluntary labor and became the main force of Haihe transformation. The construction of the gates was completed in half a year at the end of 1958, and the sewage renovation project was completed at the end of 1959. The project has alleviated the urgent need for Tianjin's industry, agriculture and people's living water in a certain period of time.

Although this project is an early warning to Tianjin's water supply, it is not enough to shake people's beliefs. It is still believed that when achieving the complete control of water and transferred enough water, the situation will be improved. Therefore, under the guidance of the Haihe River Basin Plan, the project focusing on water storage continued.

Since 1949, the Soviet experts who helped manage the Huaihe River introduced Stalin's view of nature and proposed "water is the wealth of the people. It must be controlled follow people's domination". "Only when it finishes all its work, water can be sent to the sea". Gradually, the MWR shifted the water management method from giving the priority to drainage in the past to giving the priority to water storage. This method then was recognized by the central government and became the guiding principle for national water conservancy construction. During the Second Five-Year Plan period, the investment in water conservancy changed the former balanced distribution. The proportion of investment in reservoir construction exceeded half of the total.

According to the arrangement of the HRBP, from 1958, the climax of mass construction of reservoirs began. By 1963, 21 large reservoirs, 45 medium-sized reservoirs, and thousands of small reservoirs were built with a total storage capacity of 13.72 billion cubic meters, equivalent to 1.5 times the total available surface water resources of the Haihe River. The site choice for these reservoirs is mostly reasonable. However, under the influence of the Great Leap Forward, in order to shorten the construction period, survey, design and construction carried out at the same time, resulting in some problems in design and construction quality, which brought some dangers to future flood control. In addition, a large number of water storage projects and irrigation districts were built in the plain area. The projects only paid much attention to water storage but not to the construction of drainage system, which caused large-scale farmland salinization in a very short period. And this finally became an important cause of the following famine.

7.2. The 1963 Big Flood and the Haihe River Controlling Campaign

Just as people have not fully recovered from the disaster caused by the Great Leap Forward, the big flood occurred in 1963 seemed to be a test of the water conservancy projects that built in the Haihe River Basin since 1949.

In August of that year, the largest floods since records occurred in the southern rivers of the Haihe River Basin. Although more than a dozen large reservoirs in the upper reaches controlled nearly 46.2% of the total amount of water coming from the mountains, the floods still flowed from the west to the east across the Beijing-Guangzhou railway, causing successive floods in the rivers, flooding 101 counties and cities and more than 53 million *mu* of land. Tianjin spared from this flood for the sacrifice of the places along the flood. Although there have been people who have blamed that this unprecedented scale of flood was not mainly due to the climate, the official insisted that the natural factors are far greater than human factors in causing the disaster. And the appropriate treatment is to carry out larger scale flood control projects, the so-called “great disaster only could be ruled by great control”.

On November 17, 1963, after visiting the exhibition on flood control and disaster relief, Mao Zedong issued a call to “bright the Haihe River under permanent control”. It marked the beginning of a mass campaign that lasted for more than ten years (Figure 4). MWR formulated the *Haihe River Basin Flood Control Plan (Draft)* that was based on the experience of flood fighting in 1963 and the problems of flood control. The plan gave priority to building distributary channels in the coastal area.

The massive Haihe River Permanent Controlling Campaign was mainly concentrated in Hebei Province. Millions of people had participated in voluntary labor. In order to ensure the progress, even during the Cultural Revolution, no political movement was required on the project site. More than 50 distributary channel and drainage rivers have been built to ensure all the major tributaries of the upper reaches can obtained independent access to the sea. The discharge volume of water reaches 24,680 m³/s, which is 10 times to the capacity of the Haihe River. Since then, the Haihe River Basin has return to the original state before the Wei Dynasty with all the channels controlled by human being. Hence, the foundation of Tianjin as a trade city completely changed. Almost at the same time, the Sanmenxia Dam, which is an important water diversion project to deliver water to the Haihe River Basin, had experienced serious siltation problems since its completion. A number of renovations had been carried out to save



Figure 4. *Taming the rivers.*

the dam and upper reaches in the 1960s, making the ideal of diverting water from the Yellow River a bubble.

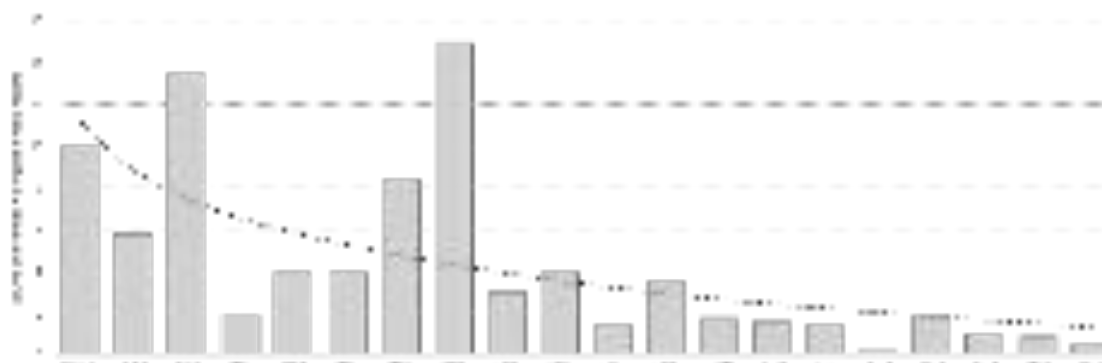
7.3. The thirsty city and tore form

Due to the closure of water resources in upstream, the construction of distributary channels, and the failure of water transfer plan, the water volume flowed into Tianjin has decreased from an average of 10 billion m³ per year (1950-1957) to only 1.8 billion m³ per year (1965-1972). The lowest was only 300 million in 1972 (Graphic 1). Due to the leakage of Haihe Gate, the agriculture and industrial sewage discharge in upstream and the opening and closing of ship locks, it still caused seawater intrusion, threatening industrial, agricultural and domestic water supply of the city. Due to the decrease in incoming water, the river channel lacks erosion and the siltation is aggravated, causing the riverbed to be 1-2 meters high, reducing the river's ability to discharge floodwater. In addition, the decline of navigation and the move of port have had a fatal impact on Tianjin.

Inland navigation consisting of the Grand Canal and the upper reaches of the Haihe River has always been one of the main ways of collecting and transporting in Tianjin Port. Even after the rise of the railway, water transports are still prevalent. After 1949, 54 rivers were excavated which made the mileage of inland navigation reached 721 kilometers. At the same time, due to the abundant water resources of the river, the port in urban Tianjin was flourishing. At that time, the 3,000-ton sea-going vessel could directly reach the city. In 1949, the seaborne throughput of the urban port was 220,000 tons, accounting for 70% of the total in that year. In 1959, it reached 828,000 tons, the highest level since 1949. After that, due to the reduction of the water amount, the construction of locks, dams, and bridges on the main stream that had cut off the waterway, the urban port that has flourished for a century and the inland navigation that has continued for hundreds of years declined.

Along with the decline of the urban wharf was the rise of the New Harbor in Tanggu. The construction of the New Harbor began in the Japanese occupation period. At that time, the Japanese were dissatisfied with the control of the urban wharf by the Westerners and planned to build a new harbor at the river mouth. But the project did not finish for the reason of war. Since 1949, the Ministry of Communications of PRC officially took over the businesses of Tianjin Port and started to build the harbor. It also started to establish the combination of govern-

Graphic 1. Volume of incoming water from 1949 to 1976.



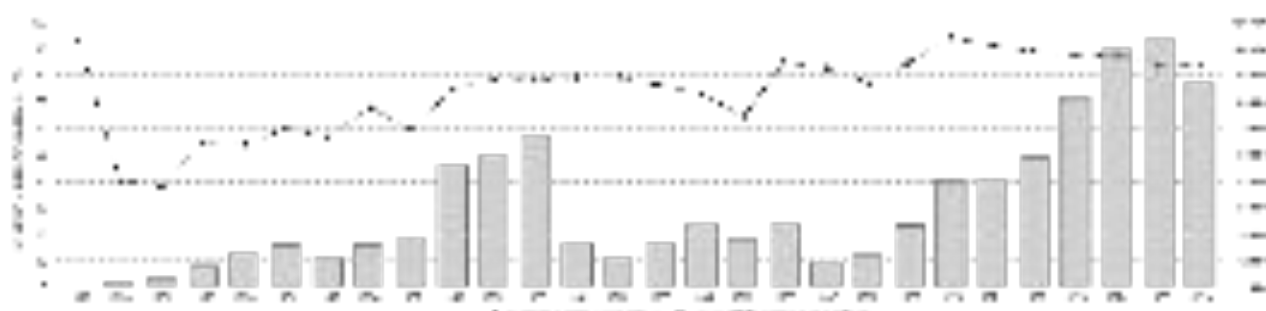
ment function and enterprise management centered on planned transportation. The city lost its right to manage the port. The central government control the international and domestic trade and determined which kind of good to import or export, and the city was only responsible for transportation and distribution. The supporting role of trade in urban industries has disappeared.

Furthermore, the spatial stripping was much more obvious. The distance between Tianjin urban wharf and the New Harbor is more than 40 kilometers. It means that all the port facilities, warehouses, railways, highways, waterways need to be rebuilt or upgraded in Tanggu. It was a huge burden for a new country to do that in a short time. On the one hand, the loss of navigation of the Haihe River increased the dependence on land transportation. As the railway transportation capacity was almost saturated, and the highway construction was slow improved, the traffic connection between Tianjin and the New Harbor was difficult for a long time. On the other hand, the various facilities in the urban wharf have been abandoned, and the storage, industry, and ancillary facilities built near the wharf have been dying. Since then, one cannot find the prosperity of a port city in Tianjin again.

The stripping of the port and the decline of navigation have completely changed the structural logic of urban space that developing along the river. After the Great Leap Forward, urban planning was considered to be the chief culprit in the blind expansion of cities. The central government proposed that “do not make urban planning for three years” during the period of national economic recovery. Later, because of the preparation for war, decentralized urban layouts became the main guidance for a long time. And during the Cultural Revolution, the planning department had been closed and the professionals had been laid off. In the second half of the planned economy, systematic planning adjustments could not be implemented. The changes in the internal logic of urban space caused by the dramatic changes in the water environment at that time can only be passively coped.

The 1959 Plan with its urban layout and structure formed on the river network became the last version of master plan of Tianjin during the planned economy period. Although the compulsory had been weakened because of the social chaos, it still played the only guiding role at that time. From the beginning of 1958, the understanding of building a production-oriented city had become extreme, unilaterally emphasized on production and compressed everyday life. The proportion of productive investment exceeds 70% of total infrastructure investment until the end of the planned economy (Graphic 2). The more than ten planned industrial zones were quickly built in a short period of time, which made the BUA grown from 107 skm in 1957 to 146skm in 1960. Due to the failure of urban river network construction, these industrial areas

Graphic 2. Amount of total infrastructure investment and the percentage of productive section.



had lost effective traffic support, which made the urban layout showing a loose structure with scattered and unreasonable components. Meanwhile, due to the continuous implementation of the policy of “controlling the size of large cities”, the area of the BUA increased from 145.95skm to 160.89skm in the following 16 years (1960 – 1976), only increased 14.94 skm (10.2%). The urban population dropped from 2.89 million in 1960 to 2.72 million in 1976. The city entered a stage of restrained urbanization that focusing on filling in the gaps (Hou, 2010). The internal adjustment of the urban structure during this period was more obvious than the change of urban form, including the continuous construction of new industrial zones, the transfer of industrial zones in the old city, especially along the river, to these new zones or satellite towns, as well as the spontaneous construction of citizens to make up for the lack of investment in non-productive construction. In the decade of the Cultural Revolution, the illegal building area was about 4.11 million square meters, close to half of the completed building area at the same time and 2/3 of the total legally completed building area in the 1960s.

8. Conclusion

The review of the planning process reveals how people consider the river and the water environment when they were drawing the blueprint of the city and how did they put intentions on the environment. Serious price had to pay when the ideals became unrealistic. The transformation in the Haihe River has weakened the river's support to the city, and changed the urban structure that centered on it. The river instead hindered the communication between the two sides. The shift of ports, factories, warehouses and the construction of supporting facilities were all huge burdens on cities in the years of scarcity. A once prosperous trading city, due to the drastic changes in the water environment and the guidance of national policies, had to make a tough turn in the era of planned economy and become an industrial city that lost its port. To some extent, the story of Tianjin and its water that happened in the planned economy era is a sorrow. This kind of thing happened not only in Tianjin, but also in some of the villages and cities in the Haihe River basins, even in other parts of China and the world. Human's desire to tame nature and create an ideal world has become fanatical with the blessing of modern technology. It is one of the reasons for the tragedy. A holistic way of reading cities may help us be more aware of this kind of history and allow us to make more sensible decisions on similar issues in the future.

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Researching and Mapping on Waterfront Industrial Heritage

The Urban Morphology Study of Suzhou Creek, Shanghai

by Yichen Zhu, Zhenyu Li & Jianjian Song

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Keywords: Industrial Heritage, Urban Morphology, HUL Approach, Suzhou Creek, Public Space.

Abstract: Waterfront industrial blocks are severed an essential part of urban morphology. Under the rapid urbanization in Shanghai, the industrial structural transformation along Suzhou Creek has turned many former industrial blocks into urban industrial heritage, which directly influence the urban morphology and further development. How to properly conserve urban heritage and recover the civic nature of public space for the built environment become a key challenge for urban designers. To respond the question, this paper focused especially on the public space of waterfront industrial heritage, based on the analysis of urban morphology and architectural typology. First, the paper would summarize the three key elements of urban morphology transformation of waterfront industrial site: the liner transportation, the warehouse and factory typology, and the residential blocks. Then, the paper would briefly review the four periods of transformation and preservation process of Suzhou Creek area since 1990s. Two typical blocks would be discussed here: the Sihang Warehouse area and M50 creative clusters, which represents two different ways for waterfront industrial area transformation. While applying the Historic Urban Landscape approach, this paper highlights an integrated, dynamic and specific way to mapping the transformation of these waterfront industrial sites, and aims to provide a holistic, dynamic and inter-disciplinary strategy for the conservation and management of industrial heritage, especially for the reconnection between the waterfront and inner city. This paper is subsidized by NSFC project (No. 51678412).

1. Introduction

Waterfront industrial blocks are severed an essential part of urban morphology. A main challenge for post-industrial cities' transformation and redevelopment is how to relink the waterfront to the inner city, from the edge of the terrain to the center of daily activities. As Alex Krieger puts it, "Along the waterfront, it seems possible to accommodate the changing needs of today's urban dwellers, as modern society continues its shift from an industrial-based economy, with its attendant spatial demands, to a service – and lifestyle – based economy, with its own requirements".

Under the rapid urbanization in Shanghai, the industrial structural transformation along Suzhou Creek has turned many former industrial blocks into urban industrial heritage, which directly influence the urban morphology and further development (Figure 1). How to properly conserve urban heritage and recover the civic nature of public space for the built environment become a key challenge for urban designers.

2. Methodology

Cities are the product of a gradual layering process (Bandarin, Francesco, & Ron Van Oers, 2014). Urban form, street patterns, open space, public transit network and buildings that define urban fabrics trace the transformation of these physical layering of heritages, and reflecting the evolution of social context. The paper presents findings from an investigation using map series analysis under the Historic Urban Landscape approach.

First, the paper would point out the three key elements of urban morphology transformation of waterfront industrial site: the liner transportation, the warehouse and factory typology, and the residential blocks. These three elements deeply influenced the evolution of urban waterfront. Then, the paper would briefly review the four periods of transformation and preservation process of Suzhou Creek area since 1990s. The first project is derived from a typical warehouse regeneration, Sihang Warehouse area, as a typical example to show the complexity, restriction and challenge of a giant historic warehouse regeneration in Shanghai. The second project, M50 clusters, explored urban form transformations by layering and comparing historic maps.

3. The Three Key Elements of Waterfront Urban Morphology

The findings traced back on a comparative study of global post-industrial waterfront regeneration. Waterfront, served as port and trade center, combined the functions of transportation, production, and worker's community. These three elements are shaping the morphology of



Figure 1. Urban morphology along Suzhou Creek Shanghai in 2019, from the intersection with Huangpu River to the Mid-ring of Shanghai. (image credit: edit based on Google Map by Yichen ZHU).

waterfront. Warehouse, factories, power houses, shipyard, and other giant buildings served as frontier of waterfront. The huge scale for good storage and manufacture production, making those buildings now a days a barrier standing along the water. While all these industrial heritages facing the challenge between conservation and development, the building typology become a key point to study the reconnection between the waterfront and innercity.

The liner transportation, usually is the railway or road, delivering the raw material, cargo, and commodities between the ship and inner land supplier or tradespeople. Behind that, is usually the residential blocks of worker community. All three sectors functioned as a sandwich spatial structure. In Shanghai, typical example would be Yangshupu Road. Massive communities can be found in the inner side of the road, while huge factories and facilities on the water-side (Figure 2). Another interesting finds is that the spatial structure does survive after all the demotion and reconstruction process of the district.

The unique waterfront spatial patterns bring challenges to the conservation and redevelopment of waterfront areas. The key conflicts are how to active the end edge of waterfront, and how to pass the transportation barrier for reconnection. In North America, the highway built in urban renewal in 1950s aggravated the split between the waterfront and the city. That's why the Big Dig in Boston and Underpass Park in Toronto are so remarkable and enlightenment as efforts of waterfront revitalization.

4. Transformation along Suzhou Creek, Shanghai

Suzhou Creek is one of the important sources of industrial civilization in Shanghai. Due to the convenient water transportation conditions, a large number of modern national industries have been gathered along the route. After Nanjing Treaty in 1843, Suzhou Creek attracted



Figure 2. Urban morphology along Yangshupu Road, Shanghai with a clear Sandwich structure. Left: google history map in May, 2000. Right: google history map in Feb, 2018 (Image credit: edit based on Google Map by Yichen ZHU).

industrial capital from both domestic and foreign interests. The area became home to China's first modern textile mill, flour mill, beer brewery, yarn factory, water treatment plant and power station (Han & Zhang, 2003). By the end of 1950s, there were roughly 1,000 factories with about three million residents living along the Creek (Sheng Zhong & Jian Zhou, 2009). However, with the acceleration of the pace of urban development and the transformations of functions in recent years, the original rich industrial building community and the historical features of the Suzhou Creek are disappearing. The relationship between Suzhou Creek and the industrial buildings along the coast has gradually been separated. The overall texture of the original industrial buildings, the working/living communities and the Suzhou River has been fragmented.

5. Four Phases of Suzhou Creek Transformation

The waterfront industrial heritage protection and adaptive reuse dates back to a comprehensive river cleaning project in 1996, which had turned the creek from black to dark green. Another turning point is the spontaneous arrival of artists and creative workers. Among them, a grain warehouse renovation project lead by Taiwanese architect Deng Kun Yan at 1305 South Suzhou Road in 1998 has won unprecedented attention and success. For the first time, people realize the lackluster space could still sound, and numerous artists, creative workers, painters, sculptures, photographers, graphic designers, architects are attracted to those industrial relics. By the end of 2002, there were over 30 converted art warehouses in the Suzhou Creek area, housing more than 100 studios (Zhong S. & Zhou J. 2009). While the first phase of industrial heritage transformation along Suzhou creek is about single warehouse regeneration, the second phase comes to the redevelopment of industrial campus. Typical example is the M50. Together with 798 in Beijing, M50 represented as a new trend to convert the deserted industrial campus into creative art clusters.

The third phase comes in the new century, while large industrial district meets the urgent need of industrial upgrading. Changfeng Ecological Business Campus in Putong District is the typical example. Transformed from the Changfeng Industrial District, the new campus proposed a concept of "One industrial park, and ten industrial related museums" to keep the memorial of industrial history along Suzhou Creek. The fourth phase is more at an urban design scale to really consider the connection between the inner city and the waterfront. The opportunities come from the merge of Jing'an and Zhabei district, which making the Suzhou Creek as the center of the new Jing'an District instead of the edge of two administrative boundaries. With this new administrative change, however, 12.5 linear kilometers of prime waterfront in the center of Shanghai were now unified. An international competition for redesign the Suzhou Creek in Shanghai was held in 2015, and Sasaki was selected as the winning team.

This paper chooses two typical cases from the first and second phases for discussion.

