Managing Knowledge Integration across Boundaries

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Division of Labour, Supplier Relationships, and Knowledge Integration

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7.1 INTRODUCTION

The increasing complexity of products and services, customers' demands for the latest technologies, and high competitive pressure have increased the use of outsourcing as a strategy to reduce costs and access specialized knowledge located outside firms' boundaries. Although we have a relatively thorough understanding of the advantages and disadvantages of outsourcing, we know very little about how firms manage knowledge integration (Bounfour, 1999; Gilley and Rasheed, 2000; Rothaermel et al., 2006; Holcomb and Hitt, 2007; Maskell et al., 2007; McIvor, 2008; Wüllenweber et al., 2008; Bengtsson et al., 2011; Dabhilkar and Bengtsson, 2011; Miozzo and Grimshaw, 2011). Whenever firms decide to make use of outsourcing, they are required to make decisions regarding the definition of their boundaries, their closeness to suppliers in terms of knowledge, capabilities, and which sensitive information to share (Gulati, 1998; Parmigiani, 2007; Parmigiani and Mitchell, 2009; Kapoor and Adner, 2012).

In this chapter, we focus on the knowledge integration requirements related to the implementation of an outsourcing strategy, that is, the mix of decisions that defines whether to outsource or not, the amount of knowledge to retain in house, and the types of relationships with suppliers. The locus of competitive advantage lies in the ability to acquire and retain specialized knowledge and to integrate knowledge bases across different organizational boundaries (Grant, 1996; Henderson and Cockburn, 1996; Patel and Pavitt, 1997; Dibiaggio and Nasiriyar, 2009). According to the literature on transaction cost economics and the resource based view, firms' implementation of outsourcing is influenced by: i) strategic factors which affect resources and capabilities; and ii) technological factors related to the technical characteristics of the production process. Boundaries are shaped in various ways, ranging from close interaction

with suppliers, which involves high levels of knowledge sharing, to rigid divisions of labour involving clearly identified tasks, rules, and roles. The range of outsourcing decisions occurs along a continuum between the two extreme points of low integration among firms and a rigid division of labour in which firms are distant from both a cognitive and organizational perspective, and high integration among firms and a blurred division of labour in which cognitive and organizational boundaries are imprecise. In this chapter, we address the following research questions. How do technological and strategic factors affect the implementation of outsourcing in a client–supplier relationship? And, more specifically, how do these factors influence knowledge specialization and integration?

Our analysis is based on a fast-evolving industry: information technology solutions (Oliva and Kallenberg, 2003; Davies, 2004), whose offerings comprise customized bundles of products and services. The offer of solutions drove the elimination of the traditional division between service and manufacturing, allowing firms to provide bundles of products and services in unique packages. More specifically, enterprise resource planning systems, comprising hardware, software, and technical support, are offered as solutions. Clients do not buy individual components from different firms; they purchase a complete enterprise resource planning system from a single supplier, which provides the software and the hardware along with consultancy services, post sales assistance, system customization, and hardware maintenance (Foote et al., 2001; Galbraith, 2002). The offer of solutions poses a number of challenges for firms that need to integrate different activities often performed by diverse firms. The activities involved in solutions are often developed in collaboration with external suppliers, and the solutions provider is responsible for integration and final delivery (Windahl and Lakemond, 2006). Our study focuses on a sample of solutions providers, taking the firm as our unit of analysis.

7.2 THEORETICAL BACKGROUND

7.2.1 The Boundaries of Organizations

When Coase (1937) first proposed the notion of transaction cost economics, this constituted a major departure from the dominant neoclassical economic orthodoxy. As Joskow (1988) pointed out, one of the most important contributions of transaction cost economics is its comparative perspective, that is, its recognition that there is a wide range of arrangements which can be used to govern transactions. Markets and hierarchies roughly define the two extremes of a variety of resource allocation arrangements. However, there is no rigid separation between markets and hierarchies in either practice or the literature.

The decision process is more complex and, once the production process is moved outside the firm's boundaries, firms are required to define the types of relationships with their suppliers. Firms are supposed to define their closeness with suppliers and, more importantly, how much knowledge and sensitive information to share.

