Rajala, Risto; Brax, Saara A.; Virtanen, Ari; Salonen, Anna

The next phase in servitization

Published in:
International Journal of Operations and Production Management

DOI:
10.1108/IJOPM-04-2018-0195

Published: 15/08/2019

Document Version
Publisher's PDF, also known as Version of record

Please cite the original version:
Rajala, R., Brax, S. A., Virtanen, A., & Salonen, A. (2019). The next phase in servitization: transforming integrated solutions into modular solutions. International Journal of Operations and Production Management, 39(5), 630-657. https://doi.org/10.1108/IJOPM-04-2018-0195

Received 2 April 2018
Revised 7 September 2018
20 November 2018
Accepted 11 December 2018

The next phase in servitization: transforming integrated solutions into modular solutions

Risto Rajala
Department of Industrial Engineering and Management, School of Science, Aalto University, Espoo, Finland
Saara A. Brax
School of Business and Management, LUT University, Lappeenranta, Finland
Ari Virtanen
Department of Industrial Engineering and Management, School of Science, Aalto University, Espoo, Finland, and
Anna Salonen
Department of Marketing and International Business, Turku School of Economics, University of Turku, Turku, Finland

Abstract

Purpose – The purpose of this paper is to identify integrated solutions business as the first generation of servitized offerings and modular solution offerings as the second development phase in servitization of original equipment manufacturers. This study examines how the servitized manufacturer, Kone, moves from integrated solutions to modular solutions business and develops the requisite capabilities to design, produce and implement modular solution offerings.
Design/methodology/approach – The paper reports a longitudinal case study of a provider of integrated solutions installed in buildings. During the ten years studied, the manufacturer implemented a strategic initiative to modularize its integrated solutions offering.
Findings – The firm's transition to modular solutions progressed through three major capability development phases: solutions based on *ad hoc* integration, smart solutions based on modular design and through-chain modularity. The modular structure aims at fostering the efficiency of the solution offering and the associated production system.
Research limitations/implications – Leveraging the benefits of modularity calls for an aligned combination of strategic, operational and technical capabilities contributing to the integration of resources in a modular production system for the solution providers' competitive performance.
Practical implications – The study reports how a solution provider can develop the operational capabilities to integrate the core and peripheral components into the solution, and orchestrate the modular production system.
Originality/value – This study is a rare longitudinal analysis of how a manufacturer builds a modular offering, the solution platform and the required competitive capabilities to provide the solution.

Keywords Servitization, Capabilities, Modularity, Ambidextrous performance, Integrated solution

Paper type Research paper

1. Introduction

In the strategic move of "servitization," manufacturers transform their business by integrating product and service elements into their offering. In the early stages of the servitization process, manufacturers may provide service-based extensions to their products, whereas more advanced stages involve complex solutions, product-service-systems and comprehensive

International Journal of Operations & Production Management
Vol. 39 No. 5, 2019
pp. 630-657
Emerald Publishing Limited
0144-3577
DOI 10.1108/IJOPM-04-2018-0195

full-service offerings (Brax and Jonsson, 2009; Oliva and Kallenberg, 2003). Advanced levels of servitization require demanding competitive capabilities to ensure flexibility, quality and effectiveness in solution provision while controlling costs. A comprehensive systematic review by Brax and Visintin (2017) demonstrates that pre-existing research has extensively documented the processes and patterns of transitions and extensions of manufacturers' business models toward increasing reliance on generating revenue through service elements.

Previous servitization research has identified various critical capabilities for the business models of companies providing integrated solutions. Developing operational capabilities into the solution providers' core competencies enhances their competitive advantages especially in industrial markets characterized by emerging technologies, heterogeneous of customer needs and accelerated competition (Gebauer, 2011). The service-based strategies diverge from transactional business logics toward a relational approach to managing customer relationships and provider networks (Lightfoot *et al.*, 2013). Addressing heterogeneous and complex customer problems through individualized offerings becomes a critical success factor for solution providers. In the management literature, modularity has been suggested as a viable approach to managing such complexity in designing and coordinating large-scale systems (Ethiraj and Levinthal, 2004).