6. Case Study 1: The Sihang Warehouse Area

From the beginning of the last century to the 1930s, the banks of the Suzhou River gathered Chinese factories and warehouses. The river runs to Jiangsu, Zhejiang and the mainland. Suzhou River can be described as the cradle of Shanghai's modern industry and commerce. It is densely packed with dozens of warehouses, stacks and large and small bank warehouses for



Figure 3. Left: The Sihang Warehouse Area and surrounding context; Right: M50 and surrounding context. (Image credit: edit by Yichen Zhu and Jianjian Song).

storing various types of materials such as coal, bamboo and wood. The river bank is full of stone docking docks.

The Sihang Warehouse (also known as Joint Savings Bank Warehouse) is located on the north bank of Suzhou Creek in Jing'an District (old Zhabei District), adjacent to Tibet Road Bridge in the east. It consists of two adjacent modern warehouse buildings, and famous for the "Sihang Warehouse Defense Battle" in the 1937 Shanghai Battle. Built in 1935, the Sihang Warehouse is adjacent to the Mainland Bank Warehouses. The two warehouses are constructed close to each other and can be connected internally. The height is 5 floors, making full use of the conditions of the base. The central part is the main traffic corridor with spacious and high height. The five-story warehouses on both sides adopt the advanced pillar nets with the same column net at that time. The concrete structure system strives for the maximum net height and improves the space utilization rate with a simple and large depth. The main entrance, pillar top and parapet wall of the south façade have a simplified Art Deco decoration. The exterior wall material is imported from the UK with red bricks and painted on the surface. It is a modern advanced storage building. The total construction area of the two warehouses is about 22,000 square meters.

The building was listed in Shanghai Heritage Architecture in 1994 and was considered as Shanghai Cultural Heritage Protection Unit in 2014. At the same year, the Shanghai Municipal Government decided to implement the warehouse protection and repair, and set up an Anti-Japanese War Memorial Hall and Memorial Square as a patriotic education base. On one hand, the list gives the building a strong legal protection from damage and demolish; but on the other hand, the adaptive-reuse was strictly limited due to the high-level protection rules.

One big challenge for warehouse renovation is the oppression sense caused by the giant solid wall façade, which was necessary for storage function but difficult for waterfront access today. When the architect introduces the original renovation design, the ground and second floor spaces were supposed to have more open access to face and embrace the waterfront, while setting up some hydrophilic platforms on the south, north and east sides, including a multi-functional flexible application roof space, so that the users can enjoy the waterfront landscape. Another plan tries to retreat the first floor of the building, leaving a distance of 3 meters on the original sidewalk to create a hydrophilic activity space that runs through the north and south. A livelier roof space is included in the design proposal, creating a terrace along the water land-



Figure 4. *The Warehouses along Suzhou Creek in 1930s, Sihang Warehouse is the leftist one. (Image credit: based on Map 22, Shanghai Street Directory 1947, edit by Yichen Zhu).*

scape and provide a larger open space, in line with the needs of the office and other functions. However, limited by the requirements of cultural protection units and policy restrictions, the project was renovated with the concept of “protection oriented and rational use”, the solid wall streetscape kept and the roof construction was removed in the later period.

In addition to the War Memorial Hall, the rest of the warehouse was transformed into a creative office and other functions, and fire-fighting performance design was carried out. Fire-fighting facilities, modern equipment and a number of energy-saving measures were added to improve the comfort and safety of the building, meeting new requirements.

7. Case Study 2: The M50 Clusters

Protection and adaptive reuse of industrial heritage have positive impact on the organic process of urban regeneration, cultural inheritance, dynamic innovation and spatial vitality. The M50, which inherits the material space of industrial construction, inherits the intangible culture of industrial construction, carries the innovative development of contemporary art and creative industry, and has experienced a complex and arduous conservation process, which made it a unique case of historic conservation and innovation of industrial heritage.

M50 Art and Creative Park, located at No. 50 Moganshan Road, Shanghai (thus referred to as). The original factory is a factory park composed of several small-scale enterprises such as Shanghai Chunming Worry Factory. The total land area is about 2.84h square meters. It is located in a large sharp corner on the south bank of the Suzhou River, a very unique riverfront location. The structural integrity of the M50 plant still retains the complete industrial buildings from 1938 to 1990s, reflecting the special architectural requirements and the planning of the unique location. From industrial production to industrial heritage, and then to contemporary

art campus, the transformation process has gone through the old industrial era of the first 60 years and the art innovation era of the last 20 years. The choice is both accidental but inevitable.

The redevelopment process is not as simple as factory re-lease. More importantly, it is the cultural power triggered by art to promote the development of a unique innovative industry in M50. Overall, the M50 update process consists of two aspects. On the one hand, it is the bottom-up, the early stage of industrial heritage protection and development promoted by artists, architects, urban planners and designers; on the other hand, it is a top-down, government-led industrial campus transformation, which was supposed to be real estate development but was modified after a serious complex negotiations.

M50 seems to be a successful model of industrial campus transforming to creative clusters. However, taking a HUL approach to check the evolution of the sharp corner in the last 20 years, we'll find the split and the fault throughout the whole district. Real estate development inserted in the site, and large warehouses in the west of M50 has been transformed to furniture market and parking lot. The north of M50 will be a new landmark 1000 Trees designed by Heatherwick. Looks like it has a numerous potential for diversity, but the original context is totally broken, and the access and connection between the inner city and waterfront is really poor.

8. Conclusion

The paper briefly reviews the four periods of transformation and preservation process of Suzhou Creek area since 1990s. The Sihang Warehouse area and M50 creative clusters, which represents two different ways for waterfront industrial area transformation has been discussed here. At the architectural level, The Sihang Warehouse's historical value has been retained, but the public space of the riverfront interface has been lost because of the strict protection regulation of cultural relics; at the level of the block, there is a lack of response to the industrial

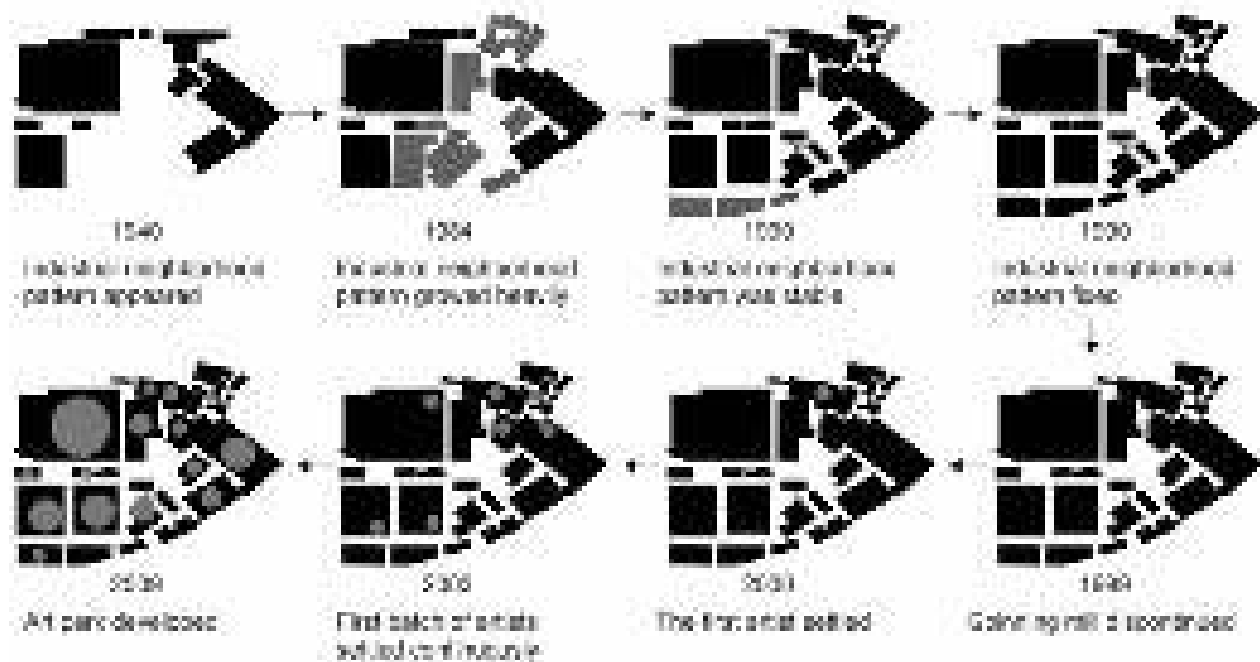


Figure 5. Infusion process of artistic vitality into neighbourhood. (Image credit: edit based on Reference (7) by Yichen Zhu and Jianjian Song).

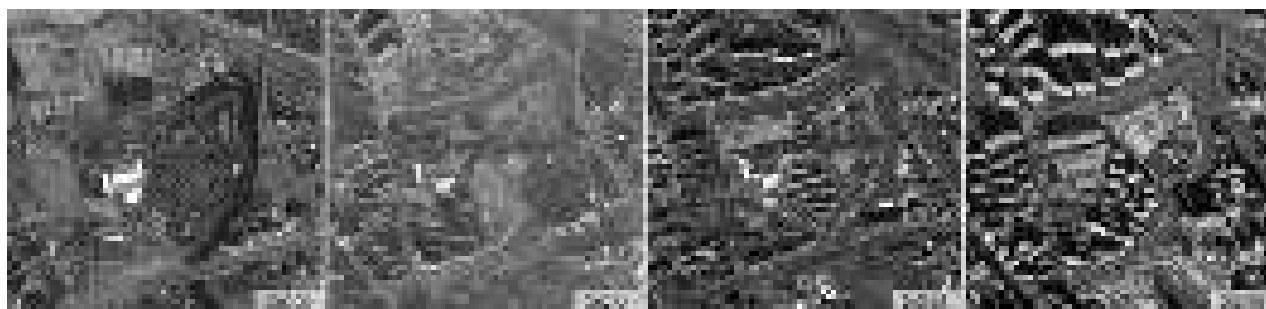


Figure 6. Google maps of different periods of the M50 and surrounding area (image credit: edit based on Google Map by Yichen ZHU).

heritage corridor along the waterfront. Meanwhile, the renewal of the M50 campus itself is full of vitality and multi-dimensional interaction, however the industrial transformation and the protection of industrial heritage lack overall coordination, and the waterfront area lacks connection with the life of the city center, in account of the entire area.

By analysis the redevelopment process along Suzhou Creek industrial heritage, the paper highlights a more integrated, dynamic and specific way to mapping the transformation of these waterfront industrial sites, and a holistic, dynamic and inter-disciplinary strategy need to be further discussed for the conservation and management of industrial heritage, especially for the reconnection between the waterfront and inner city.

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Focus: Mediterranean Port Cities in a Global Context

Comparative Analysis of Public Space Among Mediterranean Port Cities Utilizing Remote Sensing and Street View

Valencia And Genova As Study Cases

by Run He & Meiqin Che

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Keywords: Port Cities, Public Space, Remote Sensing Imagery, Street View Imagery, Urban Typology.

Abstract: Under the global theme of sustainable and resilient cities, new thinking about the development and design of Mediterranean port cities are expected. This paper shall discuss urban public space, especially the open space that determines the intrinsic characteristics of urban imagery, vitality and attraction. Valencia and Genova are selected and analyzed comparatively employing remote sensing satellite and street imagery. Firstly, urban physical form and spatial structure elements including public space, street-system, building blocks are extracted as analysis objects. Thus the analysis focuses on overall functional partition and transportation network, exploring the functional and spatial interrelation between port and city. Then extracted public spaces (landscape, theme parks, plazas, etc.) are analytically investigated with intra-urban networks and urban fabric. After the analytical and interpretive comparison under the theory of urban typology and scene perception, the results indicate that the public spaces enhance activity patterns of civil life and strengthen cities' identity. Whereas Valencia owns a higher level of vitality, the reasons owe to the following aspects:

- Multiple urban plan morphology, spatial profile, spatial interface, and spatial organization mode with strong accessibility;
- Diversified and people-oriented public space stimulates social and commercial activities;
- Local-famous buildings play the role of 'Catalysts', activating the city with creativity and resilience.

In conclusion, this paper strongly emphasizes the importance of the effective and rationalized organization of the public space in port cities. This comparative analysis of Mediterranean cities of Valencia and Genova can inspire the future urban design of port cities in a global context.

1. Introduction

1.1. *Port cities and development trends of sustainability and resilience*

Port cities play an important role in the development of social and economic development of the country from history to the present day. Port and city should be considered as a complex adaptive system (Gell-Mann, 1994). As hubs for import and export of materials, the port areas

drive regional investment and territorial development effectively, but also play decisive role in the urban development (Hoyle, 1989; Ducruet, 2007). Port activities have effect on the spatial differentiation and spatial structure of urban areas, as well as economic and social structure (Gleave, 1997; Yang, Zong, 2008; Meyer, 1999). A good relationship between port area and urban area should be a whole network, which incorporates differences and turns them into complementarity, then improve the dynamic of both areas (Debie, Raimbault, 2016; Hayuth, 1989). Thus this kind of particularity of port city leads to more attention on its relationship between port area and urban area from the current view of sustainability and resilience.

As the human activity node between terrestrial and marine ecosystems, port cities face great challenge to seek the equilibrium among the greatly complex subsystems than other type of cities (e.g. economic, environmental and so-cial system and like that) under the trend of globalization of trade and climate change. The calling for sustainable and resilient development is the acknowledged solution to this point. This kind of evaluation to waterfront or port revitalization has been considered as urban development strategy for the government agent of urban planning (Girard, 2010; Schipper *et al.*, 2017), which are in harmony with the ecosystem and are robust or adaptable under climate change. More concerned issues are to related to waterfront and port reform, as to trade off the impact between port area and urban area (Hoyle, 1989; Debie, Raimbault, 2016). However, globalization view of port city development is unfortunately and narrowly focused on trade and international transportation of port, which bring environmental and economic challenges to be integrated as urban area. Actually, this kind of port-view thinking restrict urban development into a limited view of the port economic mode. More attention shall be attracted to the redevelopment operation of city itself on port and waterfront. For instance, not only international trade, globalization actuate international tourism as an environment-friendly and economically-enhancing industry to sustainable development of city (Dwyer, 2015; Yudina *et al.*, 2016). Which shall be a promising strategy for urban revitalization, especially port city of diverse nature resource. In this paper, we pay more attention to urban open space design and its impact on livability, attraction and entertainment for residents and travelers.

1.2. *Urban public space and the its particularity for port city*

Scholars defined Urban public space from its space design, functions and social behaviours. Urban public space refers to the open collective space in between solid buildings. Public space is the space we share with strangers, people who are not our relatives, friends, or work associates (Walzer, 1986). It is the public space where citizens or tourists can develop various of activities for daily life or social communication needs, which contributes to improve leisure and quality of civil life (Lloyd, Auld, 2003). As Montgomery pointed out, "It is the public realm and associated semi-public spaces which provide the terrain for social interaction and a significant part of a city's transaction base, for example, the market square, the street vendor, the shop frontage and the sidewalk café". (Montgomery, 1997). In general, the characteristics of urban public space are opening, gathering and communicating. Urban public space is the essence of the real environment, the carrier of multi-cultural events and the source of unique charm of urban area. Under the circumstance of rapid development in cities, the public space plays a decisive role in political, social and cultural contexts. People rely on the public space for meeting, travelling, shopping, playing or relaxing. And the quality of public space construction directly affects the city's comprehensive competitiveness and public satisfaction. In modern urban planning, public space design have become a focus for sociologists, political scientists,

and architects, urban planners (Koohsari *et al.*, 2015; Girling, Helphand, 1996). Rob Krier, an influential urban planner and architect of the post modernism. He explained the designed urban space and the corresponding structures in the terms of topological and morphological elements, which impacts on the quality and relationship to urban activities (Krier, Rowe, 1979). Jan Gehl, who makes great contribution to the study of improving the quality of urban life, examines the relationship between patterns of space use, especially outdoor activities, and the spatial properties of the physical environment. Starting from the point of human dimension for his analysis, he measures the success of urban environment, by qualifying the levels of pedestrian flows, levels and length of stationary activity, including human contact and social interaction (Gehl, 2011). Good public space creates a platform for engagement and discussion, for planned and spontaneous encounters, and for learning of diverse attitudes and beliefs (Mehta, 2007). And there is also a growing belief that in modern societies and urban planning, good public space is required for the social and both physiological and psychological health (Mehta, 2014; Koohsari *et al.*, 2015; Wolch *et al.*, 2014). At the same time, responsible and meaningful public space can foster public life also as a means of alleviating urban malaise, so that to enhance the cities' vitality. According to the study of senior researches on urban public space, the essential qualities of high-quality public spaces of squares, parks, plazas, and waterfronts can be concluded as accessibility, inclusiveness, and pleasantness.

- Accessibility: easy and convenient access is the basic key element for increasing opportunities for people to participate in collective activities, because people plays the decisive role in the practical use of space. Accessibility also related to the terms of 'closed' or 'open'.
- Inclusiveness: it is also referred to flexibility, successful urban public space is an attractive platform, which provide a stage for people from different cultural groups to develop abundant kinds of activities. As these experiences are repeated, public space becomes a vessel to carry positive communal meanings.
- Pleasantness: high-quality public space is first reflected in the friendly scale, which plays an important role in creating a people-oriented environment. The quality is also reflected in the accessible landscape, ground covering materials, green plants (especially for sun shading), and the configuration of public service facilities. In a good public space, people feel comfortable and a sense of belonging.

To port city, the more concerned are about "blue space" redevelopment that is the most important advantage and complicated system for seaside cities. The waterfront reform and development is challenging and more controversial, involving community attitudes and environmental sensitivities, and influences transport evolution and urban change (Brand, 2007; Hoyle, 2000; Hoyle, 1999). However, successfully waterfront revitalization contributes greatly to urban "tourism planning" and enhances image of city (Gunn, 1977; Kostopoulou, 2013).

In this paper, we aim at analyzing the particularity of the urban public space to city image improvement and quality of urban life. Two Mediterranean port cities are compared to highlight the problematic relationship and redevelopment of space design. we collected data from GIS (Geographic information system) source and satellite imagery to compare the urban structures and relationship between port and urban area. More detailed investigation focused on space design with path analysis to understand the elements' organic combination and human behaviours. At last we pointed out the problematic space and proposed some suggestions for urban redevelopments.

2. Surveyed areas

The ports of Italy and Spain are important maritime transport nodes in the Mediterranean and an important channel for Mediterranean maritime trade. Valencia of Spain and Genova of Italy are selected as representative study cases and analyzed them comparatively under the theme of urban public spaces, which decide the vitality and attraction of the cities, applying the method of remote sensing satellite and street imagery.

2.1. *Genova*

Genova, located on the Gulf of Genoa in the Ligurian Sea, is the capital city of the Liguria Region. As the southern corner of the Milan-Turin-Genova industrial triangle of Northwest Italy, Genova has historically been one of the most important ports on the Mediterranean, it is currently one of the busiest ports in the Mediterranean Sea and twelfth-busiest in the European Union. The Genova city grows between the Ligurian Sea and the Apennine Mountains, which stretches transversally about 30 kilometers along the coast. The territory of Genoa is divided into five main zones: the center, the west, the east, the Polcevera and the Bisagno Valley (Wikipedia contributors, 2019). (The city of Genoa is subdivided into nine administrative districts officially).

The analysis of urban public space in this paper is target on its central area, including the historical center which was inscribed on the World Heritage List (UNESCO), especially aims at the old port area named Porto Antico. The old Porto Antico was under renewal plan in the 1990s. A thick barrier of offices and warehouses had been built in the 1800s, in addition the cement ribbon of viaduct highway was built in 1965, resulting in an insurmountable crack between the urban area and the port. In order to heal the separation, a series of plans were put forward. The Italian architect Renzo Piano made great contribution to this regeneration process, he put forward the importance of connecting historical center and the port area, also included a longer-term urban renewal plan, intended to return the area to the citizens of Genoa for them to enjoy. The plan has greatly enhanced the attractiveness of the city and injected new vitality into the old port and the whole city.

2.2. *Valencia*

On the east coast of Spain situated the third largest metropolitan city, Valencia, which is the capital city of the autonomous community. The port of Valencia is the fifth busiest container port in Europe and one of the busiest ports on the Mediterranean Sea, handling 20% of Spain's exports. The city of Valencia stands on the banks of the Turia River, located on the eastern coast of the Iberian Peninsula and the western part of the Mediterranean Sea (Wikipedia contributors, 2019).