Strategy and innovation scholars have begun to explore the structure of the relationships among agents in an industry. Empirical research on a variety of empirical contexts, for example, computers (Baldwin and Clark, 2000), text books (Schilling, 2000), and mortgage banking (Jacobides, 2005), suggests that industries are moving towards increasing disintegration and specialization. The structure of the industries so defined both influences and is influenced by how firms develop, share, and integrate labour and knowledge (Dalziel, 2007; Pisano and Teece, 2007; Fixson and Park, 2008). New dynamics, such as the transition from vertical integration to vertical disintegration, accelerate and alter consolidated boundary divisions. This shift poses new challenges for the integration of heterogeneous knowledge bases and the effectiveness of established knowledge integration mechanisms (e.g. systems integration) (Brusoni et al., 2009; Ferraro and Gurses, 2009).

7.2.2 The Boundaries of Knowledge and its Integration

Management scholars have long acknowledged the value and challenges of knowledge integration. Design, production, and commercialization of products and services require the ability to acquire and integrate different knowledge bases (Henderson and Clark, 1990; Rumelt, 1991; Iansiti and Clark, 1994). Integration could be seen as among an organization's primary objectives; according to the knowledge-based view, selecting appropriate knowledge bases and facilitating their integration are the ultimate reasons for a firm's existence (Kogut and Zander, 1992; Grant, 1996). In fact, the evolution of new products derives from the interaction among a variety of knowledge bases, and coordination of a network of suppliers (Prencipe, 1997). Several scholars have studied how 'firms identify and create means of sharing, shaping, and reorganizing knowledge' (Brusoni et al., 2009: 211), and the role of specialized knowledge bases as sources of competitive advantage, combined with the importance of developing dedicated mechanisms to integrate this knowledge. Thus, the ability to integrate heterogeneous knowledge bases is a prerequisite for the achievement of long-term competitive advantage (Prencipe et al., 2003).

Integration has been defined as 'the quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demand of the environment' (Lawrence and Lorsch, 1967: 11). In the context of information technology solutions, knowledge integration includes all the activities, processes, and routines a firm deploys to facilitate collaboration

among different partners contributing to the various components of its offering, with the objective of developing product–service bundles in a more efficient manner. This coordination effort is de facto a knowledge integration process 'that facilitates a common understanding of project objectives and the means to reach those objectives' (Mitchell, 2006: 924). Mitchell (2006) identifies two different kinds of knowledge integration approaches: boundary spanning and integrative. In an initial phase, knowledge integration should fulfil a boundary spanning role allowing firms to import external knowledge (i.e. knowledge about the functioning of a specific component developed by an external supplier). In a second phase, this externally acquired knowledge needs to be blended so that different stand-alone elements can be recombined into a single bundle (Dawson et al., 2010).

Outsourcing poses important questions about how to coordinate and integrate the outsourced knowledge and, in conceptualizing the possible solutions, we identify two configurations that represent the poles of a continuum of configurations decisions that firms might adopt. The two configurations represent two different challenges for firms called on to integrate different knowledge bases.

In the first configuration (faraway), firms opt for market-based relationships, with little overlap of knowledge and capabilities, and with a rigid separation of activities. In this configuration, it is vital that outsourcers retain close control over externalized activities, because higher control and rigid division of labour limits supplier opportunism (Demsetz, 1968; Conner and Prahalad, 1996; Takeishi, 2002). This configuration is appropriate for simple and well-structured problems (Farjoun, 1994; Macher, 2006). The knowledge that is outsourced overlaps very little with the knowledge that is kept in house, and coordination and integration occur via an arm's length relationship.

In the second configuration (so close), firms opt for close integration with suppliers with cognitive and administrative overlap (Petersen et al., 2003; Das et al., 2006). A close relationship with suppliers facilitates the development of similar capabilities (Borys and Jemison, 1989), lowers the risks of technological uncertainty (Kapoor and Adner, 2012), and facilitates knowledge sharing (Bonaccorsi and Lipparini, 1994; Parmigiani, 2007). This solution is appropriate for ill-structured and complex problems (Macher, 2006). In this case, there is important knowledge overlap among the collaborating firms, and knowledge integration is based on continuous and informal exchanges of knowledge and information.

7.3 HYPOTHESES DEVELOPMENT

In order to explore the knowledge integration requirements for these two configurations, we identified two sets of factors which, according to

transaction cost economics and resource-based view literatures, influence outsourcing implementation and, therefore, knowledge integration. The first set of requirements is technology related and influenced by the technology underlying the activities outsourced. Firms have less freedom to modify them. There are two factors affecting this category: i) degree of product modularity; and ii) level of process standardization. The degree of modularity depends on the possibility of developing common product interfaces, and is influenced largely by the characteristics of the activity being outsourced; the level of process standardization depends on the technical characteristics of the activity.