This study builds on the argument that in mature solution business models, there are productivity gains for the solution providers based on the benefits of modular design of the offering (Sanchez and Mahoney, 1996; Sturgeon, 2002). The benefits expected from modularization are based on the possibility of replacing the project-based approach of configuring and integrating solutions with a mass customization approach based on a modular solution architecture and a modular production system. With modular product architectures, product and service modules can be sourced even beyond company boundaries. A pressing question for operations management scholars is, how a manufacturer becomes an efficient provider of modular solutions while maintaining its cutting-edge technology capabilities (Storbacka, 2011). Empirical research thus needs to address how solution providers achieve and maintain an "ideal" state of flexibility and efficiency for competitiveness in providing customized responses to complex customer needs.

The study shows that a modular design allows a solution provider to develop effectiveness beyond the economies of repetition. The economies of repetition concept (Davies and Brady, 2000) characterizes an immature approach to servitization where the first solution delivery projects succeed although the provider lacks both experience and the volume of solution clients that modularization requires. To realize the benefits expected from modularity (i.e. the simultaneous efficiency and variability in the production and delivery of integrated solutions), the provider must align a combination of competitive capabilities to manage the complexity of the solutions in the production system (Kristal *et al.*, 2010). Roth and Jackson (1995) define competitive capabilities through broad-based factors that are critical to a firms' success in the market. In contrast with manufacturers' "intended" capabilities that might be desirable in the solution business, competitive capabilities capture the firm's "realized" or "actual" competitive strength relative to its primary competitors (Roth and Jackson, 1995). In the context of modular solutions, such capabilities facilitate an organization's ability to achieve added flexibility and quality, yet maintaining a low cost level of the operation.

Through a longitudinal study of Kone Corporation, this study seeks to answer the following main research question:

RQ1. How does a provider of integrated solutions develop competitive operational capabilities to provide and deploy modular solutions?

More specifically, the study operationalizes this main question in the case context of the servitizing original equipment manufacturers (OEM), Kone, through three sub-questions:

RQ1a. What activities are identified as prerequisites for the reaching the modular solution business capability?

RQ1b. What evolutionary stages constitute the development of the modular solution business capability?

RQ1c. What roles do explorative and exploitative modes of learning play in the development of the modular solution business capability?

The study discovers that while many of the competitive capabilities are learnt by doing within the provider organization, adopting the principles of modular system design (Baldwin and Clark, 2006) in solution development and delivery also requires strengthening of network ties with selected suppliers. To enable efficient provision of mass-customized solutions, the provider must facilitate suppliers in both technical and process integration of the essential solution components. The solution provider also should maintain a production system comprising of weak ties with complementary suppliers to improve variability and to expand the range of possible solution configurations.

The study contributes to the research on solution business by explicating how a solution provider develops competitive capabilities (cf., Kristal *et al.*, 2010; Storbacka, 2011) for the supply of modular solution offerings. It shows how a provider of complex solutions may exploit these capabilities in its partner network, which was originally built to tailor solutions as projects. The study follows a solution provider achieving ambidextrous performance through the development of a dual approach, exploiting its principal solution components while exploring viable derivatives to address varying customer needs. This way the provider combines the benefits of both exploration and exploitation.

The next section discusses the principles of modularity in the solution architecture and the production system based on previous research; the explorative and exploitative approaches to developing competitive solution supply capabilities; and the process of resource integration for the supply of modular solutions. The third section explains the longitudinal single-case research design implemented to investigate servitization activities in the studied firm for over a decade. This is followed by the empirical analysis and findings, the contribution and implications of the study.

2. Background: modularization in the solutions business

In the vast body of research literature on servitization and product service systems (PSS), modularization has gained only limited attention (cf., Brax *et al.*, 2017). In this section, the central role of modularization in the solutions business is explained through three interconnected arguments:

(1) Because of the complexity and the breadth of the PSS offerings, developing integrated solutions businesses that are successful in the long term requires implementation of modularity (Section 2.1).

(2) Capabilities to utilize modularization are complex and thus develop organically within the firm. While resource-based theories of the firm may provide a conceptual background for understanding the capabilities needed, the organizational learning literature offers a perspective to analyze the development of those capabilities. Both the exploration activities that aim at the development of competitive solutions capabilities based on modularization and the exploitation activities that seek competitiveness and productivity from implemented modularization approaches co-exist in the manufacturing firm involved in advanced servitization (Section 2.2).