The analysis of the public space in Valencia targets on the area centered in the historic center, which possesses ancient monuments and cultural attractions. Extended to X kilometers that include the attractive green belt passes through the city. Starting from middle 1990s, Valencia transformed from an industrial center to a newly cultural and economic center, and a charming tourism destination. A lot of historic landmarks were restored and renovated, at the same time, a series of open public space were arisen. The most influential one is the Turia Gardens. After severe flooding occurred in 1957, the Turia River was diverted in the 1960s (Plan Sur

de Valencia), and the old and dry river bed has been turned into a central green belt that allows cyclists and pedestrians to travel the city without the conflict with automobiles. During this path appears parks, art works, ponds, football pitches, and children's playground. Towards the eastern end lies the City of Arts and Sciences, which contains an opera house, a science museum, and an IMAX cinema, and a raised, axial walkway. This challenging architectural ensemble by Santiago Calatrava brings new focus to this previously incoherent and underdeveloped area, while linking the center city and the sea. With beautiful natural seascape, avant-garde modern architecture, and colorful open public spaces, Valencia now is a city with global mega events and cultural festivals. The city is highly dynamic and attractive.

3. Methodology

Rob Krier, known as one of the most influential urban planners and architects of the post modernism. In his book "Urban Space", he analyzed the typological and morphological elements of urban space, and he considered square and streets as basic elements of urban spaces. "In all probability the square was the first way man discovered of using urban space. It is produced by the grouping of houses around an open space. This arrangement afforded a high degree of control of the inner space, as well as facilitating a ready defense against external aggression by minimizing the external aggression by liable to attack" (Krier, Rowe, 1979). He also has considered three basic geometric shapes: square, circle, and triangle, these shapes are effected by angling, segmentation, addition, merging, overlapping or amalgamation of elements; and distortion (Krier, Rowe, 1979). This paper limits the research and observation of public open space to the study of urban squares which generate public use and active social communication to the greatest extent. The functions of squares lie in commercial activities, but above all is the activity of culture nature, such as administrative, church, activity center, leisure-oriented plazas, and children's play squares.

3.1. Remote Sensing and Spatial Statistical Analysis with GIS

Most space information can be interpreted and collected from WebMap like OpenStreetMap. However, the update of the information depends on the contribution of volunteer works and the information is almost delayed. therefore, we proposed to use Remote Sensing (RS) tool to update the all the located space and the corresponding information. The development of Earth Observing System greatly impulsed a new and promising view of urban planing and urban design. The overlooking from satellites brings us a macroscopic, integrated systemic perception of the urban structure and the organization of urban space. In this paper, Google high resolution satellite images are employed to extract and update the public open space elements, urban buildings and transport networks *et al.* To compare the urban location and natural property of Valencia and Genova, we start at using SRTM terrain data to retrieve the 3D model of both cities and visualize though the hillshade as a grayscale 3D representation of the surface, which take the sun's relative position into account for shading the image. Spatial statistic is applied to the describe urban elements in terms of total number, area, shapes, type of plan, functions, accessibility, green plants distribution, and availability of service facilities in two cities. Based on the statistic analysis and element description for each city, it would indicate more definite relationship:

- between port area and urban area (port and waterfront development),
- between transport networks and open space (the accessibility to public open space), among open space elements (the spatial continuity of open space elements),
- perception through Street Views and Field Survey.

Surveying and observing pedestrians, travels and residents, the Street Views provide a convenience and convinced manner to observe and describe human behaviours adapted to public space without enormous workload. The Google street views are implemented in human perspective, thus leading a vivid perception on plane composition, perceptive scale or volume of space and enclosure of surrounding buildings. In the open space, similarly, field investigation and observation on the human activities is necessary to valid the efficiency of the open space and reflect the interaction between human behaviour and space in a dynamic way rather than the static.

3.2. *Selected Path Analysis*

Joint with field investigation Street Views, more detailed analysis of public space focus on a selected path in both cities separately, particularly considering the historical elements and modern development elements. In the city of Genova, the old town area owns a series of streets and buildings that were included in UNESCO World Heritage Site List. Thus the selected path starts from the train station with a front square named Principle Square, where visitors always arrived in; then the path go through the three historical streets (Street Balbi, Street Cairoli, and Street Garibadi); after that the path reaches the historical center plaza, Ferrari Square; then it will arrive at the old port area named Port Antigco, which has been regenerated in 1990s; finally, walking along the waterfront area, the destination will be the Galata Sea Museum. In the city of Valencia, the selected path starts from the center train station, then there will be the City Hall Square; thus the path will go across the ancient town area with meeting several open squares, such as the Virgin Square; then the path heading to the core green belt; walking along the green areas with various public space, including parks, fountains, playgrounds, children advantage park, and then arrives at the landmark building group, the Science and Art Center. Finally the path ends with the natural beach called the Cabanyal Beach.

4. Results

4.1. *Comparison of Urban structural relationship and the spatial continuity of open spaces*

According to the 3D model in figure 1, the mountainous terrain of Genova determines the challenging configuration of urban elements, particularly restricts the transportation efficiency. This intrinsic natural property causes the result of the higher density of buildings and road networks, leading the low ratio of public spaces. Whereas Valencia expands with no terrain barriers and has a relatively moderate urban building density and simultaneously confirms the spatial continuity of a lot of open space configuration. Besides, there exists a problematic relationship and interaction between coastline and urban system of Genova. The externality effect of port and the corresponding transport split the waterfront of old port and urban area. In figure 2a, the red line is the composite viaduct, railway and urban traffic. Even though the redevelopment of old port is implemented by government of the Genova, the revitalization is

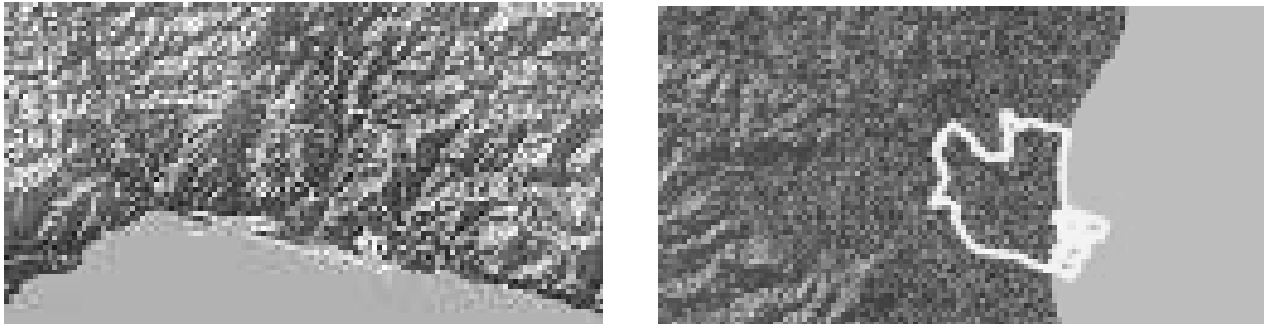


Figure 1. Urban terrain visualization in 3D model with DEM hillshade (a. The urban terrain of Genova; b. The urban terrain of Valencia).

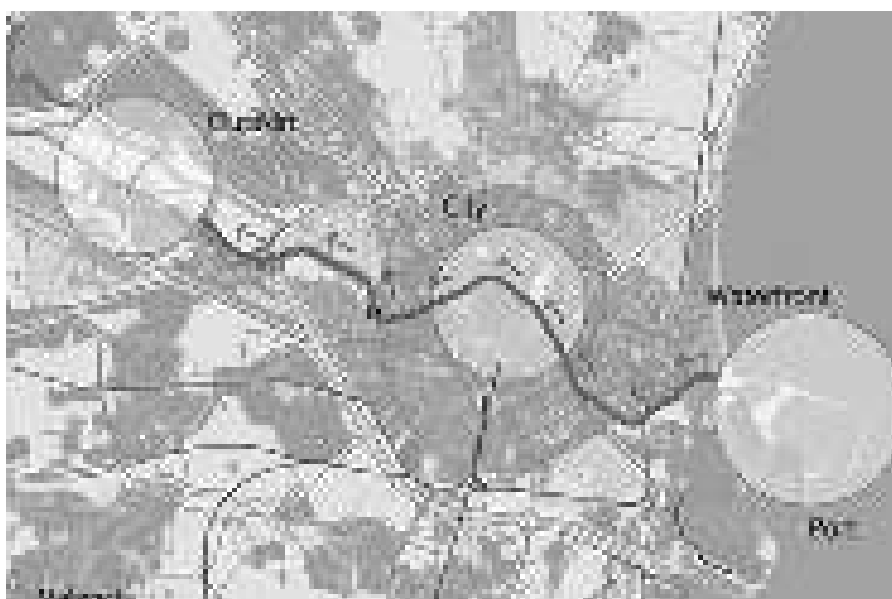
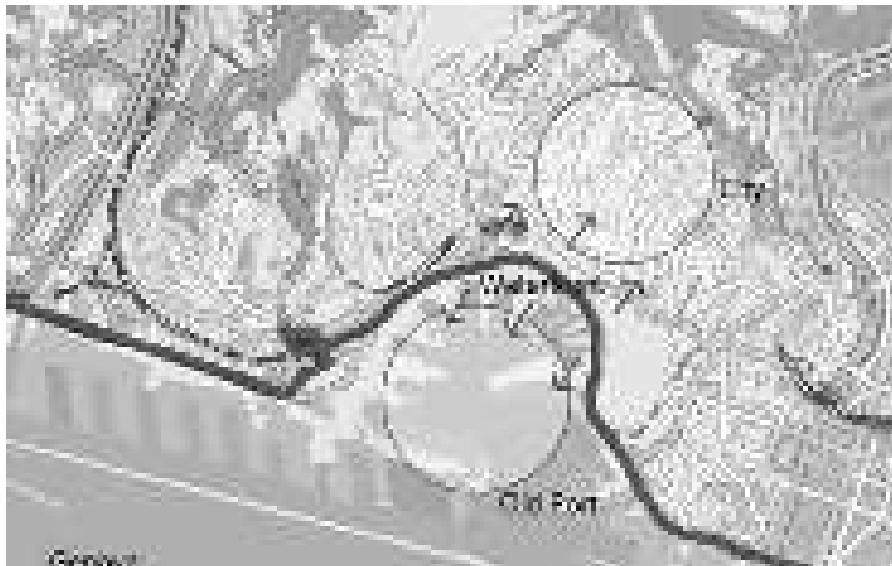


Figure 2. The relationship of public open waterfront, port and urban area (a. The relationship of public open waterfront, port in Genova and the urban area splitted by its transport; b. The relationship of public open waterfront, port in Valencia and the urban area).

not successful. Simultaneously, the chain of the open space starts from the center square is interrupted. During the city development processing, the natural relationship between the port area and the city has been broken by a progressive construction of physical barriers, from the warehouses that had been built in the 1800s, to the tough pylons holding up the cement ribbon highway which was built in the year of 1965, left the insurmountable gap between the city and the sea. Thanks to the regeneration project for the old Port Antico by Italian architect Renzo Piano, a series of plans to renovate several historic port buildings and build new structures, greatly enhanced the vitality of the port area. In Valencia, the dry river bed has been turned into a green belt with a series of various public spaces, the green belt connects the port area and the city effectively, greatly improved the space quality of the city. The Green space, the green line in figure 2b, relates to beach space, which is the most popular waterfront in Valencia. The waterfront transport line blocks the beautiful seascape. The natural relationship between port and city had, over time, been broken by the build-up of physical barriers. Furthermore, Valencia shows a lower density of buildings and road system, with much more green space and open public squares. Contrary to the insurmountable rift in Genova, a green belt with a series of open public space goes through the city, connecting the port and city effectively. The relationship between the port and city is close.



Figure 3. *Extracted public open spaces and selected path in purple (a. The spatial configuration of public open space in Genova and the purple selected path; b. The spatial configuration of public open space in Valencia and the purple selected path).*

All extracted public open spaces in both cities using the Remote Sensing and GIS are given in figure 3a and 3b, then we count the total number of the public space in both Genova and Valencia. In the center area of Genova, there are about 68 public space, including historical squares, open parks and waterfront plazas. In the city of Valencia, there are about 130 public space with both historical and modern ones.

4.2. Path analysis with Street Views and field investigation

The figure 4 lists the table 1 of each open space from train station to old port in Genova. From the selected path and the public space in which it is connected in series, the public space in the historical area of Genoa has good continuity, but some of the squares are greatly affected by traffic, especially the waterfront public space, by motor vehicles, Non-motorized parking takes up a large area, which greatly affects people's visual and spatial feelings. Due to the limited scale and less types of public space, the usage of the space is low with limited activities.

Table 1. The investigation of public open space along the selected path in Genova.

N	Name	Identity	Plan	Enclosure	Scale	Facility	Plants	Activities
1	Street Balbi	Historical street in the city center	Linear with 400m	On both sides are mostly 4-7 stores high	7m width	Commercial, museum, university, ancient palace	No space for plants	Walking, resting, cycling, bargaining, talking
2	Street Cairoli	Historical street in the city center	Linear with 180m	On both sides are mostly 3-7 stores high	8m width	Mainly Commercial, Library, small square	No space for plants	Walking, resting, cycling, bargaining, talking
3	Street Garibaldi	Historical street famous for ancient palaces	Linear with 250m	On both sides are mostly 4-5 stores high	7.5m width	Museum, palace, administrative offices, chamber	Palace gardens	Walking, visiting, communicating
4	Nerro's House	Historical integral park in hillside fields	Square	Roads on four sides	120m*110m	Museum, seats, viewing pavilion	Plenty plants and waterfall	Resting, Viewing, exercising
5	Park of Acquasola	Regeneration of a historical area	Rectangle	Roads on four sides	200m*90m	Children's playground, seats, fountain, entertainment facilities	Large amount of plants	Walking, cycling, playing, resting, talking
6	Ferrari Square	Historical and main square	Square	Historical buildings	75m*75m	Gallery, museum, theater, palace, offices, fountain	No plants but water scape	Resting, talking, gathering, important events
7	Feste Square	Old port renewal, waterfront square	Irregular shape	Buildings with 3-4 stores, water, viaduct	300m length, 25m width	Bingo structure, Embriaco Bridge, seats, Aquarium, commercial	A small amount of trees	Waking, resting, viewing, big events
8	Neptune Boat	Waterfront space with iconic boat	Irregular shape	Parking square, viaduct, main road	150m length, 30m width	Floating museum, parking,	A small amount of trees	Waling, visiting
9	Galata Sea Museum	Waterfront space for leisure	Linear along the water	Viaduct, main road	200m lenth, 8m width	Wooden paving, seats, commercial, museum	A small amount of trees	Resting, walking, talking, viewing

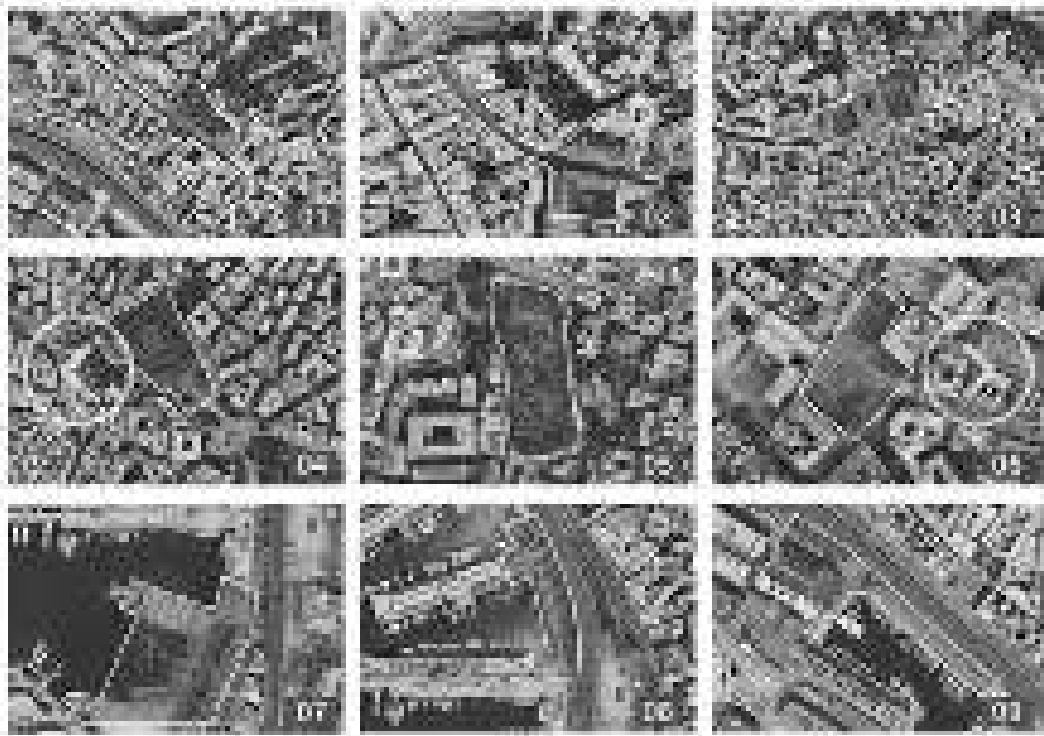


Figure 4. *The open space of selected path in Genova.*

As shown in figure 5 and table 2, the continuity of the public space, from the historic city to the modern linear park, is very strong. The linear green public space is unique for the fact that each section can be seen as a high-quality activity space. This makes it a perfect place to develop various activities, such as running, cycling, yoga, slacklining, sightseeing, viewing, skateboarding, playgrounds for children and more. So the usage ratio of the space is high, which enhance the city's vitality.

The city of Genova and Valencia have some similarities, both of them have a long-standing and splendid history. In the process of modern urban development, they have experienced the process of urban renewal. Genoa has transformed the old port area, and Valencia has transformed the old river bed. One of the development goals of the two cities is to create an attractive city of tourism. At present, both cities have certain attractiveness, and there is a certain gap in urban vitality. Valencia owns a higher level of vitality. it is the ideal choice for holding international events especially. Based on the above analysis, the part will summarize the reasons for the gap between the two cities' development and vitality.

- Different topography. Genoa's geographical location lies between the Ligurian Strait and the Apennines and runs along the coastline, thus determining its special mountainous terrain. This kind of topography with a high degree of difference poses a great challenge to the construction of the city. Due to the limitations of the terrain, Genoa's building density is also relatively high, and the compact architectural layout also limits the realization of public space. However, the topography of Valencia is mostly flat, in the plain area, and the development of the city gradually expands to the periphery with the old city as the core. Its overall building density is moderate, and it incorporates a wide variety of public spaces.
- Different urban structure. The city of Genova is developed along the coastline and the horizontal line of the mountain. The distribution of its public space is relatively frag-

Table 2. *The investigation of public open space along the selected path in Valencia.*

N	Name	Identity	Plan	Enclosure	Scale	Facility	Plants	Activities
1	City Hall Square	Historical square in old town	Triangle shape, two parts	Roads on three sides	180m length, 70m width	City hall, sculpture, fountain, seats, commercial	A small amount of trees	Resting, bargaining, talking
2	Queen's Square	Historical square in ancient city center	Rectangular shape	Historical buildings with 5-6 floors	150m length, 43m width	Valencia Cathedral, commercial parking, fountain	Some trees for shading	Gathering, resting, bargaining, talking,
3	Virgin Square	Historical square in ancient city center	Rectangular shape	Basilica, historical buildings with 3 or 7 stores.	50m length, 35m width	Valencia Cathedral, Basilica, commercial, fountain, seats	A green park besides the square.	Gathering, walking, resting, reading, talking, important events
4	Sea Bridge Square	Transforming of dry river bed	Rectangular shape	Roads and bridges, plants	360m length, 170m width	Pools, seats, pavilion, Fitness equipment	Plenty and various plants	Gathering, walking, resting, jogging, cycling, roller, exercising
5	Music Plaza	Transforming of dry river with modern architecture	Rectangular, symmetrical strictly	Roads and bridges, plants	500m length, 170m width	Pools, seats, pavilion,	Plenty and various plants	Gathering, Band show, walking, resting, jogging, cycling, skating, exercising
6	Gulliver Adventure Park	Transforming of dry river bed	Rectangular, two parts	Roads and bridges, plants	390m length, 170m width	Children playgrounds, slides, tower, rails, curved walls.	Plenty trees around the playground	Playing, sliding, climbing, skateboarding, resting, jogging, cycling
7	City of Arts and Sciences	Cultural complex with innovative architecture	Rectangular shape	Roads and bridges, green garden	500m length, 200m width	Shallow pools, Opera house, cinema, science museum, plants corridor	A small amount of trees, a green garden nearby	Gathering, walking, resting, jogging, cycling, boating, visiting
8	Vele de Vent	Modern and innovative architecture	Curved along water	Roads, water, green garden.	300m length, 120m width	Event center, fitness equipment, commercial	A green garden nearby	Gathering, talking, sailing training, viewing, resting
9	Cabanyal Beach	Natural beach area	Linear along the sea	Sea, roads	2.3km length	medical center, lifeguards, sun lounge showers, commercial	Liner green belts	Jogging, cycling, resting, enjoying sunshine, exercising

mented. It is not very orderly and lacks continuity. At the same time, it lacks large public space, and part of the port is used for ground parking lots. Rather than creating a fun space for citizen activities. The most important point is that many warehouses and buildings on the water's shore in the 19th century obscured the beautiful scenery of the port, and the elevated road built in 1965 severely separated the city from the port. Instead, Valencia effectively used the dry riverbed to create a series of public spaces for different functions, thus forming a continuous core public space system.