The second set of factors is strategy related: they do not depend on the technical characteristics of the outsourced tasks, but are influenced by the firm's decisions. These strategic factors are: i) the core-ness of the task; and ii) the frequency of the activity's inclusion in the solution. These factors influence the firm's strategic positioning, and depend on the firm's characteristics and decisions.

These four factors are identified based on the specificities of the information technology solution. Drawing on previous studies, we selected a set of factors influencing the firm's outsourcing decision (Davies, 2001, 2004; Galbraith, 2002; Windahl et al., 2004; Davies et al., 2006; Ceci, 2009; Ceci and Masini, 2011). We know how these factors impact on the decision whether or not to outsource, but we do not know the extent to which they impact on the other aspects of outsourcing. A review of the literature leads to the development of our hypotheses.

7.3.1 Modularity of Products

In modular architectures, module interfaces are standardized and must remain unchanged for a specified period of time (Schilling, 2000). Each module performs a specific function and can be designed and improved independently. Products designed according to modularity principles can be easily interconnected and bundled (Ulrich, 1995). Modularity offers several advantages: it enables the benefits of customization to be captured without incurring its full costs and, therefore, allows greater specialization; it helps firms achieve flexibility and respond quickly to the market through the introduction of new products, the extension of existing product lines, and rapid product upgrades (Sanchez and Mahoney, 1996; Schilling and Steensma, 2001). Tiwana (2008b) highlights that technological modularity can substitute for more formal control mechanisms, such as alliances, because it facilitates the decoupling of interoperating subsystems. Modularity is an interesting approach to knowledge integration, because firms' learning processes are enacted at both the component and architecture levels (Sanchez and Mahoney, 1996). In order to coordinate and manage modular products, firms must act as system integrators

(Brusoni and Prencipe, 2001), which means they face different knowledge integration requirements: thus, modularity can act as a knowledge integration mechanism. For these reasons, modularity facilitates extensive use of outsourcing, which allows the firm to concentrate on downstream activities to provide more lucrative services and solutions to customers, and mitigate the risk of technology appropriation by alliance partners, which decreases the need for intensive inter-firm interactions (Prencipe et al., 2003).

Hypothesis 1: A 'faraway' outsourcing strategy is preferred in the case of modular products.

7.3.2 Standardization of Processes

Process standardization facilitates control over the production process, making the decision to outsource more viable. However, it is not clear how high processes standardization affects relationships with the supplier. The systems integration literature suggests that a strong relationship with the supplier, and high integration, are preferred in the case of non-standardized processes (Prencipe et al., 2003; Hobday et al., 2005). On the other hand, in the case of a decision to implement a standardized process, lower integration with suppliers is required. In fact, once common protocols are developed, the integration of different subcomponents is straightforward: a standardized production process facilitates the production of components that work together easily, facilitating division of labour and integration of different bodies of knowledge (Beimborn et al., 2009). Absence of standardization makes it difficult to integrate knowledge, since it requires integration of knowledge bases that are not entirely under the focal firm's control, because they originate from both the firm and its suppliers (Sanchez-Gonzalez et al., 2009).

Hypothesis 2: A 'faraway' outsourcing strategy is preferred in the case of highly standardized processes.

7.3.3 Frequency

Another factor that influences the outsourcing strategy decision is the frequency of transactions. Transaction cost economics points out that 'specialized governance structures are more sensitively attuned to the governance needs of non-standard transactions than are unspecialized structures, *ceteris paribus*' (Williamson, 1985: 60). The cost of a specialized governance structure is higher than the costs of an unspecialized structure, so the number of transactions is central in the decision about whether to adopt an ad hoc governance structure or not. In our empirical context, in the case of a one-off transaction

there is no need for ad hoc transaction meetings or dedicated agreements: the market is preferred because it is less expensive.

Hypothesis 3: A 'so close' outsourcing strategy is preferred in the case of frequent activities.

7.3.4 Core

Firms tend to specialize in activities in which they have comparative advantage (Kogut and Zander, 1992; Teece et al., 1997; Jacobides and Winter, 2005). As pointed out by Hamel and Prahalad (1994), successful growth requires the development of adequate core capabilities. By core capabilities we mean all the capabilities essential for the firm's achievement of competitive advantage (Barney, 1991; Leonard-Barton, 1992; Patel and Pavitt, 1997). Firms' core capabilities allow access to a number of markets, contribute significantly and positively to the client's perception of the product, and make its imitation difficult. Thus, core capabilities provide the firm with strategic differentiation (Leonard-Barton, 1995). Outsourcing strategies are influenced by the firm's configuration capabilities because firms tend to retain in house those activities that are core to their business.