(3) Modularization enables different units to develop specialized capabilities and thus increases the need for effective resource integration skills in the organization. As modularization extends from the focal firm to its supply networks, the integration activities spread beyond organizational boundaries (Section 2.3).

2.1 Servitization and integrated solutions

During the past 15 years, research on service-based business approaches in manufacturing firms and other product-based businesses has grown from a niche topic to a central theme in operations management and industrial marketing (Kowalkowski *et al.*, 2017; Rabetino *et al.*, 2018). This stream of research has focused on various service management, operations and marketing topics in the context of asset-intensive industrial firms, typically OEMs. Baines *et al.* (2009, p. 555) conceptualize servitization as "the innovation of an organization's capabilities and processes to better create mutual value through a shift from selling the product to selling PSS," referring to product-service systems. Capital goods sold to customers need various kinds of support and spare parts during their use, and thus become an installed base of products for the OEMs and third-party service providers. The use of the installed base generates data; exploiting these data and combining it with their services and knowhow, suppliers can provide integrated solutions to their customers to better serve the customer's operational needs (Brax and Jonsson, 2009; Holmström *et al.*, 2010). Such service, product and information bundles are called "solutions" because they tend to address and solve customers' operational needs around the supplied capital goods comprehensively based on a sustainable long-term orientation, rather than to simply support the equipment (Brax and Jonsson, 2009; Mathieu, 2001a; Tukker, 2004). Such new activities and responsibilities increase the complexity of the provider's offering (Brax, 2005).

A recent meta-analysis (Brax and Visintin, 2017) organizes the research into a generic framework that identifies eight different value configurations based on examining how operational responsibilities are shared among the customer, the supplier, or a third party across the PSS life-cycle stages and the additional revenue model elements of ownership, payment model and financing. According to this meta-analysis, the main value constellations, arranged from the least to the most servitized, are: products with limited support; installed and supported products; complementary services; product-oriented solutions, systems leasing; operating services; managed service solutions; and total solutions (Brax and Visintin, 2017). This clarifies the discussion around servitization as a "shift," "extension" or "transition" – a servitizing OEM typically provides several value constellations of the above to serve customers with different needs, extending its portfolio of offerings to cover several value constellations, causing cultural shifts and sometimes even transitioning away from what was previously considered as core business (Brax and Jonsson, 2009; Kowalkowski *et al.*, 2017). Despite that, the firm may exploit a single technological core across several value constellations in its portfolio, providing several types of value constellations side-by-side, which increases the organizational complexity that the solutions provider needs to manage.

Majority of the literature on servitization has focused on producing guidelines and methods for implementing service strategies successfully based on case research in servitizing firms (Baines *et al.*, 2009). Recent critical research demonstrates how mainstream servitization research focuses on the development narrative of turning product-oriented firms into service-based businesses (Luoto *et al.*, 2017). The current study considers this as the first phase in servitization, and turns the focus on the next developmental phases, as discovered in the Kone case. The next phase involves further refinement of the strategic, operational and technical aspects of servitization to ensure agility and efficiency based on modular solutions.

2.2 The benefits of modularity in integrated solutions business

In his extensive review, Frandsen (2017, p. 704) outlines the concept of modularity as follows:

> Modularity is a method of designing a structure to reduce its complexity. Although complexity is clearly related to the number of different elements of a structure, the nature of the interdependencies between those elements and the way in which they interface has profound implications for structural complexity. This complexity may be handled by reducing the number of units and by grouping these units into subsystems.

Thus, modularity provides a means of designing and providing complex, customized solutions in an industrially efficient way, enabling improved flexibility, reduction of the costs of differentiation and sustained fitness in dynamic environments (Baldwin and Clark, 2000; Campagnolo and Camuffo, 2010; Ethiraj and Levinthal, 2004). Baldwin and Clark (2000) define modularity as the building of complex products or processes from smaller, independently designed subsystems that function as a whole. The main design principle for a modular product architecture is that its every subsection specializes in fulfilling a specific function and can be altered without influencing the other functional subsystems (Ulrich, 1995). Existing research agrees that an effective architecture for solution offerings consists of basic modular subsystems and their standardized components that can be modified to create customer-specific adaptations (Anderson and Narus, 1995; Brax and Jonsson, 2009; Davies *et al.*, 2007). Despite the growing interest, studies of modularization in the servitization context remain scant.

