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PROCEEDING

CONFERENCE THEME
"HALF-WAY THROUGH AGENDA 2030:

ASSESSING THE 5Ps OF SDGs
(PEOPLE, PLANET, PROSPERITY, PEACE AND PARTNERSHIP)"



co-organizer



**29TH INTERNATIONAL SUSTAINABLE DEVELOPMENT
RESEARCH SOCIETY (ISDRS) CONFERENCE 2023**

**Half-way Through Agenda 2030: Assessing the 5Ps of SDGs (People,
Planet, Prosperity, Peace, and Partnership)**

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Measuring the Carbon Footprint of a sample of accommodation facilities in Italy

Ioannis Arzoumanidis^{1,*}, Valentino Tascione¹, Luigi Ippoliti¹, Lara Fontanella²,
Luigia Petti¹ and Andrea Raggi¹

¹Department of Economic Studies, University "G. d'Annunzio", Viale Pindaro 42, 65127, Pescara, Italy

²Department of Legal and Social Sciences, University "G. d'Annunzio", Viale Pindaro 42, 65127, Pescara, Italy

* Corresponding author: i.arzoumanidis@unich.it

Abstract. Tourism is amongst the fastest growing economic sectors, with the number of international arrivals increasing by almost 53% in the decade 2010-2019, a trend which was interrupted by the COVID-19 pandemic: international tourist arrivals decreased significantly in 2020-2021. However, in this sector an ever-growing attention has been paid to sustainability by various stakeholders over time, which has been intensified also by the need to meet the United Nations Sustainable Development Goals. Online booking platforms have become one of the most common means of booking and reliable and concise information within them could guide the user in choosing more environmentally friendly or "green" accommodation facilities. This article explores the inclusion of Carbon Footprint (CF) as a possible life cycle-based indicator to be used in online booking platforms by addressing the CF of a selected sample of accommodation facilities in Italy. For this purpose, a non-probabilistic sampling strategy has been implemented for exploratory analysis. Each identified accommodation included its own peculiarities from a sustainability viewpoint. Three of them agreed to collaborate and were then assessed in terms of their CF, by using CF-specific software. The results so far highlighted the energy consumption as one of the most impacting aspects.

1. Introduction

Tourism is amongst the fastest growing economic sectors, with the number of international arrivals reaching 1.5 billion in 2019, an increase of almost 53% in the decade 2010-2019 (Statista, 2022). Such a trend was abruptly interrupted by the COVID-19 pandemic, which has affected the entire planet. Indeed, according to the UNWTO, international tourist arrivals decreased by 73% for the year 2020 and by 72% for 2021 (when compared to 2019) (UNWTO, 2023). However, in this sector an ever-growing attention has been paid to sustainability by various stakeholders over time, e.g., consumers or political decision-makers, as demonstrated also by the great number of financial incentives promoted to support sustainable initiatives (Arzoumanidis et al., 2021; Italian Ministry of Tourism, 2023). Such attention has been intensified also by the need to meet the United Nations Sustainable Development Goals (SDGs) (United Nations, 2016).

Currently, there are systems for labelling and measuring the environmental performance of services, but only few are based on a life cycle perspective (Arzoumanidis et al., 2021); this represents a strong cognitive and communicative limitation of these tools. Online booking platforms have become one of the most common means of booking in the tourism sector (Arzoumanidis et al., 2022), allowing managers to provide targeted information on their "offer package" and users to have an immediate and anticipated idea of the characteristics of the facility and activities related to their stay, and possibly personalise their stay. Objective and concise information could be inserted within the platforms to guide the user in choosing more environmentally friendly or "green" accommodation facilities (Chaw and Tang, 2019; Arzoumanidis et al., 2022).

This article explores the inclusion of Carbon Footprint (CF) as a possible life cycle-based indicator to be used in online booking platforms. It builds upon previous research of a literature review on life cycle-based sustainability and circularity indicators for the hospitality sector (Arzoumanidis et al., 2021; Arzoumanidis

et al., 2022) and addresses the CF of a selected sample of accommodation facilities in Abruzzo, Italy. For this purpose, a non-probabilistic sampling strategy has been implemented for exploratory analysis (Galloway, 2005), which is still ongoing. Each identified accommodation profile included its own characteristics and, therefore, peculiarities from a sustainability point of view. The sampled facilities were contacted for the necessary CF data collection and until now three of them have agreed to collaborate. The overnight staying at the three facilities was then assessed in terms of their CF, by using CF-specific software (CCaLC) (Manchester University, 2023).