Hypothesis 4: A 'so close' outsourcing strategy is preferred in the case of outsourcing core activities.

7.4 THE EMPIRICAL CONTEXT: THE INFORMATION TECHNOLOGY SOLUTIONS BUSINESS

In an increasing number of industry sectors, firms are moving toward the provision of bundled services and products, or integrated solutions (Galbraith, 2002; Oliva and Kallenberg, 2003; Windahl et al., 2004; Kapletia and Probert, 2010; Miozzo and Grimshaw, 2011). Solutions or integrated solutions, initially adopted by the information technology sector, are now widely diffused (Windahl and Lakemond, 2006; Kapletia and Probert, 2010). The provision of solutions consists of offering a bundle of activities. These activities (e.g. financing contracts, after-sales support, maintenance, user training, software, hardware) differ among customers and require unique, highly heterogeneous knowledge bases, which makes their integration requirements stringent, possibly undermining the effectiveness of previously developed mechanisms (Windahl and Lakemond, 2006; Ceci and Prencipe, 2008). The emergence of these new offers is forcing firms to change their approach to the definition of

boundaries: they are required to incorporate new knowledge bases that span the entire value chain and beyond. Manufacturers need to include service elements; service firms need manufacturing elements; both need to include consulting and post-sales activities. In addition, the scope of knowledge reservoirs can shift dynamically: knowledge hitherto considered critical may become unnecessary, and new knowledge bases not previously considered may become a *condicio sine qua non* for remaining competitive.

7.5 METHODS

7.5.1 Data Collection: Sampling and Questionnaire Administration

The data for this study were obtained via a survey of a sample of solutions providers operating in the information technology sector. In the first phase of data collection, we drew on the literature and empirical evidence to generate valid items to measure the constructs in our theoretical model. The literature review focused on four topics: solutions, systems integration, project-based organization, and firm boundaries (Oliva and Kallenberg, 2003; Prencipe et al., 2003; Brady and Davies, 2004; Cerasale and Stone, 2004; Davies et al., 2006). This was supplemented by a multiple case study analysis (Ceci and Prencipe, 2008; Ceci, 2009).

In the second phase of data collection, we administered a questionnaire to a sample of information technology solutions providers in Europe. Our unit of analysis is the solution provider; thus, we analyse strategic decisions from a firm point of view. Sample selection was based on an ad hoc sampling procedure. In the absence of a database of solutions providers, we developed a procedure to estimate this population, from which we extracted a sampling frame. We used the Amadeus database of European companies to construct the population of generic information technology firms. Since firms that provide solutions are former software houses, hardware producers, and consultancy firms, we considered the following NACE codes: 3001 and 3002 (manufacture of office machinery and computers), and 7210, 7221, 7222, 7230, 7240, 7250, and 7260 (computer and related activities). We then randomly selected a sample of 200 firms from this population and examined their websites to ascertain whether they provided solutions. This resulted in a group of generic information technology firms that had moved into the solutions business, stratified by number of employees, and computed on the population of information technology solutions providers. Finally, to ensure sample homogeneity, we restricted our survey population to four countries—Italy, Spain, the UK, and Sweden, which are representative of the overall population of information technology solution providers in Europe, and which offered favourable

Table 7.1. Population and sample characteristics

		No. of employees			
	Location	20 to 99	100 to 499	500+	Total
Firms operating in the information technology sector (source: Amadeus database)	Italy	895	293	65	1,253
	United Kingdom	1,791	792	202	2,785
	Sweden	610	131	29	770
	Spain	813	301	56	1,170
	Total	**4,109 *(69%)***	**1,517 *(25%)***	**352 *(6%)***	5,978
Firms offering solutions	Italy	421	147	65	632
	United Kingdom	842	396	202	1,440
	Sweden	287	65	29	381
	Spain	382	150	56	588
	Total	**1,932 *(63%)***	**758 *(25%)***	**352 *(12%)***	3,042
Sample	Italy	20	6	4	30
	United Kingdom	16	4	7	30
	Sweden	12	7	4	23
	Spain	11	5	3	19
	Total	**62 *(61%)***	**23 *(22%)***	**17 *(17%)***	102

opportunities for data collection. To select the sampling frame from this population of 3,042 firms (Table 7.1), we randomly chose forty firms from each country, yielding a final sampling frame of 160 firms. We obtained contacts for these firms from information technology professional associations, alumni databases from business schools and universities, and distribution lists from specialist newspapers and chambers of commerce.