In industrial marketing, a few studies on integrated solutions and servitization have addressed modularity in the level of the offering (e.g. Salonen and Jaakkola, 2015; Storbacka *et al.*, 2013). A modular offering structure increases the operational adaptiveness of the solutions provider and has been associated with solutions business that targets an installed base (Storbacka *et al.*, 2013). In the early days of the solutions literature, Anderson and Narus (1995) suggested that providers develop basic solutions and then provide a selection of optional added value elements to increase firm revenue as customers need to amend the basic solution bundle. Such unbundling tactics can be useful in markets where the basic solution structures are generic and robust, limited expertise is required to select a functional combination of modules, and customers are willing to invest in premium value. In operations management, scholars working in the area of servitization need to advance understanding of modularity in the back-office: how modularity is designed, implemented and managed in the product-service-system architecture, processes, organizational design and supplier networks. Thus, modularity could help manage the complexity that arises in industrial services from heterogeneous customer needs (Frandsen, 2017). In the customer interface, modularity needs to be managed within a collaborative service process involving the customer.

The standardized component interfaces in a modular product architecture provide embedded coordination reducing the need for managerial coordination of development processes (Sanchez and Mahoney, 1996). Modularity enables designing offering pre-configurations that can be leveraged into suitable customer-specific combinations, tailored and unique for each customer (Storbacka, 2011). Industrial solution business is commonly carried out through projects that vary in complexity, sometimes requiring extensive project-specific integration efforts (Davies and Brady, 2000). Hence, solution providers need to develop the competitive capabilities associated with the development and delivery of modular solution offerings.

In a modular system architecture, the components should be autonomous, loosely coupled and individually upgradeable (Voordijk *et al.*, 2006). Modular design architectures allow the subsequent design processes to be independent and distributed among different groups of designers (Baldwin and Clark, 2006). Instead of ongoing consultations and adjustments, the groups working within the modular architecture are coordinated by design rules. Such "standards" are an important part of a system's design architecture. The modularity of a solution is often manifested through a platform architecture that ties in a complex system in which certain (core) modules remain stable, and variation is implemented with complementary (peripheral) modules (Baldwin and Clark, 2006). Interfaces determine how the modules of the system work together. The interfaces that intermediate between the platform and its supplements are crucial in such architectural designs (Baldwin and Woodard, 2009).

The benefits of a modular solution structure include enhanced variety, greater flexibility and cost savings that facilitate customization (Jose and Tollenaere, 2005). Customization is an important value-adding characteristic in solution business and separates solution offerings from basic product bundles (Davies and Brady, 2000; Roehrich and Caldwell, 2012). In addition, modularity has important performance implications (Pil and Cohen, 2006). Yet, this growing literature lacks empirical studies investigating how modularity allows solution providers to enhance performance, and how solution providers acquire the desired performance effects associated with modularity (Brax *et al.*, 2017).

2.3 Developing competitive operational capabilities for modular solutions

The resource-based view (RBV) of the firm represents a turn of focus from the firms' products to the firms' resources that generate its products (Wernerfelt, 1984). According to RBV, a competitive advantage for a firm arises from resources that are valuable, rare and for its competitors difficult to imitate and substitute (Barney, 1991). Unique resource configurations evolve in organizations with idiosyncratic capabilities, contributing to the organization's long-term success (Collis, 1994). An organization has a specific capability when it has the capacity to repeatedly perform the activity reliably and in a satisfactory manner (Helfat and Winter, 2011). Organizational capabilities are defined as socially complex higher-level routines, or collections of routines, that determine the firm's efficiency in transforming inputs into outputs by conferring a set of decision options upon the firm's managers (Collis, 1994; Winter, 2003). Whereas the physical nature of technological assets makes them imitable and manageable, RBV posits that the socially complex nature of capabilities increases the difficulty of imitating and managing them (Barney, 1991). RBV is considered as a particularly useful theoretical lens for investigating diversified firms (Wernerfelt, 1984); servitization represents a form of diversification as the manufacturing firm adds new types of service elements to its pre-existing core product.