The article is structured as follows: in Section 2, the literature review basis is briefly presented; in Section 3, the procedure of the selection of the sample is described; then, the studies of the three tourism facilities are described in terms of the methods used and analysis performed; the results of the studies are presented and discussed in Section 4; finally, in Section 5 some conclusions are drawn and future development possibilities are outlined.

2. Literature Review

The previously published literature review (Arzoumanidis et al., 2021) explored the use of life cycle-based sustainability and circularity-related indicators for the hospitality sector. The results discerned sustainability indicators from the life cycle-based and the circularity indicators in the sense that the sustainability ones also included socio-economic and sociocultural aspects. These indicators have been suggested by international organisations/frameworks and have been examined thoroughly by the scientific community for the tourism industry, but they were not specifically addressed for the hospitality subsector. Life cycle-based sustainability indicators for the tourism industry in general were also little tackled, which was also valid for the hospitality subsector (ibid.). Amongst the indicators, carbon footprint/climate change was largely mentioned to be used as a life cycle-based sustainability indicator for tourism/hospitality, either alone (as a proxy) or amongst other indicators (ibid.). For this reason, this article focusses on examining CF as a possible life cycle-based indicator to be used in online booking platforms for the hospitality sector. Other Life Cycle Assessment indicators included acidification and nutrient enrichment/eutrophication. On the other hand, the circular tourism literature was found to mostly focus on practices rather than their evaluation, with the most commonly mentioned circularity indicators being recycling rate and waste-related indicators. Finally, the literature proposed that an impact assessment of hotel services could be performed following a circularity strategy, e.g., durable vs. single-use (ibid.).

3. Methodology

3.1. Selecting a sample of accommodation facilities

The selection of the sample of accommodation facilities was performed by implementing a non-probabilistic sampling strategy for exploratory analysis (Galloway, 2005), which is still ongoing. Such a process started with a census of all types of facilities (e.g., guesthouses, vacation rentals, Bed & Breakfasts, hotels, country houses, hostels, shelters, residences and farmhouses) in order to have the complete picture on the tourist offer (Abruzzo turismo, 2023).

Following a qualitative and numerical assessment of the facilities and based on the overarching objective of the project, the field of research was limited to B&Bs, farmhouses and (three- to five-star) hotels.

The selection of the municipalities, in which the facilities to be contacted were selected, was performed whilst trying not to concentrate facilities in specific areas whilst leaving out others.

For the choice of municipalities, the initial condition was that they fall within areas of high cultural heritage value (Italian National Institute of Statistics, 2023), which was prerequisite of the overarching project. These were defined as (Italian National Institute of Statistics, 2023): municipalities characterised by the presence of at least one UNESCO site, and/or a village certified by the Association "*I Borghi più belli d'Italia*" ("the most beautiful villages in Italy" – Bacilieri, 2022), and/or Orange Flags of the Italian Touring Club (Italian Touring Club, 2023), and/or that are part of a National Park, and/or that has been Capital of Culture, and/or with at least 10,000 visitors per year to a state or non-state museum, monument or archaeological site as of 2018.

In the next step, the statistical sampling method was used to identify the facilities within those municipalities of a high cultural heritage value. The regional territory was divided into four altitude ranges

through stratification: plains/hills (0-350 m above sea-level), foothills (350-600 m above sea-level) and mountains (stratified in turn into 600-1000 m above sea-level and over 1000 m above sea-level). Within these strata, a total of 6 municipalities were selected, in which 12 facilities to be chosen (a minimum statistical sample that can be considered acceptable).

In stratum I, the Municipality of Pescara was chosen, given that it is the most representative municipality of the hotel supply in the stratum but also in the region. Pescara was considered important in terms of magnitude of tourist flows as well as being the regional barycentre from a tourism point of view. The city is also characterised by the presence of tourism-related infrastructure, such as large train station and an airport, which is located 7 km away from the city centre.

In stratum II, the municipality of Sulmona, which is part of the Majella Park, is a UNESCO Geopark. It is a city of about 23000 inhabitants and rich in cultural attractions.

Two municipalities were selected in stratum III: Villetta Barrea and L'Aquila. The former is an important tourist destination located within the “Abruzzo, Lazio and Molise” National Park. On the other hand, L'Aquila is the regional capital. A high number of accommodation facilities (the highest in Abruzzo) and a wide range of cultural offerings are located in this city.