Because our survey required respondents to have direct and personal involvement in a solution project, the ideal respondent was identified as a project manager who had completed at least one project with the firm. In order to guarantee that project level data was a reliable proxy for all of the firm's (our unit of analysis) activities, project managers were asked to refer to a project that was highly representative of the company's activities (i.e. in the class of projects that generated the largest proportion of revenue for the organization) (Subramaniam and Venkatraman, 2001). To increase the response rate, we guaranteed that all data would remain confidential and would be used only for academic purposes; we also promised to provide personalized feedback, benchmarking the respondent's firm against a representative sample.

Telephone interviews were chosen as the preferred mode of data collection because they allowed the researcher to complement the data derived from the questionnaire with qualitative information that could be used to better characterize the firms. This method yielded a 64 per cent response rate, which

is higher than in similar studies (Miller and Roth, 1988; Bensaou and Venkatraman, 1995). The final sample included 102 firms.

7.5.2 Data Analysis: Operationalization of Variables

Previous studies (Ceci and Prencipe, 2008; Ceci, 2009) identify seven types of activities offered by solutions providers: post-sales (hardware maintenance, software assistance, software problem-solving, hotline service, software upgrading, user training); consulting (business consulting, network and technology consulting, engineering consulting); systems integration (all the activities that contribute to a high level of integration among different components); software development (software design, building, and testing); financial (leasing, flexible payment structure, competitive interest rate, buyout options); hardware and infrastructure manufacturing (hardware manufacturing and assembling, building works, cable and network creation); and delivery activities (software customization and installation, hardware delivery). For each solution project, we considered only the outsourced activities and, to test our hypotheses, we measured: i) outsourcing strategies (dependent variables); ii) the four factors influencing outsourcing strategies (independent variables); and iii) the characteristics of firms and projects (control variables). Since all the firms in the sample operate in the same industry, we do not need to control for sector specificities.

To investigate outsourcing strategies, we use two dependent variables that capture two distinct but complementary aspects: use of concurrent sourcing, and type of relationship with suppliers.

Firms adopt a concurrent sourcing approach if there is an overlap of activities and knowledge with those of suppliers: the term 'concurrent sourcing' is used by Parmigiani (2007) to describe the phenomenon of a firm that simultaneously buys and makes the same good or service (Harrigan, 1986; Bradach and Eccles, 1989; Parmigiani, 2007; Gulati and Puranam, 2009). Concurrent sourcing has specific characteristics: it is not a mix of make and buy, and represents the firm's discrete choice. Concurrent internal and external sourcing provides a wider range of knowledge sources, enabling the firm to exploit its cumulative knowledge and explore a broader set of technologies from suppliers (Bradach, 1997; Cassiman and Veugelers, 2006; He and Nickerson, 2006; Rothaermel et al., 2006; Parmigiani, 2007). The variable concurrent sourcing is a dummy variable based on a Likert scale. The questionnaire asked for the percentage of work done internally, with responses coded as follows: 0 = none; 1 = up to 20 per cent; 2 = 21 per cent to 40 per cent; 3 = 41 per cent to 60 per cent; 4 = 61 per cent to 80 per cent; 5 = 81 per cent to 100 per cent. The dummy variable assumes the value of 1 if the percentage of work done internally is between 20 per cent and 60 per cent (Likert = 2, 3, or 4),

and 0 if it is over 60 per cent or under 20 per cent (Likert = 0, 1, or 5). Concurrent sourcing explores outsourcing strategies from a cognitive viewpoint, focusing on knowledge boundaries and the capabilities across firms.

The second variable evaluates the type of relationship with the supplier. We understand type of relationship as the contractual form adopted to regulate the exchange, as defined by law and mutual agreement among firms. Type of relationship defines organizational boundaries from a formal viewpoint, and captures the extent of the interactions between the firm and its supplier. Studies that focus on the types of relationships between partners identify a series of factors that influence the decision such as the length of the relationship, expected exchanges of knowledge and resources, and the need for efficiency and flexibility (Borys and Jemison, 1989; Argyres, 1996; Conner and Prahalad, 1996). The variable relationship with supplier captures the type of the firm's relationship with its suppliers measured on a nominal 1–5 scale (1 = contractor, 2 = preferred supplier, 3 = strategic alliance, 4 = partnership, 5 = joint venture). This variable investigates outsourcing strategies from an organizational viewpoint, identifying administrative and organizational boundaries.