- Rich spatial types. The activities carried out by people represent the vitality of a city. A wide variety of public spaces means a rich variety of activities that give people more choices. Valencia has more types of public spaces, an adventure park for children to play, a skate park for young people, a public fitness area for all kinds of fitness equipment, run-

ning paths, riding paths, with ample kinds of plants and people-oriented scale. The scale can meet the needs of people of different ages to carry out a variety of activities.

- Iconic architecture. Important and unique architecture plays a role of catalytic in enhancing the attractiveness of the city: the significance of a building to a city can be a landmark or an imprint of a city. In the old port area of Genoa, a series of installations designed by Renzo Piano have played a significant role in improving the quality of the public spaces. The Valencia City of Science and Art, created by Calatrava, has a unique structure and shape, and a rich event space attracts people from all over the world to appreciate it.

5. Conclusions and Discussions

This paper comparatively and systematically analyzed two Mediterranean port cities, Genova and Valencia, combining the current prevailing technology (Remote sensing, GIS statistics and Street Views) to reveal the intrinsic relationship and controversial configuration of public open space and other urban space planning. From the prospective of urban design, we investigate the public open space (avenues, squares, parks and waterfronts *et al.*) in the sight of space participants (pedestrians, residents, and travelers *et al.*). The perception of participants' vision in human-adaptive scale on surrounding space and elements directly indicates the actual design utility, which would improve urban imagery and increase vitality and attraction of city if the participants' feeling is more comfortable. The selected survey areas differentiate on geographic, historic and economic backgrounds, but the problematic urban design limits Genova's developments and construction of city imagery. For instance, the event of Genoa bridge collapse and the fact of decreasing population are problematic and reflective. Conversely, Valencia is the

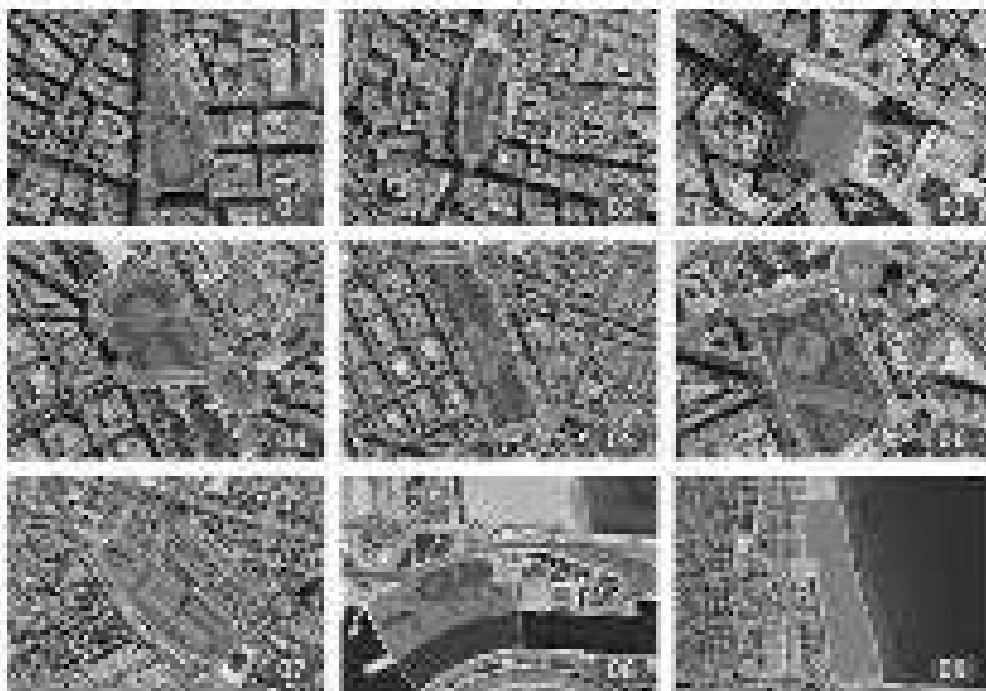


Figure 5. The open space of selected path in Valencia.

most attractive city that a considerable number of international conferences take place every year. More details are generalized as follows:

- The mountainous terrain of Genova restricts the transportation efficiency and spatially split the continuity of urban open space, which starts from station, by pass commercial pedestrian streets, squares and green space, ends at waterfront. The fact, however, the high and low levels of the building blocks, have great potential to develop seaview, enhancing the connection between coastline and inner urban area.
- Detailed analysis of public space focus on a selected path in Genova and Valencia separately. In each city, a path with nine important public space was extracted, from the historical center to the modern district, and reaches to the port area. Based on the theory of Jan Gehl, who measures the success of urban environment by qualifying the richness of activities, including human contact and social interaction. According to the field survey on both cities in the means of observations and recording human behaviors in the public space, space usage and human activities reflect the vitality and attractiveness of the city.

In general, the results indicate that the public spaces enhance activity patterns of civil life and strengthen cities' identity. But it still has a shortcoming, because the evaluation of the vitality of public space is only based on records and intuitionistic perception, mostly from visual feeling, but lacks quantitative statistical analysis and entranced survey.

5.1. Exploring the Possibility of Urban Renewal in Genova

In Genova, it is of the utmost importance to heal the fractures separating between the city and its harbor, from the thick barrier of offices and warehouse, to the lift pylons cement ribbon of



Figure 6. The high line park redevelopment for old port waterfront.

the high way, which forms a physical and visual barrier over the lively Genova waterfront. Considering about the lifted high way, the future design can take inspiration from the High Line Park of New York, which was built between 2006 and 2014 on a 1.2-mile long but abandoned elevated railway. This meaningful project transforms the negative fracture into a new lively public open space, with linear green space and leisure space, providing a new way of viewing the city, a connector to separated neighborhoods, and a distinctive asset to the city. A similar case that situated in South Korea is the regeneration project of 'Seoul Skygarden' designed by MVRDV (Netherlands). It is an abandoned railway transformation next to Seoul Central Station. The 17-metre high structure of the overpass becomes a unique public space nowadays, thanks to the ambition of making this place as green as possible, while introducing new leisure functions with adaptable approach. These extensions can inspire further additions to the area's greenery and public spaces as shown in figure 6. These successful cases can inspire further additions to the Genova's new greenery and public spaces creation. In the re-imagination of this high way as a unique opportunity, the green linear park will be transformed the concrete ribbon into an exceptional public open space.

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From Hospitality to Urban Conflict

Morphologies in Transformation in Mediterranean Ports

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Keywords: City-port, Morphology, Identity, Space Regeneration, Social Inclusion.

Abstract: Port is a complex non-place to analyze, it narrates the history of the Mediterranean, expresses the ethos of its populations, their deep sense of hospitality. Often the port coincides with the foundational nucleus or with the city gate, the economic pole, the favorite place for meetings and comparison. However, it also represents a limit, a closed perimeter that excludes the gaze and the presence of the citizen. Thus, the port is conceived only as an operational area, takes on typical forms that are difficult to integrate into the urban fabric, and can soon become an abandoned area, often in decline. The increasing migratory flows make the waterfront a very topical subject for social and design disciplines: issues of segregation and coexistence are associated with problems related to the use of public space. The aim of the research is to understand the mutual interactions between city and port, the morphological dynamics that have transformed the landscape into a territory, the role of design as a vehicle for spatial regeneration and social integration. With an integrated approach between morphology and design experimentation, applied for now only to the case of the city of Messina, the work aims to reconstruct the evolution of historic ports in the Mediterranean, recognizing the port heritage and enhancing it with inclusion strategies. Regenerating the city from the waterfront means rediscovering spaces and habits, expanding economic and cultural horizons, creating new community identity.

1. Introduction

The Mediterranean is considered the cradle of Western civilisation; hence myths, peoples, and cultures have influenced and inspired societies all over the world. For millennia, the sea has been holding lands and stories of different men together in the unitary sign of common identity (*koinè*). The main Mediterranean cities wind along the continuous line of its coasts, in correspondence with the focal points of the ancient trade routes. The common topographical and climatic conditions have favored the diffusion of similar settlement models that confirm the central role played by the port in the respective phases of foundation, historical or legendary. The seaside cities have a strong identity based on the union of the two urban and maritime cultures, but they are also heterogeneous organisms in which the continuous transformation of the natural and anthropic environment is more evident: they are based on a changing entity like the port, a place of transition par excellence, and contrast it with the historic center, a symbol of permanence and stability.

The port is a complex non-place to analyze. It is a heterotopia suspended between concrete space and allegory. It tells the history of the Mediterranean, expresses the ethos of its population, their deep sense of hospitality. Often the port coincides with the foundational nucleus or with the city gate, the economic pole, the favorite place for meeting and comparison. But it can also represent a limit, a closed perimeter that excludes the gaze and the presence of the citizen. Thus, the port is conceived only as an operational area, takes on typical forms that are difficult to integrate into the urban fabric, and can soon become an area of its own.

Port cities represent a highly topical interdisciplinary theme. On the economic-political level, their impact on the international market is fundamental, with 90% of the commercial volumes taking place by the sea. On a social level, while on the one hand the globalizing needs confirm the historical role of the Mediterranean in terms of mobility and interchange, on the other, the pressing waves of migration make it a scenario of violation of human rights and often death. On the urban level, the evolution of structures, forms and functions testify to the transition from a historical colony to a contemporary city, with very different morphological outcomes. In environmental terms, increasingly restrictive sustainability requires interventions to protect the landscape, recovery of infrastructures and enhancement of the waterfront, in which the problems of civil coexistence are associated with the management of public space. Furthermore, the relevance of the topic is confirmed in the response to Horizon2020 social challenges (inclusion, security, innovation) and in achieving the Millennium Development Goals (MDG 7th and 8th).

In an attempt to give an answer, even partial, to the questions raised, the research aims to investigate what the role and value of a Mediterranean port city like Messina is today to understand:

- mutual interactions between city and port according to their contemporary evolution;
- morphological dynamics that have transformed the territory, conforming parts of the city and influencing urban behavior and lifestyles;
- task of design as a vehicle for spatial regeneration and social integration, in the name of new models of sustainability and intercultural cohesion.

1.1. *The State of the art*

The difficulty in dealing with Mediterranean ports is already revealed in the complex of definitions of the port city or in the multiplicity of its definitions (Alemany and Bruttomesso, 2011): from the gateway city (Burghardt, 1971) we pass to the hinterland/port/mainland triptych (Vigarié, 1979), from the commercial city that is identified with the port (Dogan, 1988) to the global city where the port is only its most futuristic zone (Sassen, 1991). Ports and coastal areas are today at the center of a renewed historiographical and urban debate aimed at defining the future of the great cities of Europe through systematic investigations on the built environment (Hoyle and Pinder, 1992). Since the second half of the last century, many theories have been formulated on the interaction between port and city, such as that of F.W. Morgan (1952) who first reconstructs the history of ports in different eras and geographical areas or as the six-stage evolutionary model proposed by Hoyle (1989). The most recent historiographical studies have confirmed that the relationship of mutual necessity between city and port has been admitted since the term “port city” was introduced, that is since the general layout of the city began to be subordinated to its mercantile needs and the streets instead of converging towards the cathedral are oriented towards the port (Colletta, 2006). Against this unifying approach, many

urban planners trace the conflict of use and form between the two parts of the city to the origin of the ports: they were born as commercial colonies, foreign settlements with their own urban structure. Following their localisation and functional specialisation, colonies and commercial squares share the same spaces of public exchange (Colletta, 2012). City-port relations have changed over time, giving rise to various urban configurations that, for years, architects, urban planners, geographers have been trying to trace back to static or dynamic, inclusive or exclusionary models. According to the morphological approach, through the study of the urban form and the architectural typology, it is possible to reach the recognition of the individual development phases of the port cities. Structures, functions, and technologies form urban fabrics that tend to converge or diverge based on the historical period or the economic and political vocation of the city (Fatiguso, 2015). The coexistence of port and urban functions is undermined by the port's need to have infrastructures useful for its development and the needs of the city to mitigate its environmental impact (Conca, 2013), so the waterfront is identified as the most vulnerable part of a city on the sea (Fatiguso, 2016). The waterfront has inspired much research on unresolved issues common to most Mediterranean cities: enhancement of the existing heritage in a state of degradation or disposal; reuse of strategic architectures (forts, docks, shipyards, etc.); redevelopment of the waterfront as a strategic core of renewal for the city; space regeneration and land use; policies of urban integration and social inclusion (Alemany and Bruttomesso, 2011).

2. Methodology

The research proposes an integrated approach between morphology and design experimentation applied to the city of Messina as a privileged case study in the Mediterranean due to its historical-geographical centrality.

In the first part, morphology is adopted as a tool for reading and analyzing past and present urban transformations, with particular attention to the development and functioning of the port area. Based on written sources and graphic contributions it is possible to translate the binomial city/port into differences and analogies. The city-port relationship is studied in historical perspective as a morphological and typological process, according to the criteria proposed by Muratori and the Roman school. The analysis is conducted on two levels of depth:

1. Macromorphology. The urban and port settlement morphologies are related by comparing the key elements of the urban space: routes, fabrics, polarity.
2. Micromorphology. The particular types that make up the port can represent tangible or intangible limits and determine conditions of continuity or rupture between the two urban systems.

From the *status quo* to the *project status*, the second part of the research focuses on the design dimension proposing possible scenarios for the future of port cities. Contemporary design provides for a general renewal of the entire urban body starting from the recovery and redevelopment of the waterfront, which goes beyond the renewal of traditional commercial functions and takes into account the priority environmental issues. Through the project we want to demonstrate that the relationship between city and port cannot be reduced to a problem of homogeneity, but of diversity as an added value. Port infrastructures must be recognised as historical, economic and cultural heritage, a collective heritage to be enhanced.

Finally, in view of theories and analysis, we discuss the initial questions and the need to transform ports from segregated non-places into places of sharing. Overcoming the occasions of conflict that generate urban dualisms, it is possible to find that common sense of identity and hospitality in every port city of the Mediterranean.

3. Case study: Messina, a natural port in the middle of the Mediterranean

History of Messina is deeply linked to the geographical nature of the territory, a *borderline city* that develops on the northeastern coast of Sicily, between the Peloritani Mountains and the Strait that separates it from the continent. The first settlement dates back to 756 BC when Greek colonists founded the city of Zancle – from the Greek *Ζάγκλης*, “scythe”, a figurative description of this strip of land – on the peninsula of Falcata or S. Ranieri which with its sickle-shaped profile forms a natural harbor. The site’s defensive potential and its central position with respect to the Mediterranean made the city a cultural and economic reference, but also a geographical one, as hills and waterways represented a structured limit of human settlement. In medieval times its importance was strengthened, becoming *clavis Siciliae*, a crossroads of trade, political and religious exchanges, as evidenced by the presence of productive structures and monastic complexes (Vermiglio, 2016). Since the sixteenth century, the oldest Spanish port cities were strategically reconfigured with a renewed “monumental seafront” (Colletta, 2012). With the advent of Charles V also Messina was populated by arsenals and a massive city wall from which rises the star-shaped fort of the Real Cittadella which officially marked the border between city and port (Calabrese, 2015). With the fall of the Bourbons, the city reconquered

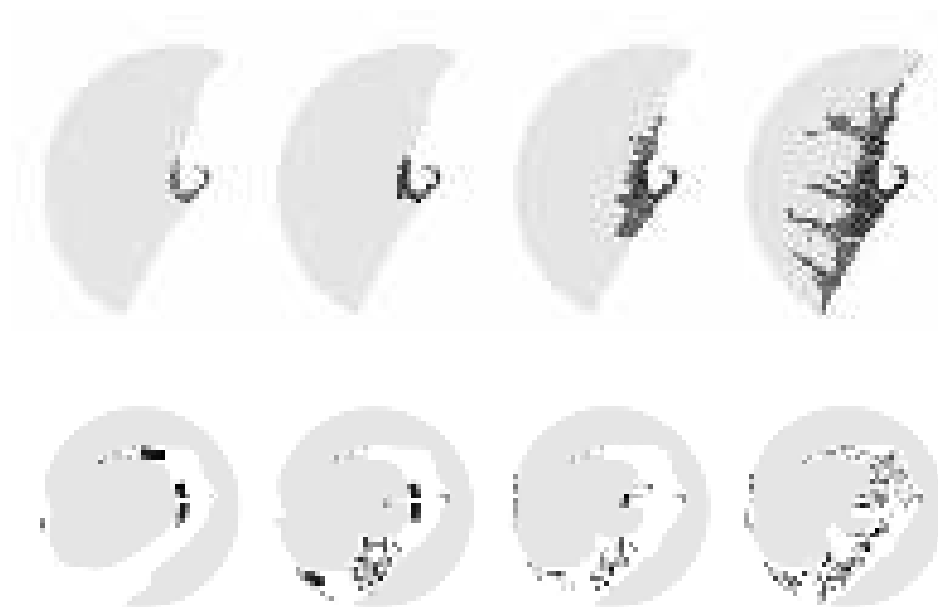


Figure 1. Messina: historical evolution of city (a) and port (b).

its port and the emblems of foreign hegemony lost their meaning; some military references remained and the rest of the area was configured as an industrial fabric. An important date in the history of the Mediterranean was 1908, the cities on the Strait were destroyed by an earthquake of unprecedented intensity. The historic city of Messina was almost completely erased along with much of its population (Berlingieri, 2008). To the detriment of the traditional trade vocation, the reconstruction orientated the urban layout towards the hinterland and followed the principle “where it was and how it was”, which reproduced the historical image of the city while applying the new anti-seismic technologies. On the one hand the city opened towards the sea, replacing the representative buildings adjacent to the port, on the other hand the port area became a foreclosing urban system between military bases, shipyards and manufacturing areas: the unique junctions between the two urban systems coincided with the traffic knots (railway and maritime stations, dry docks, piers), which sometimes gained space for the sea by extending the waterfront using material on site and earthquake debris. Although the territorial geography in principle imposed a limit to the anthropic space, with the most recent demands of demographic and building growth the landscape constraint was exceeded: the streams were buried and transformed into the main roads, the urban sprawl was extended along the hill-sides in speculative forms that were contrary to an organic development of the city (Caminiti, 2012). Today the metropolitan area of Messina is presented in a total planning and management stalemate. Despite the multiple plans and projects that demonstrate the administrative will to renovate and open up to the port starting from the rehabilitation of the waterfront, since then there has been almost no action on the matter. The city and the port coexist by excluding each other, the former lies in the need to consolidate itself at the rate of continuous environmental changes, the latter is isolated between abandoned complexes that limit free use in a place of historical and landscape value.

3.1. *Reading and Analysis*

The city of Messina developed according to a regime of the conurbation by bringing together settlements with different and still visible characters. The morphological study arises from the hypothesis that the functional and formal cohesion between city and port is as much possible as necessary, as already happened for the pre- and post-reconstruction urban systems. According to Muratori's theories, morphology is the result of a spontaneous anthropic process that transforms the landscape into a territory when paths, fabrics, and polarity are combined in a single system. In the long term, each of these components influences the other generating new synergies between disjointed areas. The analytical phase is carried out by using two distinct urban scales, it does not concern the entire city of Messina but focuses on the coastline, where urban dualism is more evident and critical. Reading and analysis are valid as a reflection on the surplus value of diversity, be it of a historical-urban or socio-cultural nature.