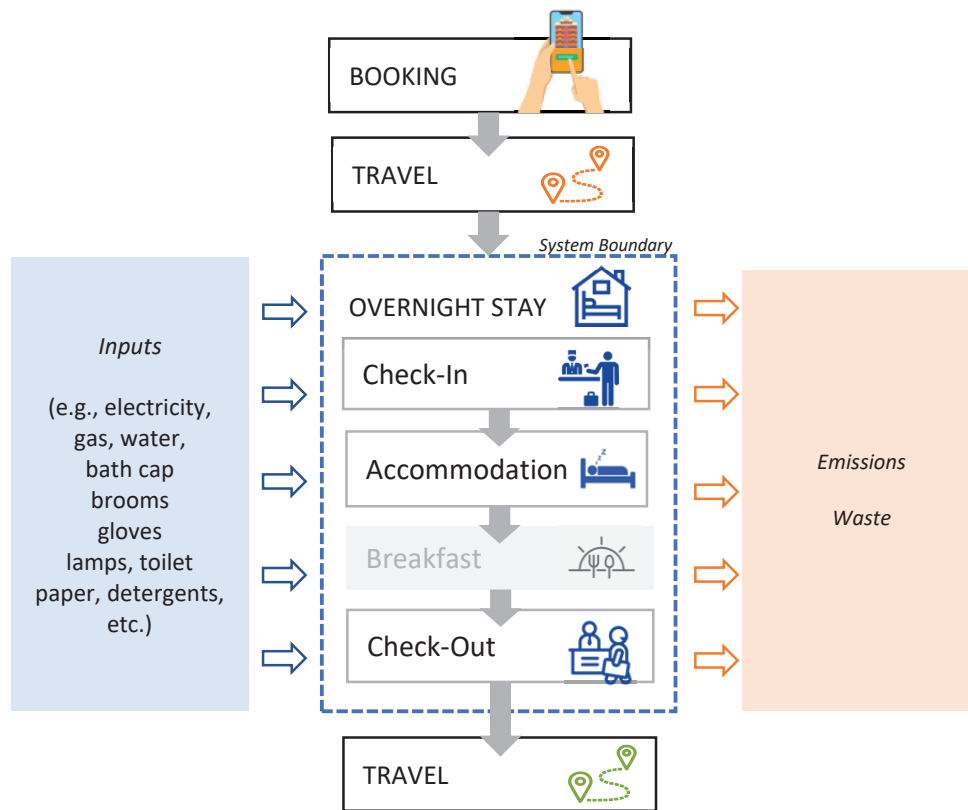
Two municipalities were also chosen in stratum IV, both of which are part of “*I Borghi più belli d'Italia*” (“The most beautiful villages in Italy”) designation. The first was Santo Stefano di Sessanio, a town that is part of the “*Gran Sasso and Monti della Laga*” National Park, characterised by the presence of a luxurious *Albergo Diffuso* hotel. The second place was Scanno, which has acquired the Touring Club's Orange Flag and is part of the “Abruzzo, Lazio and Molise” National Park, hosting the UNESCO World Heritage-listed beech forests. It also boasts a centuries-old goldsmith tradition.

The selected municipalities were then examined in terms of all the accommodation facilities that are present within their territories. The facilities were then contacted by the Authors to ask for their interest in participating in the environmental sustainability assessment by providing all the necessary data. So far, three facilities have agreed to collaborate (one from Sulmona, one from Santo Stefano di Sessanio and one from Scanno).

3.2. Carbon Footprint: Goal and Scope Definition and Life Cycle Inventory

The 3 analysed accommodation facilities include: a 1-room Bed & Breakfast (BB A), a 5-room Bed & Breakfast (BB B), and a 29-room hotel (Hotel), all situated in the region of Abruzzo, Italy (please refer to Section 2). The data collection for all three facilities was carried out with reference to the year 2019 in order to avoid any bias attributable to the COVID-19 pandemic. In line with the scientific literature (e.g., Soratana et al., 2021), the functional unit (FU) was defined as an overnight stay (1 night) of a guest, including all related activities (reception/check-in, accommodation in the room, check-out, maintenance/cleaning), with the exception of the breakfast service. Figure 1 shows the boundary of the system under analysis that was considered in all three cases.

Figure 1. System boundary (elaborated by the Authors).



The data collection was carried out at directly the facilities by using specific questionnaires and data collection forms. As regards the material inputs (different for each facility), the following consumptions were taken into consideration: laundry detergent (the service is performed directly on site for “BB A” and “BB B”, whilst it is performed externally for “Hotel”), cleaning detergent, bleach, floor rags, brooms, gloves, shampoo, soap, toilet paper, disposable plastic cups, bath caps, sewing kits, light bulbs, paper used in reception. These consumptions were quantified on the basis of purchases made in the reference year, assuming that all the materials purchased were consumed in the same period of time (without an increase/decrease in stocks), whilst data were provided also for the external laundry as well as the related transport. The values were then normalised to the single overnight stay by considering the total number of overnight stays during that year.