In relation to the independent variables, we identified four factors that influence outsourcing strategies. The technological factors product modularity and process standardization are measured on a five-point Likert scale that investigates the use of modular products and standardized process in the outsourced activity based on the following items: modular products were used for these activities, and standardized operating procedures were followed in this activity. The technological factors are operationalized as follows: the variable frequency, indicating the frequency of provision is assessed using a five-point Likert scale and the following item: this activity is usually performed in every project in this company. The variable core indicates whether the activity is central to the type of the firm's offering and is measured on a five-point Likert scale through the item: this activity is a key activity in our business.

The distinction between strategic and technological factors has been tested empirically using principal component analysis, which is a statistical technique used for data reduction that allows us to explore similarities across identified elements. We identified two components (see Table 7.2) which confirm our theoretical distinction between strategic (core and frequency) and technological (modularity and standardization) factors. Factor loadings exceed the recommended cut-off value of 0.60. We performed an Analysis of Variance (ANOVA) to investigate the behaviour of the variables across activities (see Table 7.3). ANOVA is a statistical test for whether or not the means of several groups are equal. The use of multiple two sample t-tests would result in an increased chance of a type I error; since we are comparing seven groups, ANOVA is preferred. The results show that, for technological factors (product modularity and process standardization), the effects are significant ($p = 0.058$). This implies that the means differ more than would be expected by chance

Table 7.2. Principal component analysis

Scoring coefficients for orthogonal varimax rotation		
Variable	Comp1	Comp2
Frequency	0.7089	−0.0259
Core	0.6794	−0.0038
Product Modularity	−0.1014	0.7790
Process Standardization	0.1596	0.6265

Table 7.3. One-way Anova

Strategy-related act. (comp1)		Tech-related act. (comp2)	
F ratio	Prob.>F	F ratio	Prob.>F
0.78	0.5887	2.52	0.0234
mean group differences are not significant		mean group differences are significant	

alone. Therefore, we can say that their values vary according to the types of activities, and that each activity implies a specific level of modularity or standardization originating from the nature of the activity. For the strategic factors (core and frequency), the effects are not significant ($p = 0.57$), and the differences between means are not sufficiently large to identify differences among the activities. This confirms our reasoning that technological factors are influenced by the underlying technology, and that their values differ according to the type of activity, while strategic factors are not dependent on the type of activity, and their values are not influenced by the characteristics of the activity.

The four control variables used in the models (increase in outsourcing, firm size, client size, and project length) are measured, respectively, as the difference between the percentage of outsourcing activities in the year of the analysis (2005) and five years previously (2000); the firm's annual turnover; the turnover of the solution's client; and the length of the project selected by the interviewee as representative of the firm's activities.

7.5.3 Data Analysis: Analytical Approach

We tested the data obtained from respondents for common method variance using Harman's single factor test (Podsakoff et al., 2003) and found no evidence of common method variance. The correlations are generally low (Table 7.4). We test the hypotheses by fitting an ordered logistic regression model (1) and a linear logistic regression model (2). Owing to the qualitative nature of the dependent variable, relationship with supplier, we used an

Table 7.4. Correlation matrix

		Mean	*Std Dev.*	1	2	3	4	5	6	7	8	9	10
1	Concurrent Sourcing	*0.310*	*0.463*	1.000									
2	Role Suppliers	*2.470*	*1.103*	0.008	1.000								
3	Process Standardization	*3.940*	*1.066*	−0.258	0.225	1.000							
4	Product Modularity	*3.727*	*1.059*	0.191	0.282	0.265	1.000						
5	Frequency	*4.155*	*0.952*	−0.016	0.064	0.216	0.258	1.000					
6	Core	*4.322*	*0.960*	0.028	0.143	0.153	0.238	0.381	1.000				
7	Increase of Outsourcing	*0.023*	*0.172*	0.227	0.021	−0.141	0.092	0.043	0.029	1.000			
8	Size of the firm	*979*	*3.102*	−0.002	−0.023	0.237	0.015	−0.116	−0.047	−0.037	1.000		
9	Client Size	*2.195*	*0.856*	−0.220	0.039	0.044	−0.121	−0.080	0.024	−0.046	0.259	1.000	
10	Project Length	*1.968*	*0.814*	0.122	−0.248	0.025	−0.270	0.023	−0.208	−0.138	0.188	0.154	1.000