3.2. *Macromorphology*

The first object of analysis is the road system, considering the path as the foundational act of a settlement and the most permanent element of an urban layout (Cataldi *et al.*, 2012). There are four types of routes:

- *matrix route*: it is the first path that structures a settlement. In the historic center, only a short section of the original paths on which the medieval urban fabrics can be identified,



Figure 2. Macromorphology: routes and polarity, urban fabrics.

it remained intact until the earthquake (1908). In the southern part of the Falcata, the most recent matrix route reaches orthogonally to the coast, defining the rigid structure of the nineteenth-century urban fabric. The rectilinear direction that distinguishes these two matrices is disappeared in the port area, here the central route follows the peninsula scythe-shape and remains unchanged over time despite the neighboring buildings being changed by arrangement and typology;

- *building route*: it develops perpendicular to the matrix route and is recognisable by the direction change of the related lots. It is significant that the main routes coincide with the original rivers flowing to the sea: at the beginning, they were as a limit to the settlement, then they became natural matrices for the clusters that gave shape to the Messina conurbation finally, they were buried to facilitate the connection towards the coast. On several occasions, this forced anthropization has had a high environmental impact (floods, landslides) causing extensive damage to the city and population;
- *connection route*: it connects the building routes and defines the individual urban blocks. The road system in Messina essentially consists of this kind of paths connecting the building fabrics within a unique urban network which does not include the port;
- *restructuring route*: it represents the last generation of routes, it interrupts the existing urban fabrics with transversal paths that combine more polarities according to the shortest way. An example of this is the current Garibaldi Road which attempts to unify the seafront after the earthquake destroyed “La Palazzata”, a historic linear building that represented the city-gate from the sea.

This first analysis shows the ancient lack of direct connection between city and port, leading to social isolation and autonomous morphological development for both.

The second component shapes the city is the *urban fabric*. It is the result of a morphological

and typological process in which route imposes a direction, lot suggests a type, typology leads to a prevalent form of house aggregation (Caniggia and Maffei, 2001). In the historic city of Messina there are three main urban fabrics for standard housing typologies:

- *inner core*: it is the oldest building fabric, obtained by the diachronic development the two main phases of the history of Messina, from the Middle Ages to reconstruction. Its irregular pattern persists following the profile of the Peloritani Mountains but the road sections have been enlarged and the urban density has been decreased as a result of reconstruction. Each block was formed by the evolution of two- or three-storey terraced houses, they were compact on the external front, more articulated towards the inner courts/common spaces;
- *West district of Mosella*: the typically orthogonal pattern can still be seen, as shown by dimension and layout of buildings. After 1908 most of the displaced people concentrated here, in the barracks that evolved first in isolated buildings, then in the current blocks thanks to a long process of subsequent aggregation and specialised starting from the isolated typologies;
- *East district of Mosella*: the other half of the district extending towards the port looks like the most heterogeneous fabric. On the one hand, distances and positions confirm the preexisting square pattern, on the other hand each block differs in typology: terraced houses, lines, and isolated buildings are combined in angular solutions to shape closed, open or semi-open internal courtyards. Today it is possible to find sporadic portions of pre-earthquake buildings that have been completely included into the new urban fabrics.

In the Falcata port, different fabrics are recognisable from typologies and functions, even though all of them respect the low density and the spatial order imposed by the matrix route. In this area you can find:

- *monasteries*: there are few traces of the original complexes, churches, and related areas are still visible, while the lazaret and the cemetery connected to them there are no more;
- *military areas*: bastions, arsenals, garrisons of the Navy are associated with the ruins of the Real Cittadella. The existing structures confirm that a specific urban fabric corresponds to specific building types, although the mutual relations that distinguish an urban fabric from a simple aggregate are not so clear;
- *manufacturing areas*: docks, industries, merchant ports, maritime and railway terminals alternate with shipyards. They are the prevailing urban fabric spread throughout the peninsula of Falcata.

As opposed to the housing fabric that homologates the hinterland by repeating similar characters, the port can be considered a building environment of specialised typologies. Over the time the co-presence of specialised typologies has contributed to its historic isolation from the city in a completely arbitrary way: a traditional city includes areas dedicated to different uses (nature, sport, commerce, services), without interrupting the urban continuity, creating the fringe belts or favoring the urban sprawl.

Finally, polarities are fundamental elements for understanding the organisation of urban space since they have effects on structures in terms of permanence and continuity. These are not

intersection points like nodes, but references that tend to orient the city towards a specific direction. A pole is a centrality that attracts the population. In the city of Messina, we recognize:

- *inner polarities*: the matrix route abovementioned is dotted with public, religious, cultural buildings and squares which mark the most representative axis of the city from beginning to end;
- *outer polarities*: they correspond to the access gates to the city, such as the Messina Marittima Station with respect to the hinterland or the Ethiopia Pier with regard to the port. In particular, Fort Saint Salvatore surmounted by the Madonna of the Letter not only indicates the extreme tip of the Falcata peninsula but is also an iconic image for all: it attracts those who come from the sea, orients those who remain in the city or those who set sail. This last example underlines the importance of starting from the symbols of a common identity to regenerate city as a unitary organism.

3.3. Micromorphology

Moving to a smaller urban scale, the analysis focuses on the port area, here the typologies are examined not as a process but in relation to the functions that impose specific types and forms on the territory.

Over the centuries the peninsula of Falcata has played on a strategic role, because of its liminal position it was chosen as a privileged location for extra-urban functions. They were military,

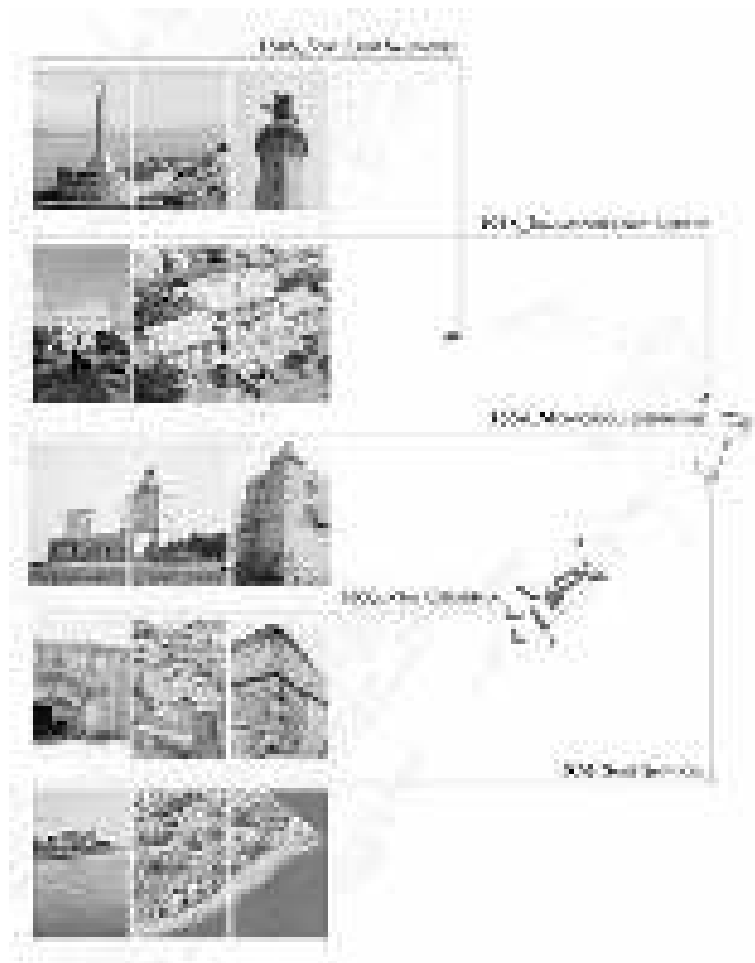


Figure 3. Micromorphology: historical typologies and functions.

religious or commercial institutes, necessary for the city to be located in neighboring areas, but not so important to be established in the urban core, where they could not find a place also due to the considerable volume of soil. Given the concentration of special functions within the peninsula, the few civil buildings have been reduced to service buildings (eg 6000 homes for the military). Thus, there was the spread idea that the port was an additional appendix to the city, not an integral part of it. The current problems of inclusion find far roots not only in this conceptual and intangible limit, but also in a series of physical and formal limits that have kept the two urban systems separated for a long time: sea for almost the entire length of the peninsula, the railways at the only point of connection to the hinterland, the fortifications that in more places interrupt visual perspective and constrain accessibility, the specificity of typologies that tend to create small introspective and autonomous realities from the surrounding context. The ideal type is shaped a particular strategic form that tends to repeat itself over time, as shown by the historic structures still present on the site:

- *Fort Saint Salvatore*: on the extreme tip of the Falcata stands a part of the sixteenth-century reconstruction (1540) of the oldest Basilian monastery founded in 1086 AD to support the work of “Frate Ranieri” (from which the peninsula takes its name). The Fort marks the first step for the fortification of the peninsula desired by the Spanish government, determining its subsequent predominantly military use;
- *Montorsoli Lighthouse*: another military structure, the octagonal lantern that surmounts the base of the original building still works;
- *Real Cittadella*: it is the most representative symbol of the Bourbon domination, it carried out the dual function of defense against attacks from the sea or from the city. Only two of the five original ramparts and portions of the double walls facing the city remain of it, the rest has been buried or destroyed by the earthquake;
- *Thalassographic Institute*: it is the last reference to the historic salt pans that have composed the landscape of the Falcata since 1100 AD. Furthermore, it is one of the few buildings with architectural and stylistic value (Liberty);
- *Smeb, Palombo, Rodriguez, Cassaro shipyards*: they represent the shipbuilding tradition that inaugurated the industrial phase of the peninsula reaching levels of excellence, here was built the first hydrofoil in the world.

Today the area is almost completely manned by the base of the Navy and by the few shipyards still active (Smeb): production facilities, abandoned structures, and disused docks main in full view, while public access is forbidden to most of the area.

3.4. *Towards social inclusion: a landscape project hypothesis*

According to the most recent planning, the local administration appears willing to reopen the area to citizens and tourists, preserving the active services (ports, moorings, terminals, and shipyards) and intervening on the re-functionalisation of disused areas (forts, civil construction). In particular, the new functional set-up would include a system of interconnected parks (archaeological and marine), a tourist/hotel hub, urban and building recovery of existing structures.

We need to remember that Messina is a relatively new city because in 1783 a terrible earthquake left only a few 16th-century fortifications standing and, in 1908, the city was almost totally destroyed again by a tremendous earthquake and tsunami.

Therefore, the present configuration of Messina reflects the drafting of a regulatory plan aimed at rebuilding Messina as it was and where it was. The Falcata area, less than two kilometers from the city center, has been the subject of study by the Messina port authority which has drawn up the harbor town development plan. From this dedicated urban planning tool, the recent thesis project by Chiara Sturiale, lecturer Prof. Rosalba Belibani, takes inspiration and develops it in accordance with its directives. Part of the peninsula is currently occupied by a Navy base, while the shipyards, the dry dock and the adjacent Nuremberg dock where the boats of the Messina-Salerno line land are still in operation.

The port area has a significant heritage not only of the landscape but also historical and cultural. The landscape is bordered to the south-west by the Angiolo Mazzoni station, built in 1939 as the first connection between Falcata and the city of Messina even if the railway limits its access actually. In the heart of the port zone, there are the ruins of the Real Cittadella, a stratified and imposing construction of which only some buildings remain; a landmark in the Messina skyline that today, due to the burial of about two meters, is almost invisible. In the North, the Montorsoli Lighthouse was built in 1554 by Giovannangelo Montorsoli, while the octagonal base was added in the 1800s under the French government. Fort Saint Salvatore has a very ancient history: the original construction dates to around 1000 or even earlier as the tower of Sant'Anna. In 1546 he Fort Saint Salvatore was built, together with the construction of the walls and the lantern. It suffered some damage during the earthquake and during the course of the 10th century, the Stele of the Madonna of the Letter.

The design hypothesis has the primary purpose of putting these important pre-existing structures into a landscape system through a network of connections. The project is divided into its

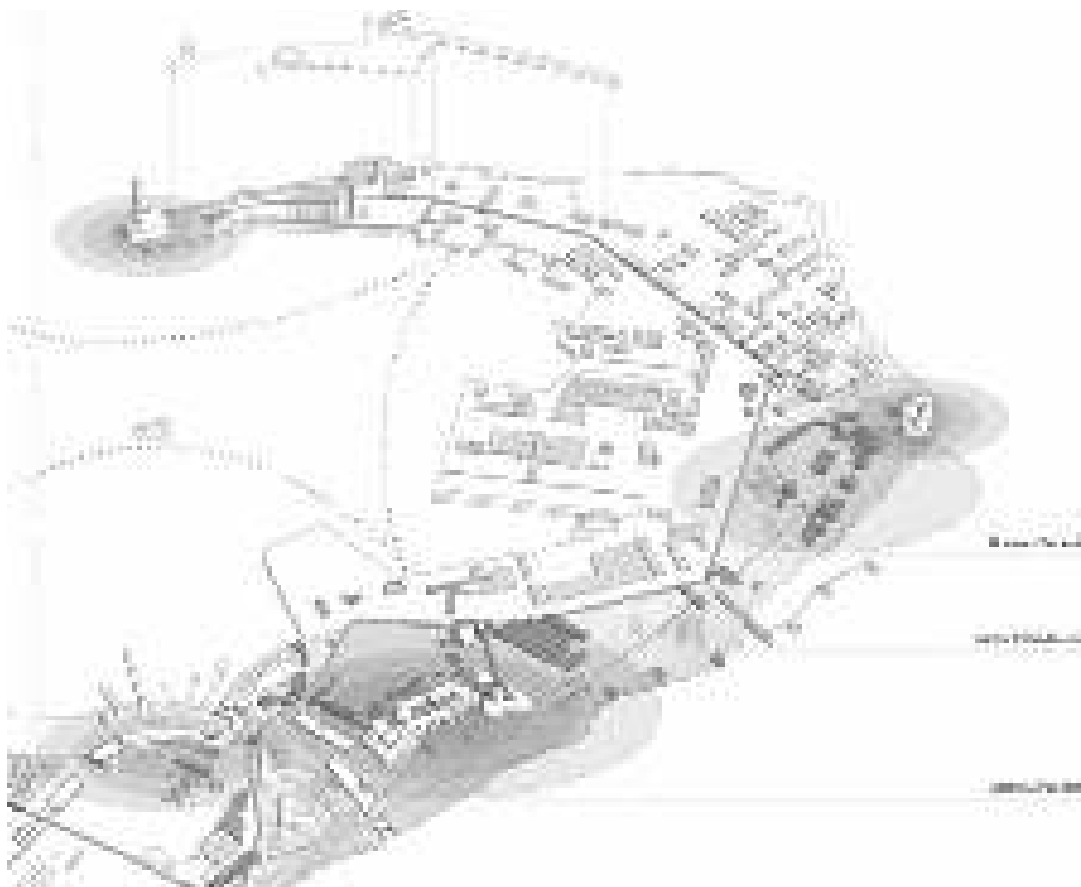


Figure 4. Peninsula of Falcata: a landscape design hyp

thematic areas following the course of the matrix route, connected to a secondary pedestrian road and a cycle path. The area, accessible through a renewed maritime public transport system in agreement with the port regulatory plan too, is designed as a large urban park within which other special projects and panoramic polarities are planned.

The first area of the project concerns the ruins of the Real Cittadella, involves the inclusion of new functions and an urban museum center. Since one of the design objectives pursued is to restore to the city of Messina the memory of the Real Cittadella, an imposing construction that over the years was a hindrance to the realisation of works such as the station or the port, the thesis proposes to rebuild the original star-shaped configuration including a square, paths, and thematic green lands. To mend the vaults of partially intact bodies and the best-preserved fragments of the Cittadella, the project prefigures a set of vertical elements, separated from each other. The solution is inspired by the restoration technique of "rigatino" which consists in filling a gap through a striped texture. The operation is also repeated outside with the presence of some stone septa that reproduce the pentagonal shape of the fortification. The connection system is completely new and is visibly in contract from the original form, in terms of colours and materials.

The second intervention involves the insertion of new housing fabric with sports services located where the Smeb shipyard once stood. In this area, there are still the metal silos of the degassing station, artifacts which show no quality and of which the plan provides for demolition. Housing fabric is connected horizontally by balconies and punctuated by some voids that allow the design of common spaces facing the sea. Following the curtain-theme, the buildings present Messina's pre-earthquake typology of terraced houses, characterised by continuous and tight facades overlooking the waterfront, as it was once "La Palazzata". The façade is composed of sunshade panels, facing the seaside on the south-east.

On a large territorial scale, the design proposal is also based on a secondary strategy: a complex system of visual perspectives. The axes identified starting from the historical monuments define the four volumes destined for housing, public spaces and connections.

4. Conclusion

Following the theories and analyzes expressed, the port cities requalification is timely and urgent today, as well as it is necessary to discuss the transition of the port from segregated non-place into a place of urban living, and how this would be possible by means of the design act. The critical process of integration must be preceded by a careful study of the forms of the territory (morphology) and of the construction (typology) that helps to understand the critical issues and the potential of the existing heritage, in order to achieve the transformation objectives aimed to urban and social inclusion. In this process of social inclusion, the design is a vehicle for spatial regeneration in which human and social integration are irreplaceable.

Recently the project has adopted analysis methods and tools based on the principles of Inclusive Design developed with attention to social sustainability. Through the design disciplines, the territory is not only regenerated but the bases are set up to promote comfort and a sense of identity and well-being that favors social inclusion. Regenerating the city from the waterfront means rediscovering spaces and habits, expanding economic and cultural horizons, creating new community identity¹.

1. All graphics (Figg. 1-2-3-4) were drawn up by C. Sturiale and included in her MSc. thesis project titled "Urban renewal of Falcata, harbour area in Messina", Supervisor Prof. R. Belibani.

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Cities of Collages: a Comparative Study of Urban Morphology Evolution between Macao and Monaco

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Keywords: Urban morphology, comparative method, port , plan unit, urban evolution.

Abstract: Macao and Monaco share similarities in topography, climate and colonial history as two entrepôts and have evolved into a unique urban construct as a “collage” reflecting the urban development traditions of their respective cultures. This paper conducts a comparative study of the urban morphological evolution between Macao and Monaco, and explores the underlying determinants and mechanisms of the formation of their fine-grained urban fabric. By historicizing the developmental process of two cities, the paper summarize the typical features of the general spatial structure based on Conzen’s analytic framework of Town-Plan, which includes the typology of buildings, streets and open spaces. The land pattern of Macao and Monaco presents a hybrid of vernacular quarter and international quarter corresponding to the historical context and economic vision respectively. It is a result of reciprocal renewal, expansion and redevelopment in Macao’s participatory planning with the Parish zoning and Monaco’s authoritarian planning with the Quariter zoning in the late and post-colonial period. By summarizing the morphological development models of Macao and Monaco, the paper profiles a vision of future coexistence of historical conservation and modern urban development of small port cities in the context of globalization.

1. Introduction

Small port cities developing under the influence of colonial governance often take the form of enclaves. In the formation of this kind of city form , the opposing bilateral relations between islands and mainland, or colonial and local governments, continues to prevail in the morphological process. The change in the internal working of the ruling power forms a special setting in which different cultures merge and thrive with each other. In addition, geographical and environmental factors, such as narrow territory and topographical segregation from the inland economic centers, have become favorable development conditions for the early maritime era. Hence, as a trade stronghold the port city prospered due to commerce. However, under the tide of contemporary globalization, the port city is extremely vulnerable to the competition among comparable rivals , thus forcing itself to move towards further industrial transformation. Special industries has become a general formula for the sustainable expansion of small port cities.

The analysis of this kind of contested and fragmentary morphological evolution is necessary to understand the coexistence of historical protection and modern development of urban space under the background of globalization. Macao and Monaco, are two small port cities that have also developed under the interaction of enclave-like geographical setting, long colonial history and modern gambling industry. In the previous studies on the relevant city forms, the study on Macao is relatively limited to the lineal space along the inner harbor. M.R.G. Conzen's Town-Plan is employed to discuss the regularity of the evolution of plan-forms with some deficiencies in the dimensions of time and space. However, there is little systematic research on Monaco's urban morphology. Therefore, the paper has made certain extension in the research scope and research method. Based on the sound study of the overall zoning pattern of the two cities, this paper focuses on the old and new port spaces of the two cities, and compares the old port as a product of diachronic accumulation with the new port as a product of modern comprehensive planning. At the same time, it links the process of morphological evolution with the development of mainland and pays more attention to the transformation of the functions of autonomous port cities in the context of globalization.

2. Methodology

This paper employs the method of literature research, field survey and morphological mapping to conduct a comparative study on the application and expansion of M.R.G. Conzen's "Town-Plan" theory. Based on the analytical diagram of the overall urban framework and the plan units of specific plots of ports during four morphological periods, and assisted by typological research, the paper classifies the public nature of streets and depicts the types of buildings in the plots, so as to explore the underlying social and economic engine of the morphological evolution.