Organizational capabilities can be divided into operational and dynamic capabilities: operational capabilities enable the firm to conduct its business in its current state, earning a living, whereas dynamic capabilities enable the firm to alter the way it conducts its business (Helfat and Winter, 2011). Competitive capabilities refer to a firm's capabilities that have actual and realized strength in relation to its primary competition (Rosenzweig *et al.*, 2003). Not all operational capabilities are competitive in this sense; such basic but required capabilities have been called ordinary or zero-order capabilities (Collis, 1994; Winter, 2003). Non-routine development activities that do not fulfill the criteria of dynamic capabilities being patterned and repetitious are called *ad hoc* problem solving (Winter, 2003).

While existing research of strategy is rich in studies of dynamic capabilities that help organizations renew their operational capabilities over and over again, the focus of this study is on the development of specific operational capabilities – those associated with modular solutions business in the context of an OEM providing PSSs. The modular solutions capability investigated here is an important new operational capability for the case firm, Kone, and can also be considered a competitive capability at the time of conducting the longitudinal analysis. Its development draws on a series of explorative and exploitative learning activities, some of which fulfill the definitional criteria of dynamic capabilities.

Organizational capabilities are embedded in the routines of the firm, making them essential system-level properties that influence the organization-related aspects of efficiency (Collis, 1994). The provision of service-intensive solutions requires organizational capabilities and processes that are different from the manufacture and sale of goods (Baines *et al.*, 2013) and project-based solutions (Brax and Jonsson, 2009; Davies *et al.*, 2007). Thus, manufacturers adopting integrated solutions business models need to develop new service-oriented capabilities. Firms may acquire distinct external service-related knowhow, which needs to be combined with pre-existing knowhow about physical products and

related processes, meaning that solution business capabilities are complex configurations of knowledge and resources that develop organically.

Keeping the focus on modularization-related capabilities, this study identifies the main differences between integrated solutions and modular solutions. First, integrated solutions depend on the ability of firms and their network members to orchestrate disparate product and service elements into comprehensive offerings (Bastl *et al.*, 2012; Davies *et al.*, 2007; Johnson and Mena, 2008). Reliable information about the system's condition and operations is a prerequisite for viable solution offerings (Brax and Jonsson, 2009; Holmström *et al.*, 2010). Second, proper functioning of the solution in use is critical (Bastl *et al.*, 2012), as the solutions business model has a long-term perspective on value creation instead of one-off product sales (Brax and Jonsson, 2009). Third, the service management literature emphasizes that value is co-created from the solution through its use (cf., Sandström *et al.*, 2008; Smith *et al.*, 2014). Because the provision of integrated solutions involves collaboration with the customer in the installation, training, operations and maintenance, the customer relationship becomes more complex and long-term as compared with that of one-off system deliveries (Brax and Jonsson, 2009; Smith *et al.*, 2014). Thus, the shift to modular solutions requires translation of the "traditional" production competencies to managing the performance of the provided solutions in multi-actor contexts of use, often involving third-party suppliers and a multidimensional definition of customers (cf. Baines *et al.*, 2013; Gebauer *et al.*, 2013; Saccani *et al.*, 2014).

Classical operations strategy literature argues that firms should choose between their priorities and subsequent capabilities (e.g. efficiency and low cost vs effectiveness and quality) to achieve and maintain competitiveness (Hayes *et al.*, 2005). Departing from this view, the concept of combinative capabilities recognizes that agile companies pursue these conflicting goals simultaneously, exploiting various competitive operational capabilities to outrival competitors (Menor *et al.*, 2001, p. 274). These internal competencies enable manufacturing organizations to move smoothly from one short-term advantage to another (e.g. Kristal *et al.*, 2010) and support effective handling of variability in customer needs (Yusuf *et al.*, 1999).

The development of competitive capabilities requires explorative and exploitative organizational learning (Sirén *et al.*, 2012). Supporting the firms' long-term effectiveness in meeting changing needs, exploration involves a search for new capabilities, a variation of the offering, risk taking, experimentation, flexibility in the execution of a strategy and discovery of new opportunities (March, 1991). Exploitation encompasses the refinement of existing processes, selection between known options and improved efficiency in the implementation of a strategy (Auh and Menguc, 2005; Jansen *et al.*, 2006; March, 1991). Exploration and exploitation are complementary competencies (March, 1991); firms that hold these competencies simultaneously can create value through innovative responses to changing demand and capture that value through efficient processes. Most research in the solutions field has focused on activities that build the organization's commercialization processes through exploration capabilities, overlooking the side of exploitative learning.