Table 7.5. Ordered Logit Model 1 and Logit Model 2

	Model 1		Model 2	
	Dependent variable: Role of Supplier		Dependent variable: Concurrent Sourcing	
	Ordered Logistic Reg.		Logistic Reg.	
	Coeff.	S.E.	Coeff.	S.E.
Process Standardization	0.454***	0.148	−0.808***	0.210
Product Modularity	0.305**	0.140	1.054***	0.289
Frequency	−0.067	0.157	−0.373	0.273
Core	0.061	0.147	0.239	0.260
Increase of Outsourcing	0.037	0.749	2.563**	1.085
Size	−0.000	0.000	0.000	0.000
Client Size	0.224	0.159	−0.747***	0.247
Project Length	−0.416**	0.173	1.017***	0.293
N	*212*		*212*	
Log Likelihood	*−280.059*		*−86.527*	
PseudoR2	*0.055*		*0.260*	
LR chi2	*32.84*		*60.88*	

*p<0.10; **p<0.05; ***p<0.01

ordered logit model for Model 1. In Model 2, the dependent variable is binary (concurrent sourcing: 0; 1). Table 7.5 reports the results.

$$Y_1 = \alpha + \beta_1\, standardization + \beta_2\, modularity + \beta_3 frequency + \beta_4\, core + \beta_5\, increase\ in\ outsourcing + \beta_6 firm\ size + \beta_7\, client\ size + \beta_8\, project\ length + \epsilon \quad (7.1)$$

$$Y_2 = \alpha + \beta_1\, standardization + \beta_2\, modularity + \beta_3 frequency + \beta_4\, core + \beta_5\, increase\ in\ outsourcing + \beta_6 firm\ size + \beta_7\, client\ size + \beta_8\, project\ length + \epsilon \quad (7.2)$$

Model 1 (Table 7.5) yields the following results: two out of four independent variables have a significant effect on the dependent variable relationship with supplier. The two technological variables, standardization of processes (+0.454) and product modularity (+0.305), have a positive impact on the dependent variable role of suppliers, while the two strategic factors (the variables core and frequency) are not significant. Hypotheses 1 and 2 are not supported since the direction of the impact is opposite to the direction hypothesized. This finding contrasts with the previous literature. In the case of Model 2 (Table 7.5), analysis of the results of the logit regression shows that

product modularity has a positive impact (+1.054) on the firm's choice to engage in concurrent sourcing, while the variable process standardization has a negative impact (–0.808). Similar to Model 1, none of the strategic factors, the variables core and frequency, is significant.

7.6 DISCUSSION OF RESULTS

Analysis of the two models, briefly discussed in Section 7.5.3, suggests the following. In the case of Hypothesis 1 (A 'faraway' outsourcing strategy is preferred in the case of modular products), we expected the variable product modularity to have a negative sign. However, product modularity has a positive impact in both models. The use of modularity facilitates the integration of different knowledge (Schilling, 2000); this pushes firms to increase their use of outsourcing. Moreover, modularity helps to resolve complex problems, enabling division of labour also in complex systems. However, such complexity requires strong integration with suppliers. Our results suggest that the use of modular products in a solution requires close integration among the players, because of the need to develop common interfaces to facilitate the functioning of different modules. Therefore, we can confirm that modularity acts in two steps. It facilitates the outsourcing of activities and, once the activities are outsourced, it requires close relationships with suppliers.

Hypothesis 2 (A 'faraway' outsourcing strategy is preferred in the case of highly standardized processes) is only partially supported. The variable process standardization has an impact on both dependent variables, but its role is ambiguous: in fact, it has a negative impact on the use of concurrent sourcing (Model 2). This supports Hypothesis 2, suggesting that standardization of processes increases division of labour: process standardization facilitates control and reduces the need to share knowledge and sensitive information. In Model 1, standardization of processes has a positive impact on the dependent variable role of suppliers, which does not support Hypothesis 2. The variable role of suppliers measures the structure of the firms' boundaries from an organizational viewpoint, while the variable concurrent sourcing is focused more on knowledge and information sharing. Our results suggest the existence of overlap in the organizational boundaries of companies: the standardization of processes (as in the case of product modularity) facilitates the use of outsourcing (as suggested by transaction cost economics), but, among all the possible configurations of outsourcing strategies, a strong relationship with partners is preferred.