On the other hand, with regard to energy inputs, the consumption of electricity and natural gas were taken into consideration. Finally, water consumption was also taken into account. For water, electricity and gas, for facilities “BB A” and “BB B” and given that they are small and without additional services (e.g., restaurant, swimming pool, etc.), the consumption that was taken directly from the supply bills was used (for the reference year), without making any allocations. When it comes to the “Hotel” facility, however, a 15% decrease in the total billed consumption was performed (Hotel Energy Solutions, 2011). Finally, all packaging materials and waste with the related destinations (e.g., landfill, recycling, etc.) were considered. With regard to packaging, the three facilities provided information on the type of material used as well as on the mass (in the few cases where the mass was not indicated, estimates were used: in any case, since these are minimal quantities, they could possibly be also excluded, by implementing a 99% cut-off –please refer to ISO 14040:2006 (ISO, 2006a) and 14044:2006 (ISO, 2006b)).

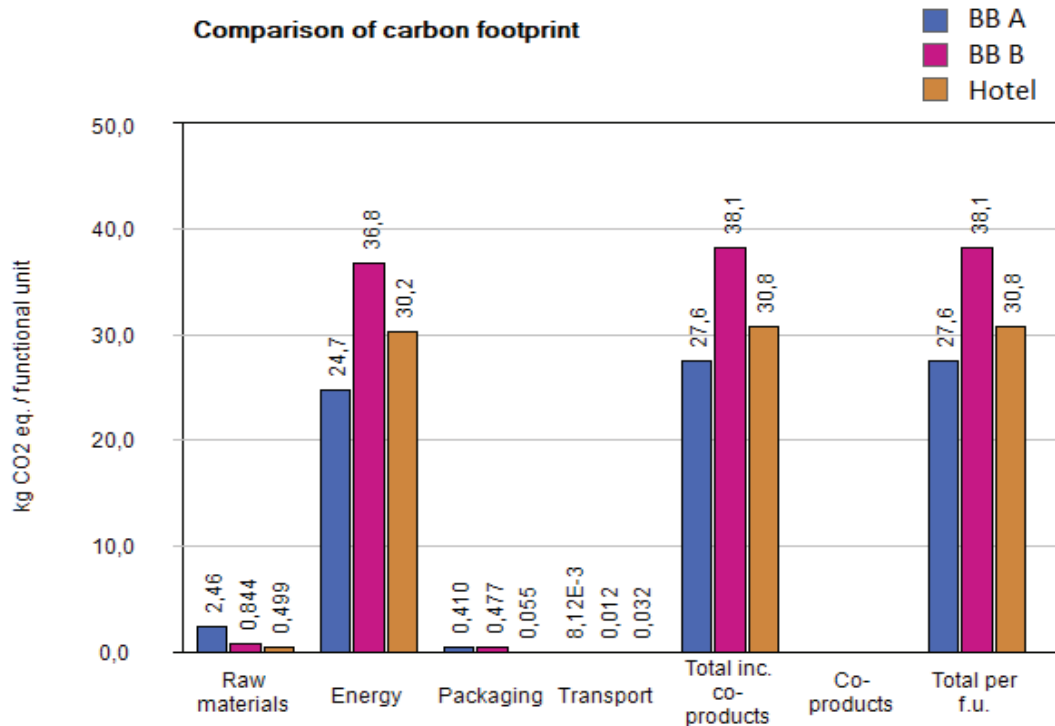
As far as the transport of the various inputs from the supply points to the locations of the facilities are concerned, in the case of “BB A” the owners used their own passenger car for a distance of 3 km, whilst for “BB B” a 3.5-tonne truck was used for long distances (e.g., 60-80 km) and their own car for shorter ones (approximately 30 km); finally, for “Hotel” all transport was carried out using a small van (the distance is 60 km). In all cases, the owners of the facilities have also indicated, for each means of transport, the European reference standard relating to polluting emissions from vehicles (e.g., EURO5).

Subsequently, the collected data was entered into the CCaLC software, using its incorporated database, paying the utmost attention to select, amongst the processes present in the database, the most relevant to those identified during data collection. No problems were highlighted during this operation: indeed, all the relevant processes were identified in the database. Nonetheless, for the case of soap, shampoos and detergents, these had to be aggregated under the same entry “soap”, given that the software did not provide differentiated entries.