First of all, Conzen's system of Town-Plan, as a theory, emphasized the formation of urban form as the accumulation of dynamic evolution rather than simple superposition, embodied in stages of four morphological periods: institutive phase, repletion phase, climax phase and recessive phase. However, for Monaco and Macao, two typical port cities having a large amount of urban space by reclamation, the newly-built plots are undergoing a rapid and large-scale morphological development while the old port plots are entering recession. After redefined the fourth period as the redevelopment phase, the paper applies the perspective of dynamic development to explore the dominant causes of each period and to make horizontal and vertical comparisons to sum up their development laws and internal generation mechanisms.

Secondly Conzen's system of Town-Plan, as an analytical method, clarifies the research object which is a complex of the following three elements:

- Streets and their layout in the street-system
- Plots and their agglomeration in the street-block
- Buildings and their block-plan

The form complex with the same morphological characteristics different from other plots around, is called Plan Unit. On this basis, the paper selects the continuous plots linking the old port and the new port, and summarizes the types of plan unit in each period to further refine the evolution law. In addition, the paper employs the concept of "Resolution" (Karl S. Kropf)

to explore the stability and function of different types of planar elements in morphological evolution at three levels of low-medium-high resolution.

3. Analysis/Results

3.1. *Evolution and Mechanisms of urban structural pattern*

The urban structure of the Macao peninsula has experienced a linear spatial structure of “Straight Street” (Institutive phase: -1840), linking churches, forts and other important monuments and squares (front yards) as the nodes, the “Dual-Core and Three-Zone” (Yan Zhongming) model (repletion phase: 1840-1910s) in which Portuguese and Chinese local neighborhoods merge and extend with the “parish” model as the blueprint for management, the structure of the “Five Parishes” (climax phase: 1910s-1980s) with reclaimed land, and the “Double Port model” (redevelopment phase: 1980s-) in the co-existence of the new city and the colonial communities of the “inner port-outer port”.

Compared with Macao’s linear development system, Monaco’s urban spatial structure developed on the basis of scattered point-like symbolic spatial elements, from the “single-core” model (Institutive phase) with Monaco’s royal palace as the center, along the “One-Port and Three-Zone” model (repletion phase) established by the port Rade de Monaco and two added regions with Monte Carlo Casino and Marché Couvert as the core, continuous expansion (climax phase), to the eight thematic “quartier” (redevelopment phase), under the development model below the French city level, the current city-state structure is formed.

Corresponding to the characteristics of each period, a specific category of factors is highlighted in the interaction among various kinds of influences, becoming the dominant factor in the formation of a specific form in this period, which can be summarized as follows.

Terrain

The naturally formed inner port along the coast is suitable for the establishment of trade ports of both two cities, and the rugged mountains provide conditions for the colonists with strong defensive consciousness to build fort. Especially in Macao, in order to resist the risks of the attacks of other western powers, the Portuguese built forts on many commanding heights, including eight forts and city walls, forming a complete military defense. Monaco’s first city was also established in a similar way.

Commercial benefits

In order to establish, develop and protect their own interests, Portuguese businessmen bought off the Qing government to set up strongholds, united churches to build churches to set up parishes, and built a large number of forts and city walls, forming an important consolidation line in the historical period.

In addition, casinos became an important factor in the later development of the two cities. The internal causes are the decline of Macao’s internal port and the pressure of Hong Kong’s free port development, as well as Monaco’s fiscal deficit after seeking protection from France. The fundamental causes are the lack of independence as a colony and the weak economic development.

Game of Political Power

In the early stages, Macao's political power game was mainly concentrated between the Qing government, the local Chinese power, and the Portuguese government, the colonial power. After Macao's transfer of sovereignty back to China, Macao gradually tended to develop in concert with the mainland.

In the institutive phase, the Qing government adopted the policy of "governing but not curing" towards the Portuguese. Under the control of Portuguese construction, the early urban pattern presents an irregular and organic street layout with large religious and military buildings distributed in dots as the structural core.

In the second stage, the Qing government established a political power core in the northern part of the Macao peninsula to strictly controlled Portugal's trade with China's interior, forming a confrontational force. Therefore, the north developed in a form of typical Chinese communities with trade links to the interior. The south is a concentrated area of Portuguese, connected with maritime trade. So the central region has become a meeting point and has thus formed a mixture of Portuguese planning structures and Chinese self-organized "LiWei" neighborhood.

After the opium war, the Qing government gradually lost control of Macao. In the climax phase, the Portuguese government's need to independently develop Macao's industry and commerce prompted the process of land reclamation and the renovation of the internal port.

In the redevelopment phase, under the overall policy guidance of Gulf region of Guangdong, Hong Kong, Macao after the handover, the development of the Macao Peninsula, especially the new city area, is all integrated into a part of the coordinated development of the region, realizing the positioning goal of "building a world tourism and leisure center and a platform of business cooperation between China and Portuguese-speaking countries" (the State Council's "Outline for the Development of Guangdong, Hong Kong, Macao and Gulf Region"), with the focus on the development of the outer port.

Compared with Macao's long-term occupation by Portuguese, Monaco experienced a chaotic period of being contested by many countries at the earliest. Lacking of overall planning, there was no complete system similar to Macao's "Straight Street". Until the late 18th century, Monaco still maintained a single-core model of development with the palace as the core.

Due to Monaco's special geographical relationship with France, the game of regime mainly focused on Monaco's royal power and France after the 18th century with three stages of the relationship: protection, control and peaceful coexistence.

In the institutive phase, Monaco sought French protection from Spain in 1641, which started the bilateral relations.

Later in the second stage, Monaco is attached to the territory of the French Republic under the name of Fort Hercules during the French Revolution. It becomes the chief town of the canton of Alpes-Maritimes until 1861. Monaco gave up most of its territory to France in exchange for its independence. At this time, Monaco's urban zoning has already begun to apply the French zoning system based on Quartier.

In the third stage, Prince Albert first announced a constitutional monarchy in 1911. The combination of the prince's supreme power and the need to speed up economic construction to make up for the fiscal deficit has brought Monaco's Monte Carlo development model with casinos as its core and the construction boom after 1910.

In the new century, Monaco and France achieves a major breakthrough in the relation by a series of treaties to enhance Monaco's sovereignty. Therefore, Monaco's urban planning has

opened up more thematic new areas, especially a series of new ports, as an important aspect of strategic development, following the French zoning model.

Monaco-France has a similar relationship between the enclave and the mainland compared with Macao-mainland of China, and a similar colonial relationship compared with Macao-Portugal. However, the characteristics of the localization of the two cities' forms are completely different. Because the relatively loose control by Qing government in the early days, residents had some freedom in building their houses, forming a large number of "Li Wei" and "Tang Lou" that transplanted the characteristics of traditional Chinese dwellings. Fragmented and gradual bottom-up renewal dominated the local urban form in the historical period before Macao's return. However, Monaco's history of becoming a French subsidiary city territory has led to a lack of hierarchy under the application of the French urban planning system. The uniqueness of Monaco's development as a city-state became apparent after its independence, in which long-term system of highly centralized monarchy has greatly influenced its important decisions in urban development. The Monte Carlo model, the layout of maritime museum and its region are the results of a top-down overall planning.

3.2. Town – Plan Analysis on Evolution of Port Plots

Macao (figure 1)

During the institutive phase, Macao's inner port area are filled with fragmented plots without subdivision due to the lack of systematic planning, but there had been a clear division of land use. Bounded by markets, the northwest is mainly used for Chinese storage and commerce, while the southeast for Portuguese public municipal space and residential land. Two important landmark monument under colonial influence have also been established during this period: the Palacio Pavilion, as a place for the early Portuguese to handle affairs, has extremely high political significance. Igreja de S. Domingos, as an early church established by the Portuguese Jesus church, is also a material form of political control to cooperate with the Council. The controlling power of the two monuments led to the shaping of the front yards, highlighting the memorial and publicity.

During the repelation phase, the most remarkable changing feature of inner port is the outward expansion of its boundary. The prosperity of port trade has not only formed a new port business district, but also stimulated the integration of Chinese and Portuguese culture-dominated urban forms. The road network in the expanded area broke the traditional organic street form in the Middle Ages and turned to an orthogonal grid system with higher efficiency for rapid expansion. Portuguese municipal plots still maintain the overall layout, but the filling of plots has obviously taken place, making the boundary of streets and front yards clearer. Meanwhile, due to the rise in population density brought about by the sharp increase in trade, Chinese plots have been transformed into residential patterns with further subdivision, forming the traditional Chinese "Li Wei", which was an important filling content under the Portuguese planning framework. In terms of architectural types, Chinese residential building "Li Wei" and commercial building "Pu Wu" appear as new types of self-organized construction by Chinese residents. Following the "Li Fang system" in ancient China, similar to the traditional "Siheyuan", "Li Wei" has clear boundary and enclosed spatial form with a mixed residence, and the entrances are controlled by residents themselves, forming a relatively closed self-consistent area. In addition, Li Wei's naming after lower classes, such as "blacksmith Wei" and its charac-

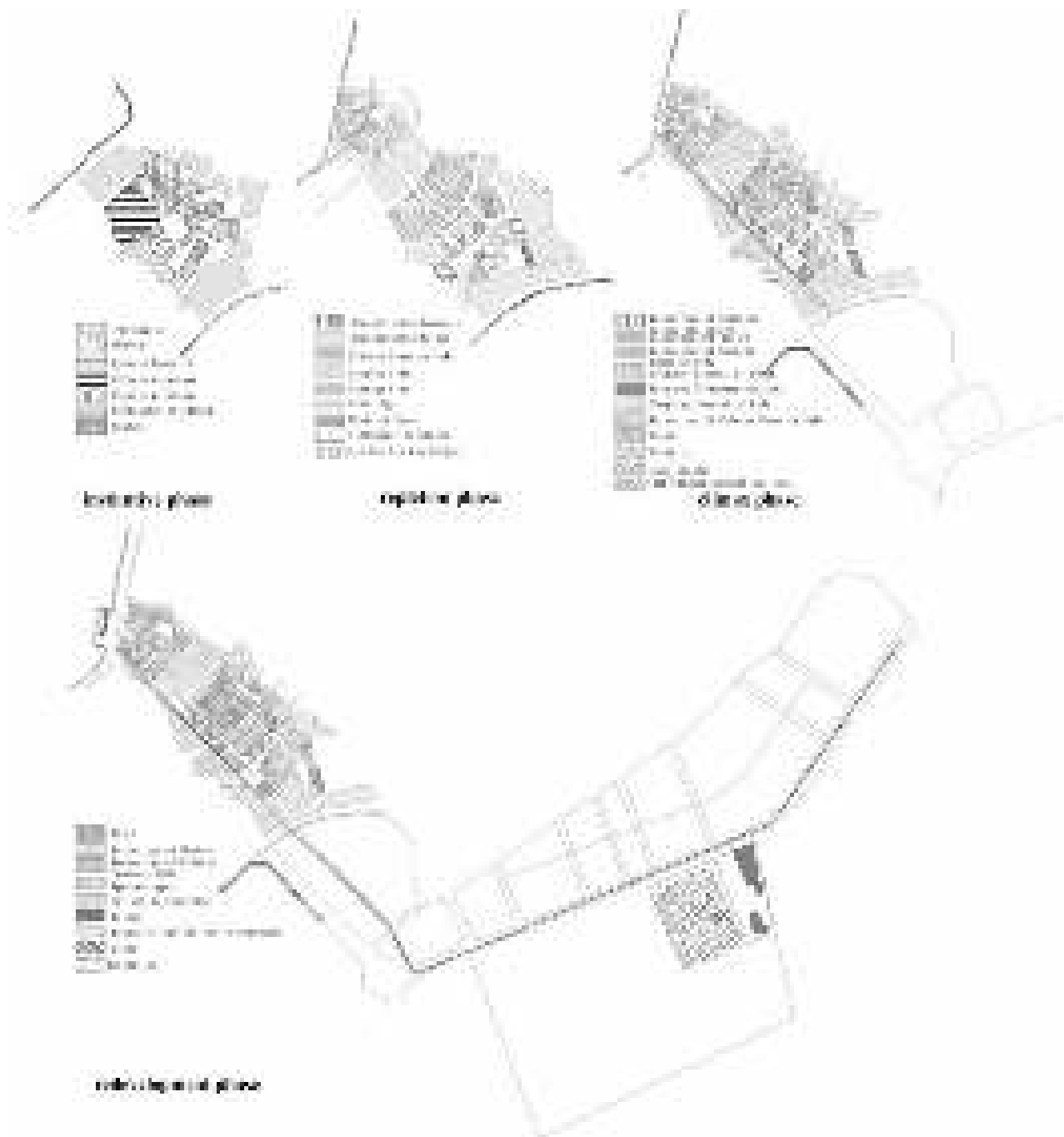


Figure 1. Low resolution – Morphological evolution of inner port and outer port in Macao.

teristics of high density and high volume, reveals that the construction of Li Wei is to improve the intensity of land development and meet the needs of more lower class citizens.

During the climax phase, impacted by Hong Kong's free port, Macao accelerated the reclamation of land and linked the internal and external ports by Avenida de Almeida Ribeiro. Therefore, the construction of the new road cuts the existing blocks with a straight line space running through the inner harbor, creating a brand-new street interface, leading to the adaptive redevelopment of the surrounding blocks. The internal space of the original residential area has been transformed into an outward-looking space along the street with largely improved publicity, which has stimulated the reshaping of these plots. The reshaping takes the mode of combining residents' self-organization renewal and upper-level government management.

According to the historical archives (Macao Archives Bureau), the reconstruction of shops is designed by individual merchants and instructed by Portuguese government. Therefore, within the scope of their respective cadastres, various morphological characteristics of newly-built shops are created. Traditional residential areas have also experienced the impact of the influx of refugees brought about by the war, stimulating the vertical development led by developers with the architectural form transformed to “Tang Lou” of high-density, as in Hong Kong in the same period.

During the redevelopment phase, the form of the inner harbor has developed to a mature and stable stage, except for the succession of individual high-rise residential buildings, the reconstruction of camp markets, and the establishment of casinos and hotels. The main morphological evolution took place in the newly built outer harbor area. The studied plot is selected as a typical block under the modern overall planning of Outer Port. The plot presents a homogeneous distribution pattern of grid network. Unlike the inner harbor block composed of small plots, most of the blocks in Outer Port are independent and complete large-scale plots composed of “double-C” commercial and residential high-rise buildings, while the large number of casinos and the front square form a higher-level block.

Monaco (figure 2)

During the institutive phase, Monaco’s urban built-up areas were mainly concentrated in monaco-ville. The city wall was used as the consolidation line to define the urban space, forming a cohesive form with Monaco’s royal palace as the core. The land use was mainly municipal, including city hall and churches, which were arranged along contour lines.

In the repeletion phase, Monaco’s urban construction broke through the limit of monaco-ville and built new areas of La Condamine and Monte Carlo. The division of the built-up areas clearly adopted the division mode of the French urban planning system due to its colonial status. Since Monaco’s entire country is equivalent to a French city in both administrative level and scale, the zoning directly adopts Quartier in French Ville-Quartier system. Monaco has maintained the stability of the previous period with new building types added such as hotels and schools on the basis of merging and filling the plots. La Condamine is closely connected with the port due to its relatively flat terrain. The plots are mainly composed of centralized commercial spaces like bazaars. Residential buildings were distributed along contour lines in typical unit plots of low density. Monte Carlo was developed by Prince Charles III who opened the first casino in 1856 to solve the financial crisis. Hence a development model of large casino, grand theater and other large-scale recreational buildings as the main body is created. These large-scale buildings also acted as monuments and controlled the layout of adjacent plots in the next morphological stages.

During the climax period, a large number of plots were filled and merged within the basic plot layout. With the influx of refugees, the density of residential buildings in La Condamine has increased significantly, the previous vacant private residential units have been fully occupied, and the collective housing has also developed more intensive. The influence of the Prince of Monaco’s personal power on the construction is also highlighted. Albert I’s personal love and research for marine science resulted in the construction of a marine museum with cultural landmarks, which became an important monument controlling the development of the surrounding squares and plots. Lanier III also made urban construction develop vertically, in which the transfer of the railway to the underground has made room for increasing housing. In



Figure 2. *Low resolution – Morphological evolution of inner port and outer port in Monaco.*

addition, the renovation of the old port also sped up, including the construction of sea barriers, which increased the throughput of the port.

During the redevelopment phase, Monaco, similar to Macao, began to set up more ports to meet the needs of a richer population. The plots of the three old quarters were further merged, corresponding to the newly-built high-rise office buildings, hotels and frame-type collective houses. The construction of Portier Cove in new port area creates a district with high-end luxury residences and businesses, while the west side forms a public activity square as an expanded part of the Grimaldi Convention Center. The new port maintains a high degree of continuity with other built areas in the form of hill landscape and coastal walkways.

The longitudinal comparison of the development of the four periods of inner harbor under low resolution proves that the street and monument as relatively stable elements play a role in controlling the overall plot morphology relationship. Under the medium resolution, the two inner harbors have seen subdivision, filling and merging of plots and outward boundary expansion under basically the same division of plots (table 1). Changes in building types and increases in volume and height under the high resolution increased the volume ratio under the condition that the density of buildings remains unchanged or even decreases (table 2). It reflects the important population growth periods, including being refuge (World War II and the Chinese civil

Table 1. Medium resolution – Types of street pattern.

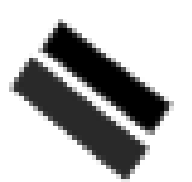
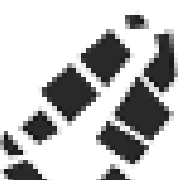
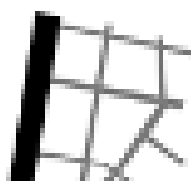
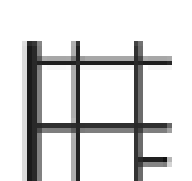
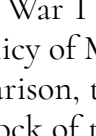
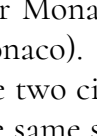
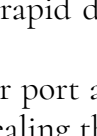
	fabric	layout	composition of publicness	configuration
A Li Wei				
B Puwu (Determinant store)				
C Group shops facing the street				
D Square (Front yard)				
E Homogeneous mixed commercial and residential community				
F Large-scale Grid Commercial-residential blocks				

Table 2. *High resolution – Evolution of building type.*

		TIME		
		EARLY	MIDDLE	LATE
URBAN	Industrial (1)			
	Commercial and residential (1)			
	Public			
SUBURBAN	Public (2)			
	Public (3)			

war for Macao and World War I for Monaco), and rapid development of casinos (especially with the tax exemption policy of Monaco).

In the horizontal comparison, the two cities' outer port and inner port show different resolution levels under the block of the same scale, revealing the different action mechanisms of the cities' modernization in different periods. The former is a gradual evolution in the vertical direction due to the population growth on the basis of the existing small-scale land division. The latter is the most economical and efficient planning mode based on industrial demand on completely newly-built land, which also reflects the functional change of the government from a leading decision maker to a cooperative developer.

3.3. *Applicability and limitation of Conzen theory and method*

According to the foregoing, Conzen's Town-plan has a strong guiding effect on the early morphological changes of the two cities. But after the repeletion phase, within the basically mature boundaries of plots and building pattern, there are great changes in the height and types of

buildings, reflecting changes of population density and social structure, which cannot be highlighted in plan pattern analysis.

Therefore, we can put forward a similar analysis method of Section Unit based on Plan Unit and superimpose it with the former to obtain a three-dimensional interpretation of the evolution process of urban form.

The paper attempts to select residential and commercial plots in the inner harbor and outer harbor to establish a vertical analysis of plots and architectural evolution (figure 3).

The division of plots in the traditional LiWei area of Macao's inner harbor has hardly changed from the institutive phase to the climax phase. But after that, several adjacent plots merged, corresponding to the evolution from private residence to collective residence, which is reflected more intuitively in terms of volume. In the evolution of collective residence itself, although Tang Lou was constructed with the merging of plots, its facade still preserved the trace of plot boundary and the concept of "household" with prominent columns. In the later high-rise collective residence, such traces disappeared in the unified facade, suggesting a more homogeneous social residence.