The results of Models 1 and 2 do not support Hypothesis 3 (A 'so close' outsourcing strategy is preferred in the case of frequent activities) or

Hypothesis 4 (A 'so close' outsourcing strategy is preferred in the case of outsourcing core activities): the variables core and frequency are not significant. We tested the effect of these variables on the decision to outsource or not, and found a significant relation (details available from the authors upon request). However, these two variables play no role in influencing either the type of relationship with the suppliers or the use of concurrent sourcing. This is an important result: the variables frequency and core represent decisions taken by the firms; their lack of significance suggests that firms, on their own, have a minor impact on the outsourcing strategy. It would seem that outsourcing strategies are shaped mainly by the characteristics of the activities and much less by the strategic choices of firms. Our results suggest strong technological determinism: firms have little strategic discretion when defining the type of relations with the suppliers, and making decisions related to knowledge specialization and integration.

7.7 CONCLUSIONS

Outsourcing is a viable strategy that is being used by firms increasingly, to lower costs, to access new knowledge and capabilities, to gain flexibility, and to allow a focus on distinctive and core capabilities (Bettis et al., 1992; Brusoni et al., 2001; Mol et al., 2005; Rothaermel et al., 2006; Holcomb and Hitt, 2007). However, this strategy must be carefully considered. It carries risks and, in the long term, could lead to losses in core technologies and capabilities, and to the transfer of internal knowledge outside the firm's boundaries. It is crucial to understand the challenges related to knowledge integration.

The decision to outsource a specific activity is only the first in a series of important decisions about which knowledge to retain in house, which abilities to acquire, which specialized knowledge to keep, and which different organizational knowledge bases to integrate. The knowledge integration requirements related to implementing an outsourcing strategy were the central focus in this chapter.

There are two main findings from our investigation. First, high levels of product modularity and process standardization lead to close interactions among players, which is contrary to what we expected. Previous work suggests that the use of modular products and standardized processes facilitates division of labour: activities with these characteristics can be outsourced in a straightforward way from a technical perspective, but there is still a need for knowledge integration.

In the literature review we refer to the work of Mitchell (2006), who describes two different knowledge integration approaches—boundary spanning and integrative. Knowledge integration needs first to fulfil a boundary-

spanning role to enable firms to import external knowledge (i.e. knowledge about the functioning of a specific component developed by external suppliers). This externally acquired knowledge needs to be recombined into a single bundle (Dawson et al., 2010). We believe that our results enhance this interesting classification: modularity and standardization operate as mechanisms facilitating the boundary-spanning role of knowledge integration and eliminating overlaps in firm and suppliers' knowledge. However, knowledge interactions are still required. Our results can be interpreted as technological factors act as boundary spanners, but integrative mechanisms are still needed. To implement integrative mechanisms, close interactions are needed among the players.

Second, our empirical results show clearly that strategic factors have a limited impact on the implementation of outsourcing strategies. The role of strategic factors in shaping firms' boundaries is generally accepted, and there is vast empirical evidence and theoretical justification for the central role played by the variables core and frequency in the decision to outsource or not. However, if we focus on how close firms want to be to their suppliers, and how they integrate the knowledge outsourced, this decision would seem to be independent of strategic factors. It would appear that the final configuration of the relationship is influenced much more by technological factors. Technological aspects and the characteristics of the productive process determine the knowledge integration strategy. This is coherent with Fixson and Park (2008: 1296), which points to 'the existence of multiple linkages between product architecture and industry structure'. Thus, the structure of the product influences the outsourcing strategy more than firms' internal characteristics. This reinforces the idea of technological determinism: firms have little strategic discretion in defining knowledge integration mechanisms.

Our results have some limitations. First, the analysis is based on a small sample, which might reduce their statistical power. The study's target population was narrowly defined to include a homogeneous set of firms, which could limit the generalizability of this research. Second, there are some data limitations: data were gathered at one point in time, so it is not possible conclusively to infer causality. Another consequence of our data-gathering approach is that whilst the analysis provides a very good static picture of the firms studied, it provides limited information on their evolution over time. Finally, our study does not evaluate firm performance. Our results refer to the decisions taken by the firms with no insight into the optimal decision from a performance viewpoint. These observations suggest several avenues for future research. Follow-up empirical studies are needed to confirm our hypotheses, and these should be extended to different industry sectors.