The infinite variety of organizational capabilities complicates the creation of exhaustive, mutually exclusive typologies (Collis, 1994). In this empirical analysis, the observed activities are arranged under three broad categories: strategic, operational and technical. Activities at the strategic level focus on seeking direction, defining the business model, creating an understanding of the markets and refining strategic goals. Operational-level activities address the structural and processual organizational arrangements, and coordination of the production system. Finally, the technical level describes the development activities associated with the product and production technologies, and the technical solution requirements to create feasible modular solution offerings.

2.4 Resource integration in the modular production system

Modularization enables different organizational units to develop valuable resources and specialized capabilities (Campagnolo and Camuffo, 2010). While this increases the efficiency of the production system, it also requires effective resource integration capabilities. As noted earlier, integrated solution offerings broadly cover a customer's business need, and seamlessly integrate physical products, service processes and information to produce a comprehensive functional solution (Brax and Jonsson, 2009). Therefore, modularization efforts in the solution business are grounded on strong integration capabilities.

Recent extensions of the RBV cover external resources, emphasizing the capabilities to integrate resources among interconnected actors (Kraaijenbrink *et al.*, 2010; Lavie, 2006). In the context of modular solutions, the complexity of both the production system and the modules complicate resource integration. As solutions increasingly depend on a network of providers rather than a single firm (Windahl and Lakemond, 2006), a key challenge concerning modular solutions is the management of the relationships among the production network. A solution provider often takes the role of the systems integrator, being responsible for integrating sourced components into customer-specific solutions (Davies *et al.*, 2007).

The provider expands its range of solutions-related capabilities through relationships with external suppliers (Galbraith, 2002). A key challenge for modular production systems in the industrial manufacturing context is that material components lack the degree of modularity, open standards and interfaces that enable modular solutions in industries more mature in this area, such as ICT. Thus, industrial solution providers need roadmaps for modularizing their offerings and the processes linking actors in their service systems (Van Liere *et al.*, 2004; Vervest *et al.*, 2004). The roadmaps should address both the upstream and downstream activities and involve actors in the OEM's supply chain.

Modularity enables the designing of flexible and scalable production systems based on cells (Baldwin and Clark, 2000). Modularity allows sub-assembly and pre-testing of the modules and supports the reconfiguration and imitation of technological and organizational capabilities among the actors in the production system (Campagnolo and Camuffo, 2010). Integrating resources from the production system with internally developed resources is the "make-or-buy" in the solution business: should the provider develop the necessary capabilities internally or acquire them externally (see Davies and Brady, 2000; Paiola *et al.*, 2013). Three options for capability development have been suggested: internal, external and hybrid (Brax *et al.*, 2017; Kowalkowski *et al.*, 2011; Mathieu, 2001b). The benefits of internal development relate to process optimization (Gebauer *et al.*, 2010), proximity to key resources and interaction between the service provider and the customer (Mathieu, 2001a, b), and ability to differentiate the solution (Matthyssens and Vandenbempt, 2010). In external development, organizational specificity drives the development of competitive capabilities through clearly directed efforts (Kowalkowski *et al.*, 2011). Innovative combinations of these capability development options contribute to the solution provider's ambidextrous performance (see Paiola *et al.*, 2013). The desired outcomes of modularity include variability of the aggregated solution and efficiency in the production of the modules in the production system (Figure 1).

3. Methodology: a longitudinal single case study

Because organizational capabilities develop over time, a longitudinal case research design was chosen to investigate the development of competitive capabilities associated with the provision of modular solutions. A single case study approach enables the collection of rich, longitudinal data in a real-life context (Eisenhardt and Graebner, 2007; Yin, 1994), making it a purposeful and efficient methodological choice.