4. Results and Discussion: Carbon Footprint Life Cycle Impact Assessment and Interpretation

The CCaLC software calculations follow the international ISO 14044:2006 (ISO, 2006b) and PAS2050 (BSI, 2011) standards and provide the characterisation results for the environmental impact category “climate change”/ CF. The CF results (Figure 2) showed that it is “BB B” to reach the highest total CF score (38.1 kg CO₂-eq per FU), which strongly depended on energy consumption (36.8 kg CO₂-eq per FU) and to a lesser degree on the other inputs (called “raw materials” in CCaLC) (0.844 kg CO₂-eq per FU) and packaging (0.477 kg CO₂-eq per FU). The second-highest CF score derived from “Hotel” of 30.8 kg CO₂-eq per FU, which once again mainly depended on energy consumption (30.2 kg CO₂-eq per FU). Finally, “BB A” reached a total of 27.6 kg CO₂-eq per FU, which also depended mostly on energy consumption (24.7 kg CO₂-eq per FU). Such a value for the total CF is higher than the global average of 14 kg CO₂-eq per FU found in the scientific literature (Gössling and Lund-Durlacher, 2021); this can be justified by the fact that the area under analysis is a mountainous region that requires the facilities to consume high amounts of energy for heating during wintertime.

Figure 2. Carbon Footprint comparison of the three facilities (extracted from the CCaLC software; elaborated by the Authors).



Indeed, a more in-depth analysis of the CF of the three facilities in terms of energy consumption was performed to confirm that. As Figures 3-5 demonstrate, for all three facilities (irrespective of the type of accommodation) it is the consumption of natural gas, which is mainly used for heating, to have the greatest impact in terms of CF: 17.6 kg CO₂-eq per FU for “BB A”, 32.8 kg CO₂-eq per FU for “BB B”, and 28.1 kg CO₂-eq per FU. Such findings confirm the importance of energy consumption in CF and, more in general, in Life Cycle Assessment (LCA) studies in the hospitality sector (e.g., Filimonau, 2016; Nofriya, 2022).

Figure 3. Carbon Footprint related to the energy consumption of “BB A” (extracted from the software; elaborated by the Authors).

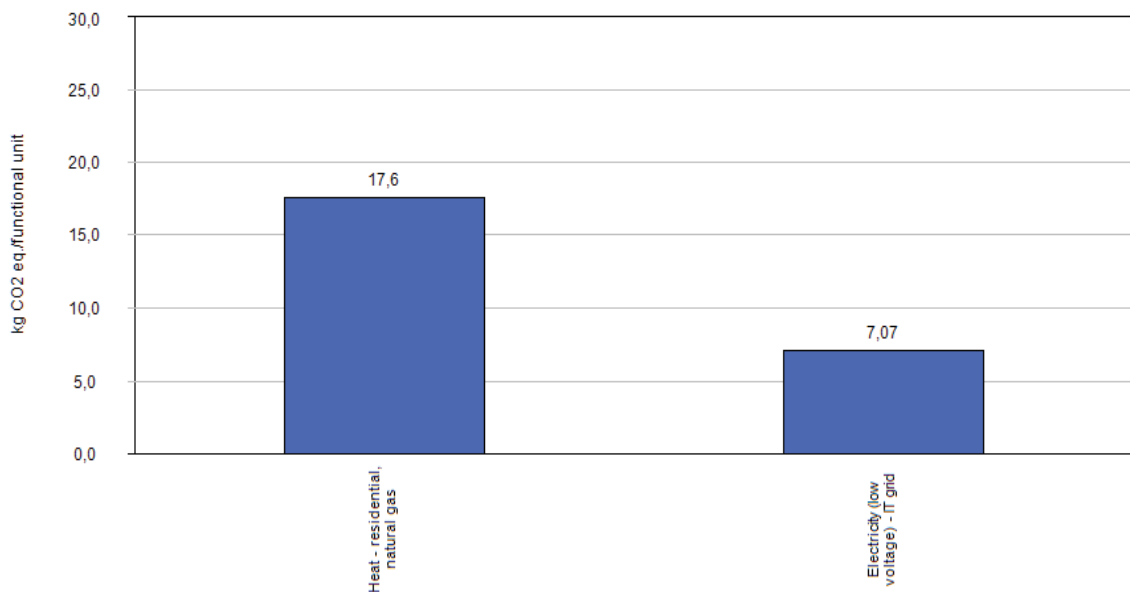


Figure 4. Carbon Footprint related to the energy consumption of “BB B” (extracted from the CCaLC software; elaborated by the Authors).