In the evolution of commercial plots along Avenida de Almeida Ribeiro, the boundaries of the plots also maintain their own stability. However, the changes in style and the rapid development in height directly reflect that the connection with foreign ports greatly enhance the openness and publicity of both sides of the street and its branches. The reservation of the space of the commercial plot similar to the "arcade" colonnade in Southern China continues the close

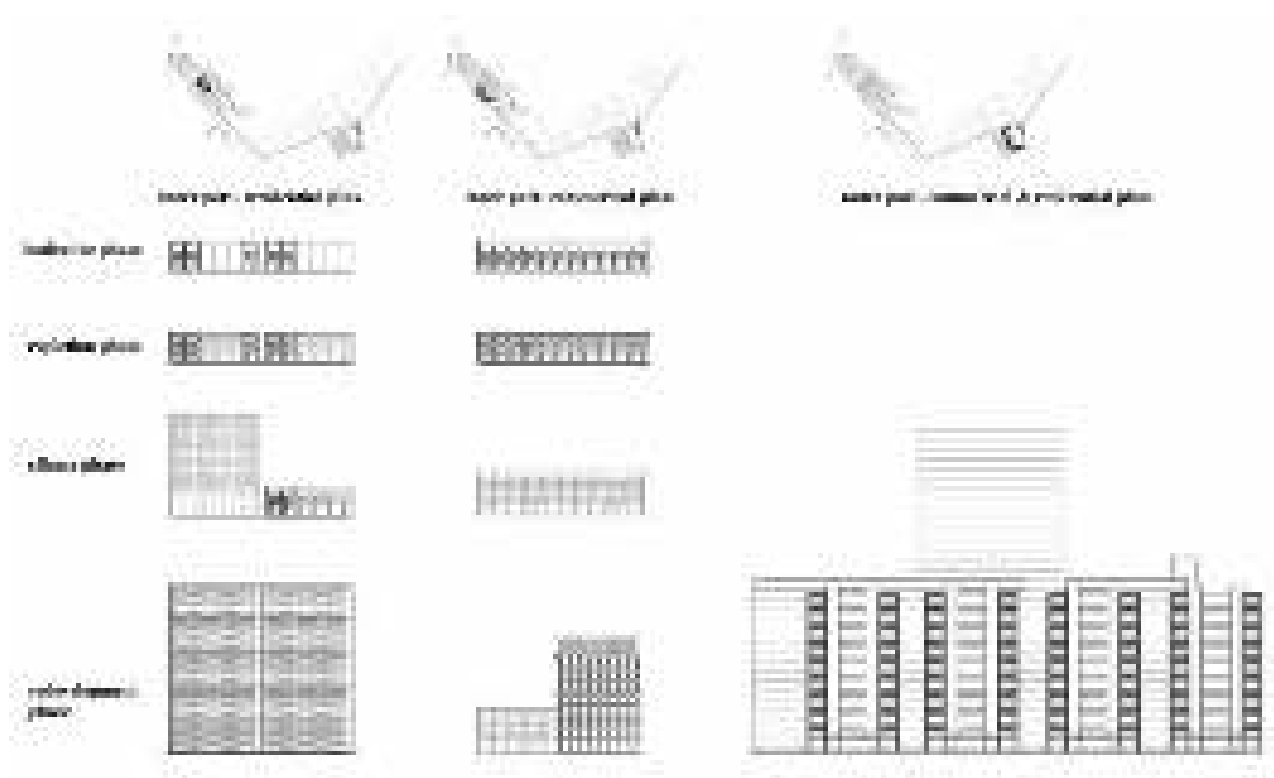


Figure 3. Section Unit of outer and inner port in Macao

connection between shops and walking streets, which illustrates the inherent consistency of the spatial logic of the commercial development needs in the central historical area.

Finally, in the outer port built entirely by reclamation in the 20th century, large-scale new development mode of residential and commercial is developed under the modern efficiency-oriented planning. With the second floor platform as the boundary, the bottom floor of the new Double-C block is the layout of the parking garage and shops, and above the second floor are enclosed modern apartments. The shared courtyard on the platform realizes the transition from streets to residential areas and creates an inward public space. Compared with the independence of many new cities in mainland China, the sectional relationship of commercial and residential areas in the outer harbor shows strong continuity of the openness of the inner harbor district.

4. Discussion/Conclusion

¹ The comparison of the overall development of the two cities reveals certain developmental rules of port cities under the direct influence and aftermath of colonial governance.

1) Morphological framework:

According to the four periods defined by Conzen, the development structure of the two cities has experienced the evolution from single-track space, the multi-nuclear space, to the co-existence mode of “new port-old port” juxtaposition after the land is greatly expanded by reclamation. However, the difference lies in the fact that the Macao peninsula is spread by the linear arterial structure of radiant hierarchy, while Monaco’s spatial development is formed by the spread and interconnection of multicentral growth.

Causes and mechanism:

First of all, the two pairs of bilateral geopolitical relations between islands and the mainland, colonial regime and local regime, are prevailing factors. The dominant party in the process of mutual game directly led to the formation of the city form through the control of the powerful and prototypical core and its adaptation, utilization and development with the topography.

Secondly, there are also important third-party forces in the evolution process of urban form. The traditional “Li Wei” residential area built by the Chinese in Macao Peninsula is self-organized and updated on a small scale from bottom to top. However, Monaco’s cities have long been under the overall planning of highly centralized leadership. The influence of third-party forces is manifested in the cooperation between big capitalists and rulers, leading to a large-scale Monte Carlo model within the “Quartier” zoning pattern in the French “PLU” plan.

At the same time, two cities’ dual status as colonies and enclaves resulted in the absence of real autonomy in the making of planning policies, lack of support from local industries, and high dependence on the outside world. Changes in the external economic and political situation also brought profound changes to the development of the two cities’ own forms and provided opportunities for transformation. This is mainly reflected in the intensive development brought about by the influx of population during the World War II and the rise of gambling industry caused by the pressure of competitive port economic development, which has accelerated the vertical extent of buildings and the reclamation in the two cities.

2) At the plot level, through the analysis at low, medium and high resolution of the old and new harbor areas in the two cities, the factors that maintain the stability of urban form or bring about changes are confirmed. Streets and monuments as linear and nodal elements of control maintain the stability of urban pattern and plot configuration. To be specific, the monument

has exceeded its role as a building itself and has transformed into a civic infrastructure, which controls the boundary of square together with the streets. The mechanism of morphological evolution are divided into two categories. First, due to the rapid population growth, the two cities have experienced homogeneous filling, subdivision, merging of plots and changing in building masses, as a gradual process of accumulation in history. Second, the large-scale reshaping of existing forms took place in a short period of time by large events as heterogeneous elements.

The construction of new ports has spread to an intensive mode under the development of modern economy and the change of population structure. Meanwhile, the height of construction is also limited by the protection of the historical harbor district. The inner ports have also been reshaped due to its connection with the new ports, reflecting the interaction between historical protection and modern development.

3) As a method, Conzen's analysis of plan unit fits well in the exploration of early historical morphological periods of the two cities, but has lost its direct effectiveness in the analysis of the rapid development of the city's three-dimensional development in modern times.

Therefore, the paper seeks to propose a analytical concept of "section unit", which follows Conzen's theoretical perspective but rather focuses on the vertical dimension, and applies it to further exploration of the evolution of residential and commercial plots in Macao. Between high and medium scales, this analysis considers the change of architectural form and the evolution of its relationship with streets. Although the relationship between residential and commercial plots in Macao's outer port and inner port is quite different in form, it shows the internal consistency of the transition from street or courtyard connection and public-private connection in the sectional dimension, which forms a continuation of the developmental rules of historical urban area under modern planning.

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Morphological Characteristics of Traditional Residential Districts in Chinese and Southeast Asian Port Cities

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Keywords: Maritime Silk Road; Urban Morphology; Port Cities; Traditional Residential Districts.

Abstract: From the rise of the ancient Maritime Silk Road via the Age of Discovery to today's globalized era, the development of maritime trade has transformed human lives and culture, and accordingly intensified changes in urban morphology, which would otherwise have remained relatively stable over the ages. The theoretical and methodological systems underpinning urban morphological analysis of Western traditional cities are relatively complete and mature; however, research on Chinese and Southeast Asian port cities, in which maritime trade began much earlier and had a more profound influence, is still scattered and unmethodical. In this paper, four typical port cities in China and Southeast Asia including Quanzhou, Guangzhou, Hanoi and Malacca are selected as case examples, and the morphological characteristics of traditional residential districts are expounded at two levels: street-block and plot. Comparative analysis is conducted at both of the two levels to explore important similarities and differences. This not only casts light on the motivation to transform traditional residential districts to adapt to commercial development, but also promotes the protection and renewal of traditional port cities in China and Southeast Asia, as well as providing inspiration and assistance in the future adaptive development of these port cities.

1. Introduction

The Silk Road, deriving its name from the lucrative Chinese silk trade, is a series of trade and cultural-transmission routes running through Asia since ancient times, which connect the West with the East. From the Tang Dynasty, as the emphasis of the Silk Road gradually turned from land to sea, the maritime Silk Road, especially the South China Sea route, experienced accelerated growth. Europe's early modern era, from 1500 to 1800, was roughly contemporary with China's transition from the Ming to the Qing Dynasty. This period saw great transformation through the movement of ideas and diverse reactions to these ideas across Eurasia. Due to the colonial rule of European countries and the impact of modern civilization, maritime rights were gradually turned over to European countries. Although affected by colonization, coastal trade between Asian countries was not interrupted. It is evident from the above that trading activities enhanced communication between regions and promoted the integration of regional cultures. The expansion and development of maritime trade further weakened the natural

barriers between countries and regions. With the development of global trade and cultural communication, both Chinese and Southeast Asian traditional port cities have gained relatively rich and diversified civilizations. In the two regional cities sampled in this study, urban morphology, which is considered the physical or material carriers of culture, manifest cultural change across historical periods. At the same time, they possess a dual function conferred by both regional inheritance and global characteristics.

2. Methods

The characteristics of a “residential district” have been defined in different ways by scholars of urban morphology and urban form. From a Conzenian perspective, three spatial units – residential districts, central business districts and fringe belts – together constitute the entire urban landscape (Caniggia G., 2001). Residential districts occupy a large proportion of urban land, playing a decisive role in urban morphology. At the level of land or housing utilization, residential districts have a more uniform form and function than the other two spatial units, which reflects the universal spatial characteristics of homogeneity and compactness. According to Muratori-Caniggia, the various processes of change in residential districts not only affect urban tissue and form, but are closely interrelated with the urban life and physical structure of cities. This evolution is a long-term process, reflecting the results of different kinds of collective operation and construction at two levels: synchronic and diachronic. This evolution represents the “operational history” of most cities (Conzen M.R.G., 1960). The development characteristics of residential districts in traditional port cities, especially traditional residential districts with commercial functions closely related to maritime trading activities, can be summarized as follows. First, these districts occupied very large areas of their respective traditional port cities, forming the foundations for the development of a whole city. Second, these districts once accommodated the vast majority of the urban population. The population contained various ethnic groups, closely connected by trading activities. As a result, the urban morphology of these districts was flexible and diverse. Finally, the formation and development of these traditional residential districts did not happen quickly. Instead, they developed over a long period of accumulation. Analysis of the morphological characteristics of traditional districts with the hybrid commercial-residential functions of port cities offers helpful insights into the key internal factors driving the formation and development of these cities.

The concepts and methods proposed by M.R.G. Conzen and Gianfranco Caniggia provide invaluable scientific and systemic frameworks for the study of urban morphology in many specific towns or cities. The relationships between urban forms, building types, culture, economy, technology and other social conditions in the process of urban evolution are always afforded significant attention in typo-morphological research. The research scope of this study, in the broad context of the Maritime Silk Road, is much wider: not limited to a single city or country. The study explores both the homogeneity and the diversification of traditional port cities on the Road throughout their historical urban development.

According to Conzen and Caniggia, Streets and blocks are constituent elements of a plan unit or urban tissue. A street system can be viewed as the structural framework for urban form. First, districts with different characters require different modes of organization and management, leading to different patterns of streets and blocks. Second, important main streets or special blocks are located at the junctions of city districts with different characteristics, facilitating connection and transition. These main streets can gradually enlarge the potential for urban develop-

ment by connecting certain special blocks that can be used as spatial joints. The areas within a town plan unoccupied by streets and bounded wholly or in part by street lines are blocks. Each block represents either a group of contiguous land parcels or a single land parcel. Each parcel is essentially a unit of land use; it is physically defined by boundaries on or above ground and may be called a plot, whatever its size. The arrangement of contiguous plots is evident from the plot boundaries and, when considered separately from other elements of the town plan, may be called the plot pattern. Street-blocks can differ widely in their plot patterns, and this variation represents one of their most important geographical characteristics. A row of plots placed contiguously along the same street line, each with its own frontage, forms a plot series.

3. Results

In the following discussion, the morphological characteristics of traditional residential districts in four port cities are expounded at two levels: street-block and plot. Both of the two levels are analyzed with attention to their types and patterns in different typical residential districts in the four selected port cities under study, which have been considerably influenced by maritime trade in different historical periods.

3.1. Quanzhou

The cruciform street system in the north of the city, which originated in the Chinese Tang Dynasty, formed perpendicular to the administrative city. In the inner city, following the Chinese Li-Fang unit system, markets were created to the east and west, respectively, of the north-south main street. The two markets were sites of assembly and trading. The traditional Chinese emphasis on central positioning and symmetry in urban construction was clearly embodied here. The district of West Street in Quanzhou was a typical example (Figure 1). The southern cruciform system, which emerged in the Song Dynasty, significantly strengthened the relationship between the port area and the urban center (Hoang Dang Thai, 1985). Shophouses with both commercial and residential functions were set along both sides of the north-south main street, Zhong Shan Middle Road (Figure 2). In addition to the major streets, some secondary streets were inseparably interconnected with city moats and brooks, providing both land and water transportation for daily travel and trading activities. This street layout not only met production and residential requirements inside the city walls but conformed to local geographical conditions. The port area outside the city walls gradually became another commercial center that provided trading opportunities, transport and living space for traders and manual workers. In summary, the overall street system and block structure of Quanzhou displays a single political center and multiple commercial centers, reflecting the politics-oriented and commerce-assisted foundations of ideology and culture in ancient China.

Plots in the inner city of Quanzhou were significantly affected by the traditional cultural values underlying Chinese urban construction. Plot patterns in this area were circumlocutory and complicated. Intersection patterns, corner patterns, and irregular pectination patterns were common. Plots tended to enclose open space of different sizes and shapes, sometimes even some dead-end space (Figure 3). All of these arrangements reflected the rich and varied characteristics of concentrated urban space in China. In contrast, in commercial districts and port districts with definite functions, the plot types and plot patterns were more unitary and regular, dominated by pectination patterns, and functional characteristics were more obvious.

3.2. Guangzhou

Apart from two main streets crossing from south to north and east to west, the street systems of the inner city of Guangzhou mainly consisted of perpendicular streets forming T-junctions. The inner city was also equipped with three city moats and numerous natural ponds that were used for both transporting commercial goods and everyday travel. Unlike those of the inner city, the street systems of the outer city were significantly limited by the shoreline of the Pearl River. Some north-south streets extending from the inner city began to bend, eventually running perpendicular to the river bank. Due to the narrowness of the outer city from north to south, only a few



Figure 1. *Street-block Patterns of the District of West Street, Quanzhou.*



Figure 2. *Street-block Patterns of the District of Zhong Shan Middle Road, Quanzhou.*

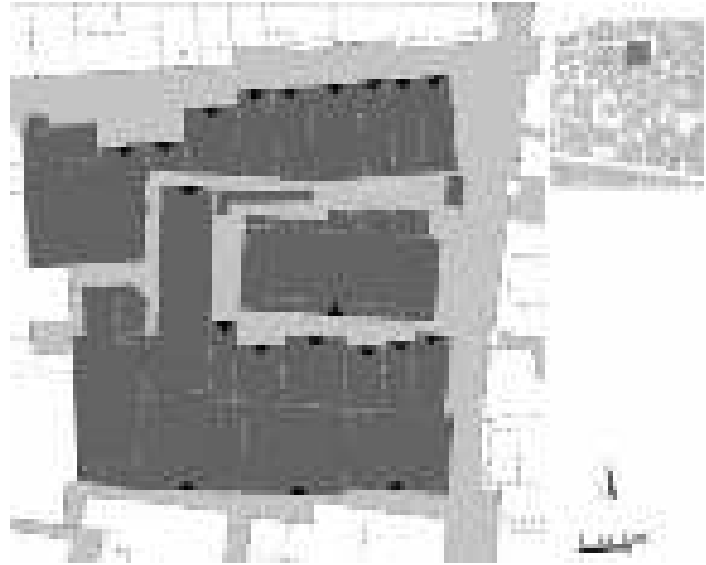


Figure 3. Plots along West Street, Quanzhou.

streets in this area were parallel to the river bank. Most of the streets or lanes used to obtain water or transport goods were developed perpendicularly to the bank, forming dense street grids (Kien To, 2008). Xiguan, on the west side of the outer city, had a flat terrain. Its inner streets intersected in a perpendicular grid pattern (Figure 4). The characteristics of urban morphological evolution in ancient Guangzhou were shaped by various factors, such as the requirements of traditional hierarchy, topography and urban functions. The city's structural patterns were the result of interaction and compromise between these elements. In the early stages of Guangzhou's development, the inner city formed largely in accordance with tradition, with enclosed districts and less accessible roads. The later development of the inner and outer cities was more dependent on features of the external environment and functional requirements.

The plots in Guangzhou retained the principles of traditional Chinese urban planning and construction, while at the same time absorbing the influence of European ideas. The traditional residential blocks contained plots of different sizes and shapes; however, compared with those in Quanzhou, Guangzhou's plot patterns were more regular (Figure 5). The formation and development of the typical residential plots in ancient Guangzhou could be viewed as the result of interaction between traditional Chinese large-scale plot planning and the creation of small elongated plots to meet the needs of commercial development. In addition, the urban-planning concept of functional zoning, as demonstrated in the Sha Mian concessions, the "Thirteen Hong" and other functional areas, led to the uniform development of plot types and plot patterns across functional areas (Lim Huck Cin, 2006).

3.3. Hanoi

The forms of streets and blocks in Hanoi evolved through different historical stages. Initially, both the division and the layout of urban Hanoi were influenced by Chinese traditions. City planning tended to follow natural laws, with streets developed according to original geographical conditions. In the traditional residential and commercial district – the Old Quarter, for example, the formation of the street system and block structure was largely based on the needs of rural families or settlements, and reflected local ways of life and production styles, such as agriculture, fishing or small-commodity trading (Figure 6). In the following French colonial period, however, the development of streets and blocks was affected by Western colonial culture.



Figure 4. *Street-block Patterns of the District of Duobao Road – Enning Road, Xiguan Area, Guangzhou.*

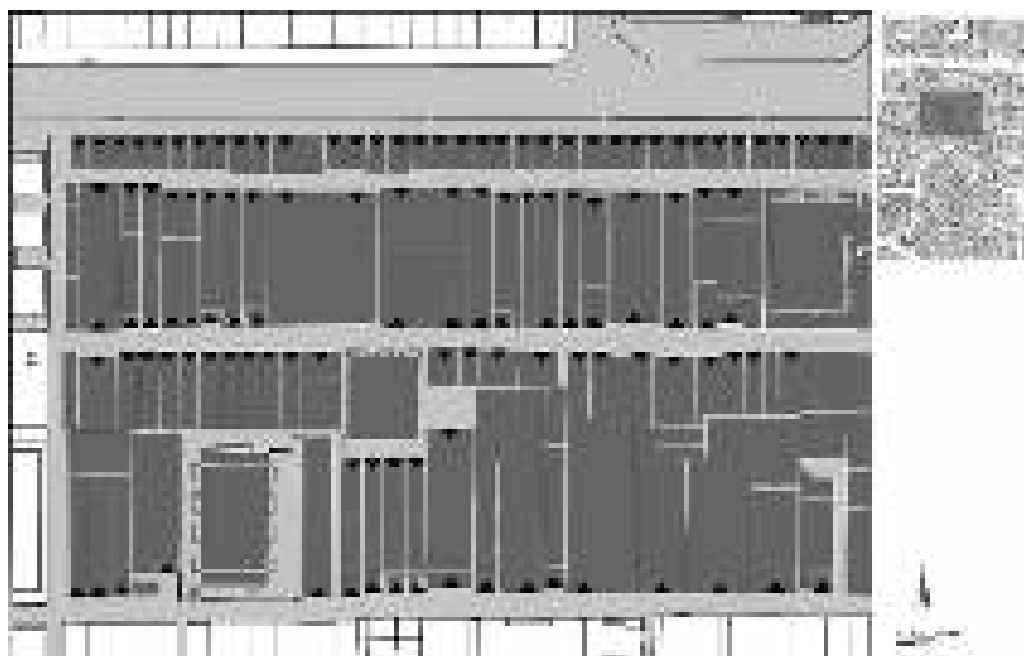


Figure 5. *Plots in the District of Duobao Road – Enning Road, Xiguan Area, Guangzhou.*

The rational planning strategies and methodical layouts common to Western urban construction were brought to Hanoi by the French colonists. Therefore, street and block development in Hanoi no longer simply followed nature. New urban planning was implemented and construction projects carried out in this period, such as the building of the grid system of streets in the French Quarter, the filling in of original water systems and the renovation of the Old Quarter (Widodo Johannes, 2004).

Plots in Hanoi, Vietnam developed based on local rural culture and the characteristics of the local terrain. The major role of the Old Quarter in ancient times was to satisfy the commercial and other living needs of the imperial family and the local people, connecting the Imperial city with the Red River (Zeng Zhaoxuan, 1999). Therefore, compared with the traditional Chinese plots inside some commercial blocks, plot types in the Old Quarter were relatively homogeneous. Most fell into the elongated categories. Different plot series arranged in

pectination patterns enclosed traditional blocks. These elongated plots were relatively deep. The development of the plots in each block expressed a kind of centrality, with each narrow plot expanded and polymerized inward. Direction was clear; there were few interlaced plot patterns inside the blocks (Figure 7). These plot types and plot patterns in the Old Quarter were more conducive to local models of business such as the traditional handicrafts industry, as well as to the integration of traditional local lifestyles.

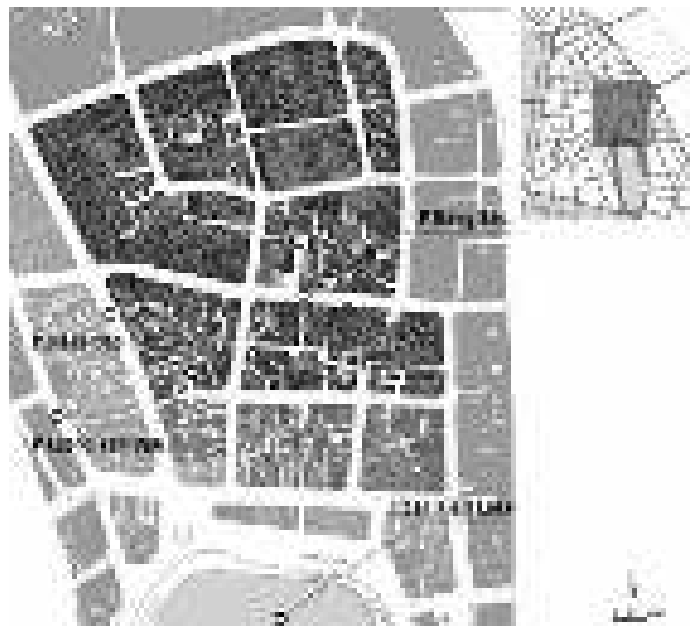


Figure 6. *Street-block Patterns of the Old Quarter, Hanoi.*



Figure 7. *Plots of Hang Dao Street – Dinh Liet Street, the Old Quarter, Hanoi.*

3.4. *Malacca*

The spatial layout of the European area adjacent to the Malacca River was random and scattered, conforming to topography while retaining certain aspects of the Western urban planning tradition. On the other side of the river, there were two major street systems. One of these systems, with streets adjacent to the river or the coast, formed a waterfront pattern, developing horizontally alongside the river bank or coastline. The other system showed a clear grid pattern, dividing the town into several large blocks. The grid street system can be viewed as a colonial product: brought to Malacca by its colonists (Figure 8). When the boundaries of race became blurred in a later stage of the city's history, the original correspondence between block characteristics and ethnic features was lost. Wealth became the main criterion for block division (Zheng Jianyi, Tian Yinsheng, 2014). Different functional layers were arranged from the shoreline to the inland area. Therefore, the influence of European colonists on Malacca's culture and urban morphology was clearly limited. The European influence on urban morphology had already weakened by this time, serving only a minimal adjustment and planning function (Zhou Xia, 2005). Malacca's traditional urban morphology stressed functionality. The selection of sites for and construction of ethnic areas based on the social division of labor were largely determined by production and living requirements. At first, urban forms in this port city were naturally generated in accordance with their own development laws and requirements. Once they had grown to a certain size, however, due to the multiplicity of cultures within the city, these elements began to interact and influence each other. However, their intrinsic morphological rules have always been well respected and inherited largely intact in this traditional port city.

With a long history, the formation and development of plots in Malacca is highly representative of most Southeast Asian port cities. The early plot types and plot patterns in the old urban core of Malacca were designed mainly to provide commercial functional services for the harbors. Under Dutch unified planning according to the living and production modes of different ethnic groups, plots with shophouses inside were arranged tightly and in an orderly fashion in different blocks. The elongated plots along the coast or river bank were arranged in pectination patterns perpendicular to the coast or bank line for the convenience of goods transportation and trade activities (Figure 10). Compared with those on the waterfront, the plots in the inland blocks had a higher density. Trading activities in the old urban core were operated not only by the markets but also along every main street, by shophouses. Therefore, the plot patterns always showed characteristics of balance and homogeneity.

4. Discussion

The following summarizes the similarities and differences between street-block and plot features in the above typical traditional districts in the four port cities under study.

4.1. *Comparison of Street forms and Street Interfaces*

The commercial street interfaces in these traditional districts were organized in a consecutive spatial order, reflecting the relationship between the scale of human activity and neighborhood environment. Influenced by trading development and foreign cultures, most of the commercial street interfaces in these port cities were diverse and hybridized. Affected by Chinese traditions, most of the building elevations along traditional commercial streets in Quanzhou and

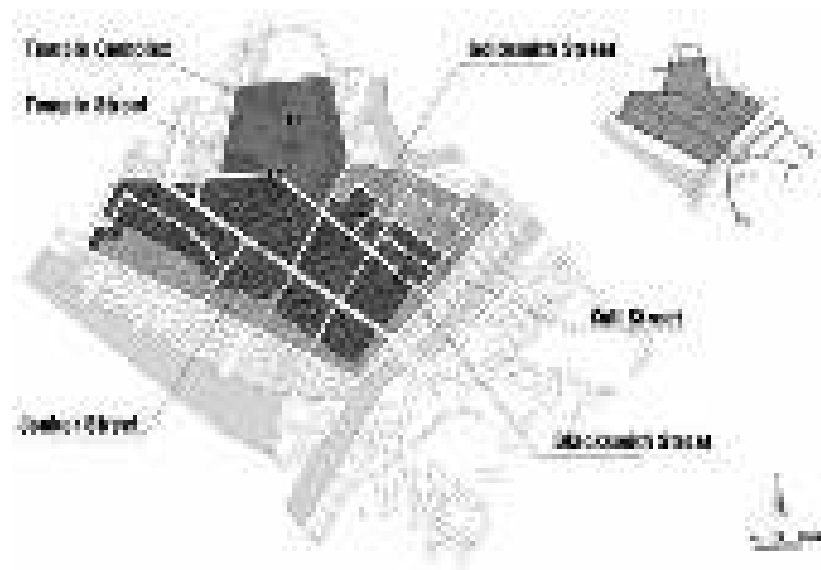


Figure 8. Grid-pattern Street-block System of the Town Quarter, Malacca.

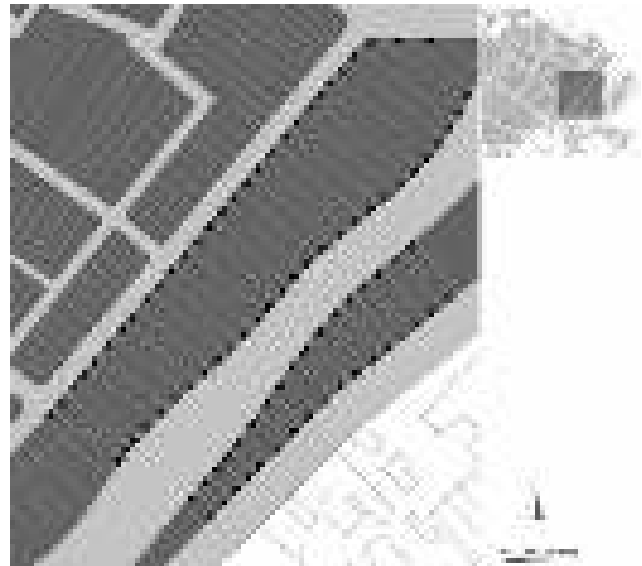


Figure 9. Plots along Malacca River, Malacca.

Malacca were relatively low – only one or two stories – and exhibited brick walls or exterior paint finishes. The horizontal connection was strengthened by the presence of continuously pitched roofs and steps. In the Republican period, the street interfaces of Zhong Shan Middle Street in Quanzhou and Enning Road in Guangzhou were reconstructed, largely influenced by the arcade-house style. The building elevations clearly exhibited Western architectural features. Several adjacent buildings with the same style formed one building group. The ground floors of the arcade houses strengthened their horizontal connections and consistency with the overhanging parts. The first or second floor underlined the vertical independence of a building. Street interfaces in the Old Quarter in Hanoi showed freer characteristics. Due to their different heights, the buildings were highly independent, emphasizing vertical development. The commercial forms on the ground floor were various, without a uniform street interface.

The development of street orientation and street form in these port cities also reflected these two characteristics in its cultural attributes and functional requirements. On the basis of features of the terrain, orientation planning for major streets in traditional Chinese port

cities always took a transverse east-west or longitudinal north-south form, with mutual intersection. As traditional Chinese dwellings always faced in the south-north direction and showed an axisymmetric layout, the street interface of the east-west streets was mainly composed by the major elements of buildings along both sides of the streets. For example, buildings along the two sides of West Street in Quanzhou were wider and shorter than buildings along commercial streets in other port cities, forming a multi-courtyard combination. The buildings on both sides of the streets in Quanzhou in its early period had predominantly residential and other living functions, with a fairly low commercial value. In contrast, the buildings along some north-south major streets, such as Zhong Shan Middle Road in Quanzhou, were east-west facing; this direction was not suitable for living. Most of these buildings had an emphatically commercial function and were narrow, deep and closely connected. Many east-west secondary streets or narrow lanes formed at intervals to capitalize on the southward arrangement of the buildings. As Zhong Shan Middle Road was connected with the inner city and the port areas of Quanzhou, it had a strong transportation function and high commercial value. In sum, building width along these streets reflected the buildings' commercial value, and orientation was emphasized in both the streets of traditional Chinese cities and the buildings on both sides.

Unlike their counterparts in Quanzhou, Guangzhou's major streets developed based on terrain characteristics. Along both sides of a given street were narrow, deep bamboo houses or arcade-houses. Most of the buildings had stores in front, highlighting their commercial value. Secondary streets or small lanes linked the major streets to the interior areas. The interior layout of residential blocks in Guangzhou took the traditional form of neighborhood units, unlike those in Quanzhou. Inside a residential block of a certain scale, inner lanes and buildings were arranged in a regular pattern. Compared with buildings along major commercial streets, wider houses were built close to each other along both sides of the lanes. The arrangement of housing in Guangzhou was based primarily on street orientation and street form; in Quanzhou, houses inside residential blocks were scattered and randomly positioned, reflecting traditional principles of building orientation.

Streets in the traditional districts of many Southeast Asian port cities, represented by the Old Quarter in Hanoi, were usually arranged in a crisscrossed network. Traditional commercial and residential districts were divided into many blocks on a smaller scale than their Chinese counterparts, and integrated commercial and residential functions. Very narrow tubehouses were positioned very close to each other in a single line along each street. Few concretely realized secondary passages connected the streets to the inner areas of each block. Instead, a very narrow lane was usually opened across the ground floor of a tubehouse, linking with the inside parts of each block. Compared with buildings in Chinese port cities, tubehouses were narrower and deeper. Limited by their width, when tubehouses could no longer be developed longitudinally, they began to extend vertically, forming buildings with multiple stories. Therefore, streets in the Old Quarter in Hanoi had a very high commercial value. The commercial value of streets in the Town Quarter of Malacca was much lower, due to the city's sluggish development after British colonization. Compared with those in Hanoi, shophouses along the streets of Malacca were wider and lower.

In terms of the division of commercial and residential blocks, the size of each block in Chinese port cities was usually larger than that in Southeast Asian cities. Shophouses along the streets were usually clearly delimited from purely residential buildings inside the blocks. In contrast, blocks in Southeast Asian port cities was smaller. Their residential and commercial functions merged together, without clear delimitation.

4.2. Comparison of Plot Dimensions

Based on their dual residential and commercial functions, the dimensions of plots in traditional districts in different cities transformed to suit the cultural and functional requirements of specific regions. Plots in traditional residential blocks in Chinese port cities were influenced by Chinese traditional building forms, emphasizing a centrosymmetric layout. The width and depth of the plots did not differ substantially, presenting the typological characteristics of square large-scale plots, such as Quanzhou's official-type mansion plots and Guangzhou's Xiguan grand house plots. However, the plots in traditional commercial blocks were significantly affected by the high value of commercial streets. Therefore, it was difficult for these plots to develop transversally. Instead, elongated plots formed with longitudinal development. Influenced by multi-courtyard traditional buildings in ancient China, this type of plot formed multiple functional areas divided by courtyards. Under normal conditions, of plot depth was about three to eight times greater than plot width, which could be viewed as the result of the longitudinal connection of multiple courtyard units, such as Quanzhou's elongated towel-house plots and Guangzhou's bamboo-house plots.

Whether large-scale or elongated, the dimensions of early plots in Quanzhou were significantly influenced by traditional Chinese residential buildings inside the plots. With later commercial development, changes in plot dimension began to be more strictly controlled by factors relating to commercial value. Compared with those in Quanzhou, plots in Guangzhou were usually narrower, due to high land value and commercial development in the Qing dynasty. With the increase in commercial value of plots along streets, parts of original residential plots were separated to become specialized commercial plots. The width of the new plots remained the same, but they became much shallower; examples include arcade-house plots in Guangzhou in the Republican period.

Most of the plots in traditional commercial and residential blocks in Southeast Asian port cities were elongated: narrow and deep. The depth of typical traditional plots was usually six to twelve times their width. To increase the effective commercial interface along the street, these plots were positioned close to each other, with only small openings (narrow lanes) connecting the inner areas of the blocks. This phenomenon was particularly noticeable in the Old Quarter of Hanoi. Very narrow lanes (less than 1 m in width) opened directly onto the ground floor between buildings. Unlike traditional Chinese elongated plots, which had multiple courtyard units, elongated plots in Southeast Asia were more fully integrated. Their commercial and residential functions were fused, and inner courtyards provided primarily lighting and ventilation, unlike their counterparts in China, whose ritual and cultural value was predominant. Therefore, these plots in Southeast Asian cities were not obviously segmented by courtyard. Later, under the influence of Western planning concepts, and in order to maximize commercial value along streets, more elongated plots – narrower and smaller than traditional ones – emerged in certain new districts of Southeast Asian port cities. Fairly shallow multi-story shophouses with front or back courtyards were built on these plots.

5. Conclusions

Different from the Western port cities, most street-blocks in port districts in Chinese and Southeast Asian port cities emerged in the early time did not experience some unified planning. The morphological characteristics of these blocks were formed based on their natural

terrain features and the requirements of local people's production and lifestyle, developed via self-organization. Due to the limitation of land transportation, the natural watercourse systems were used for the main way of goods transportation. Houses were built along the bank with decks directly leading to the water. In this way, goods could be transported directly to each house, realizing the integrative development of living, trading and transportation. Unlike the traditional port districts, the street-blocks of inland districts of China and Southeast Asia reflected obviously differences. In most of the Chinese traditional districts, commercial areas and residential areas were located separately at beginning, such as the planning of commercial concentrating areas – “East Market” and “West Market” in many traditional Chinese cities. With the later emerging of market streets, one or several main commercial streets were set in one district, while the commercial and residential areas could still be clearly distinguished. In contrast, the street-blocks of most traditional inland districts in Southeast Asia were divided based on different characteristics of commodity production or commercial trade, blending in different activities modes like living, production and trading. With the introduction of Western trading activity and cultural ideology in the later period, in order to enlarge the commercial scale and improve the efficiency of the activities, parts of the water systems were filled, roads were widened and some partition walls were demolished. The planning concept based on functional partition was adopted, with more orderliness and purposiveness. Therefore, it can be seen that the early Chinese and Southeast Asian commercial cities, including these commercial port cities, were based on the formation and development of traditional agricultural civilization, while the western commercial cities were developed based on maritime civilization, or called commercial civilization. In general, traditional port cities in China and Southeast Asia process more morphological characters of diversity and inclusiveness. In contrast, western port cities reflect high efficiency and uniformity.

The evolution of plot patterns occurred gradually. The early residential plots in Chinese traditional port cities were mainly large-scale plots containing traditional dwellings, such as official-type mansions, with a clear-cut orientation and axial symmetry. There was no strict requirement for terrain features. Later, with the introduction of commercial factors via maritime trade, there were corresponding requirements for terrain features, and the locations along commercial streets became more valuable, thereby emerging the elongated plot type. With later commercial development, many of the elongated plots added auxiliary functions along the streets, such as shops or workshops. On the contrary, the plot patterns of traditional blocks in Southeast Asia reflected commercial requirements. Unlike those in Chinese port cities, plots in these Southeast Asian port cities were used primarily for commercial trading and daily production, with auxiliary residential functions. Each plot can be viewed as an independent unit. Later, some adjacent elongated plots were combined to form large-scale plots, reflecting the needs of growing families. Therefore, these plots gradually took on a residential function. However, as these changes were slight, the original plot patterns were not substantially transformed. In summary, the formation and evolution of plots in China and Southeast Asia is the opposing process. The large-scale plots always reflected more local regional cultural characteristics, reflecting their primarily residential function. In contrast, elongated plots, which were usually arranged in pectination or other patterns, were built for local practical functions; their flexibility of construction reflected their commercial and production functions.

Analysis of the close relationship between the street-block level and the plot level also reveals similarities and differences between the two regions. The formation and development of traditional Chinese plots in traditional residential blocks mainly relied on families' continuous multiplication and expansion. Their morphological characteristics reflected Chinese tradition-

al culture, emphasizing the central or axial symmetry of the layout. Compared with those in Southeast Asia, most Chinese residential plots were on a relatively large scale. An organic development mode from smaller to larger and from less to more gradually formed as the whole city developed. The mode can be viewed essentially as the gradual convergence of a single unit into large groups. The composition of plots inside a block always showed a randomly self-organizing character, which was less influenced by the outline and restrictions of street-blocks. Compared with their Chinese counterparts, plots in the residential blocks of traditional Southeast Asian port cities had smaller dimensions and were much more closely related to the characteristics of street-blocks, as they were intended to meet the production and trading requirements of local people. Therefore, plots were usually built along streets, closely linked one by one. The utilization of these plots improved over time.

The overall development of traditional street-blocks in Chinese port cities had obvious scale requirements and sequential characteristics. Different functional blocks were divided by street width, length, or form. The plots inside each block were influenced by the production and living needs of the local residents. There were no strict rules or restrictions governing plot type, plot pattern or plot dimensions, which instead showed organic features. Streets and blocks in Southeast Asia before the colonial period were more affected by terrain features, reflecting a disorderly and organic development mode. The formation and development of plots inside blocks, due to the requirements of commercial development, reflected a more compact and orderly development mode.

Most of the districts located near port areas in Chinese and Southeast Asian port cities developed based on small traditional fishing villages, with many small ports along coasts and river banks. However, there was a key difference between the two regions. With the continuous expansion and development of maritime trade, the development of port areas in Chinese port cities was dominated by one or several specific major ports or commercial streets, while other ports gradually weakened or disappeared. Therefore, the commercial development of the whole city extended from the ports to commercial areas and thence to residential areas. Plots with different functions were arranged along both sides of the main commercial streets. In early Southeast Asian port cities, the forms of streets and blocks near port areas showed some characteristics similar to those of Chinese ones. Later, in line with further commercial development, commercial streets or blocks along coasts or river banks developed in a balanced manner, linking together and forming a commercial belt. Plots arranged along streets with similar forms and dimensions were connected with each other and showed homogeneous characteristics.

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