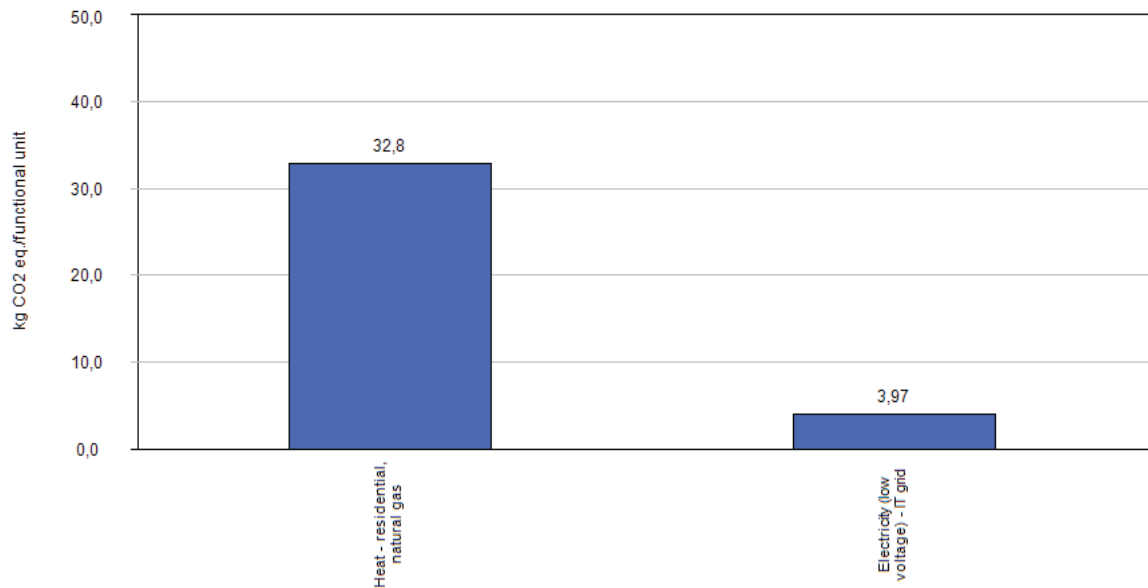
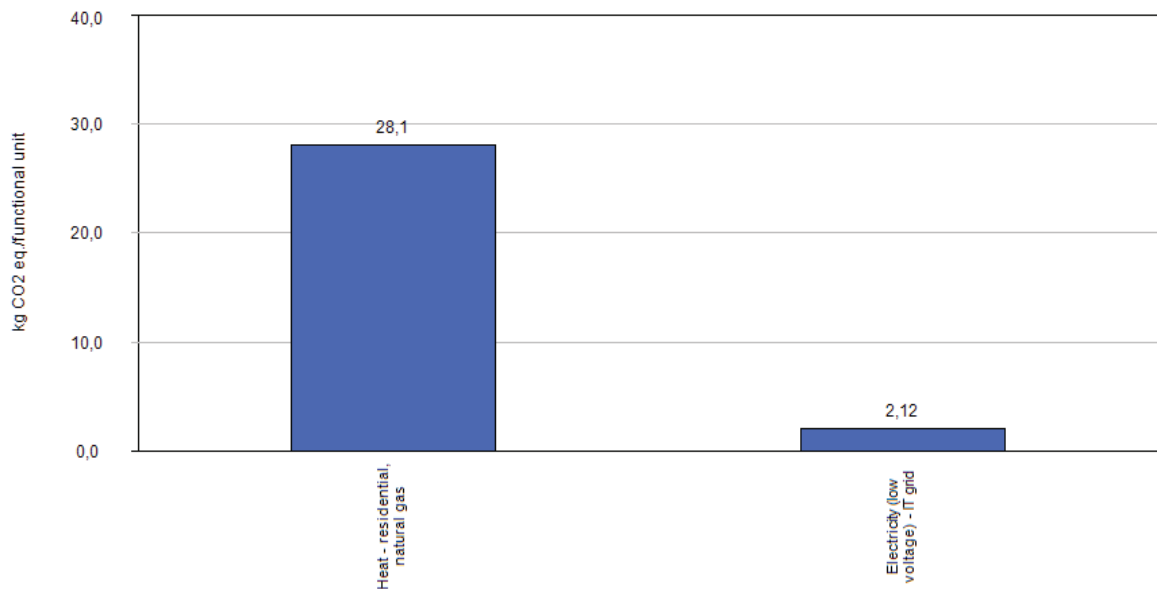


Figure 5. Carbon Footprint related to the energy consumption of “Hotel” (extracted from the CCaLC software; elaborated by the Authors).



Finally, in terms of raw materials (i.e., the input-related materials for one overnight stay), it is the consumption of soap to be more impacting for “BB A” and “Hotel”, followed by water consumption (Figures 6 and 8), whilst for “BB B” it is the use of LED lamps the most impacting followed by water consumption (Figure 7); however such values are much lower than the energy consumption-related ones (Figure 2). As aforementioned (Section 3), the inputs soap, shampoos and detergents had to be aggregated under the same entry “soap”, given that the software did not provide differentiated entries. For this reason, no detail can be acquired in terms of which of the soap, shampoos or detergents impacted the most (however, given their low impact in terms of CF, a higher level of detail would not be significant). Furthermore, the water consumption (Figures 6-8) refers to the best available dataset that was present in the software’s database (“UK tap water”). Nonetheless, it has to be acknowledged that the choice of an “Italian tap water”, which was absent in the database, could have entailed different CF results.

Figure 6. Carbon Footprint related to raw materials of “BB A” (extracted from the CCaLC software; elaborated by the Authors).

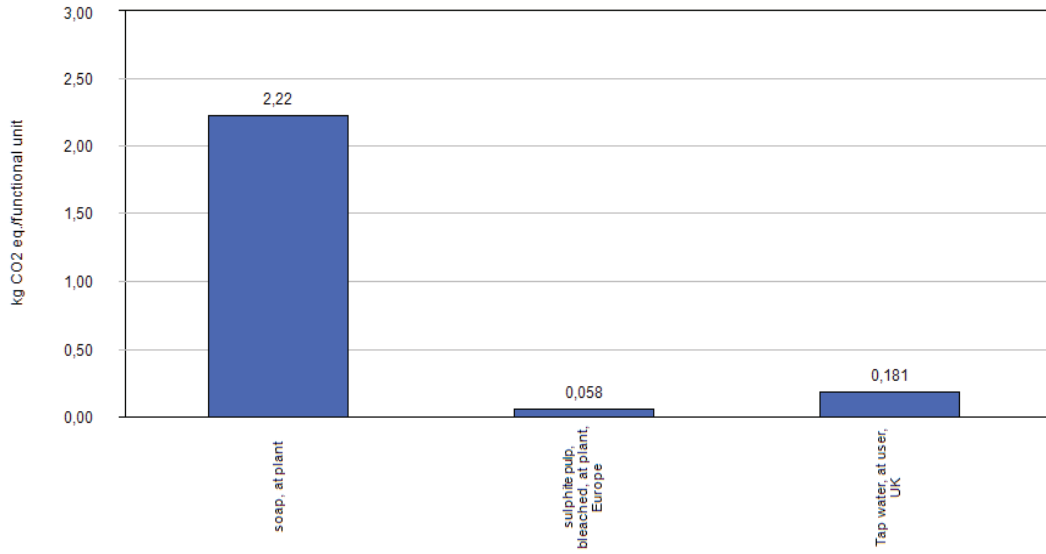


Figure 7. Carbon Footprint related to raw materials of “BB B” (extracted from the software; elaborated by the Authors).

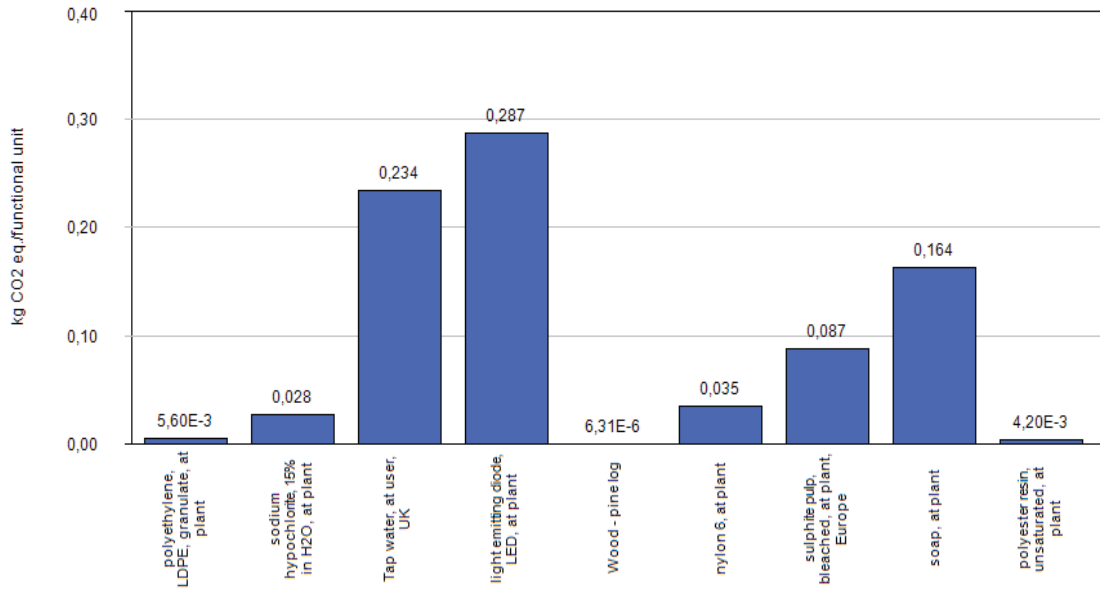
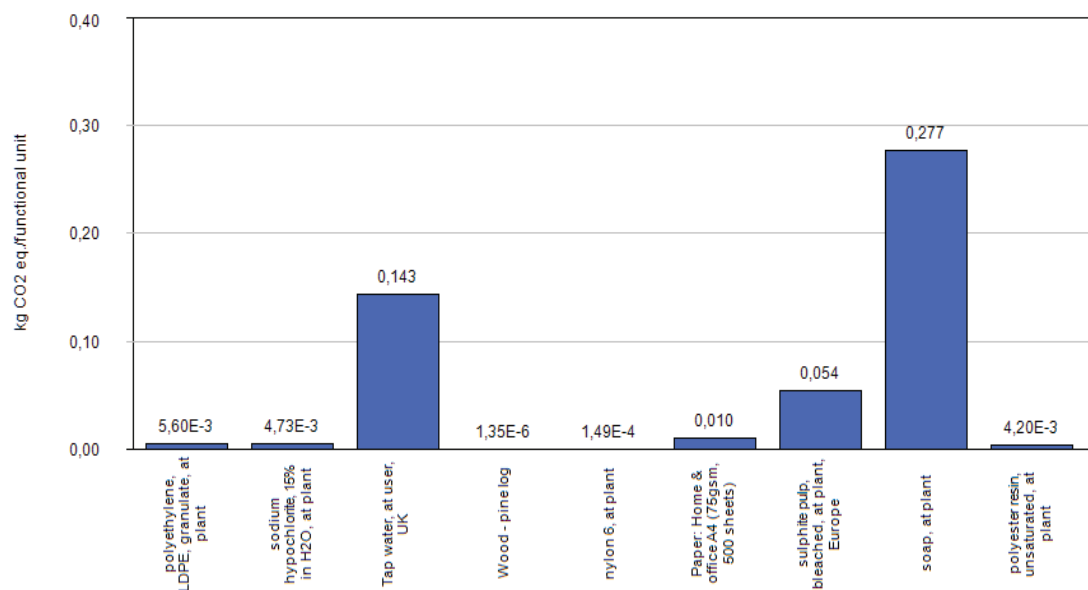


Figure 8. Carbon Footprint related to raw materials of “Hotel” (extracted from the CCaLC software; elaborated by the Authors).



5. Conclusions

Tourism is amongst the fastest growing economic sectors, with an ever-growing attention that has been paid to sustainability by various stakeholders and intensified also by the need to meet the United Nations SDGs. Online booking platforms have become one of the most common means of booking and information within them could guide the user in choosing more environmentally friendly or "green" accommodation facilities. This article explored the inclusion of CF as a possible life cycle-based indicator to be used in online booking platforms by addressing the CF of a selected sample of accommodation facilities in Italy. In this direction, a sampling strategy of the accommodations was implemented for exploratory analysis and until now three of them agreed to collaborate and were then assessed in terms of their CF related to one overnight stay.

The results highlighted that the highest "climate change"-related impact is attributable to "BB B", followed by "Hotel" and "BB A", thus demonstrating that such an impact does not depend on the type of accommodation. Such a statement however has to be taken carefully, given the limited number of facilities considered so far.

An important finding, which seems to confirm the existing scientific literature, is that energy consumption is the most impacting input in terms of CF (*circa* 90% of the total CF for "BB A", 97% for "BB B" and 98% for "Hotel"), which in this case depends strongly on the heating used during wintertime. Therefore, the owners of the facilities should work on this in order to reduce their total CF, e.g., via insulation activities to reduce building energy losses and/or replacing the energy source with a cleaner one.

Future developments of this study will include more facilities in order to assess the robustness of the results that have been acquired so far. Furthermore, full LCA implementations will be carried out in order for a holistic assessment of not just one environmental impact category to be performed. In this way, the most affected environmental impact categories, as well as any trade-offs between impacts will be identified.

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