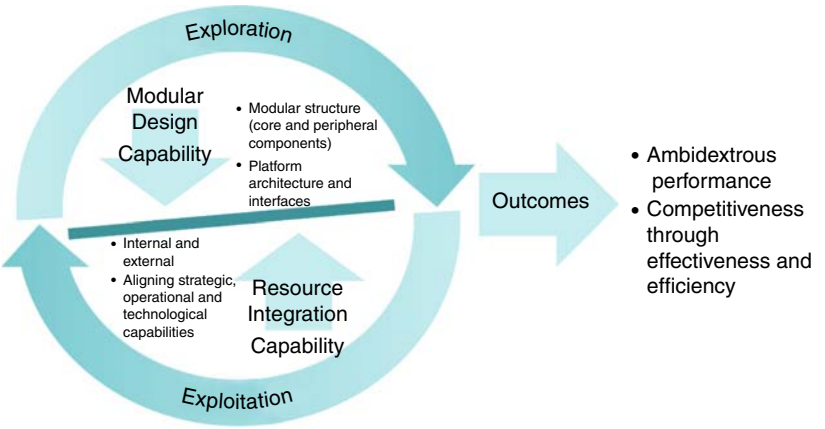

Figure 1.
Conceptual framework: competitive capabilities development for modular integrated solutions

3.1 Case selection

Aiming at an in-depth understanding of complex phenomena, single-case designs use an information-oriented selection of the context of study to maximize the utility of the empirical inquiry in terms of expected new information gained (Flyvbjerg, 2006; Patton, 1989). Important characteristics for the case firm were: excellent industry standing in terms of company size, business performance and technological competence; that the company was in early stages of building integrated solutions business; and the opportunity of continued access to the company, which is a reasonable, practical criterion for a longitudinal case study approach.

In a study that analyzed the level of servitization, using the Osiris 2007 data set (Neely, 2008), Finland ranked second with 53 percent of its manufacturing companies servitized. Thus the Finnish industry, therefore, provides a fruitful context to study servitization. The selected case firm, Kone Oyj, is a provider of integrated building solutions, operating globally among the leading companies in its business sector. The company began as a manufacturer of elevator and escalator systems and has evolved into a provider of integrated systems for built environments, characterized by a comprehensive and service-dominant business approach.

The investigation of Kone's transition into solution business covers the years 2006–2015 with follow-up interviews conducted in 2018. In 2006, Kone provided integrated solutions to selected customers and sought to implement its new servitization strategy more broadly. This focus of development efforts on integrated solutions at the time created a fruitful opportunity for research collaboration. While research initially focused on servitization capabilities, in general, the scope was soon refined to focus on modularization capabilities, as Kone's need to develop a modular offering architecture become apparent.

3.2 Data collection and analysis

The data consist of interviews, researchers' field notes, participant observation and various types of company documents obtained from the company. The purpose of the interview data was to build an in-depth understanding of the underpinnings and the influences of modularity in the case firm. In total, 41 semi-structured interviews were conducted with managers and experts in different positions and levels of the case organization, able to provide first-hand information and experiences on implementing

modularity in the solution business (Table I). The interviews were voice recorded and transcribed. The investigator that engaged in participatory action research did not attend the formal interviews. With a few interviews that could not be recorded, extensive note-taking was used to document them.

Interviews	*Date*	*Duration*	*Contributing data*		
		min	*Phase I*	*Phase 2*	*Phase 3*
Vice President, Design	December 13, 2006	109	X		
Vice President, Sales and Marketing	November 3, 2006	91	X		
Managing Director, R&D	December 20, 2006	107	X		
Vice President, Global Customer Management	November 8, 2006	38	X		
Head of Product Business BU	November 2, 2006	131	X		
Senior Vice President, Technology	November 20, 2006	155	X		
Senior Vice President, Marketing	November 30, 2006	42	X		
Product Porfolio Manager	November 14, 2007	30	X		
Assistant Vice President, Product Business	October 10, 2007	52	X		
Several interviews with top managers	November 30, 2007	124	X		
Senior Vice President, Marketing	January 31, 2008	32	X		
Assistant Vice President, Product Business	June 28, 2010	52	X	X	
Head of Projects BU	August 20, 2010	21		X	
Director, Solution Business	April 25, 2013	84	X	X	
Director, Solution Business	March 4, 2013	56		X	X
Platform Manager, Solution Business	May 7, 2013	74	X	X	
Director, Solution Business	April 17, 2014	83		X	X
Head of Marketing and Communications	April 4, 2014	59		X	
Director, Solution Business	February 28, 2014	38		X	X
Project Manager, Solution Business	March 28, 2014	97			
Senior Legal Expert	April 11, 2014	46	X	X	X
Platform Manager, Solution Business	March 28, 2014	60	X	X	X
Director, Solution Business	April 11, 2014	77		X	
General Manager, Sales (local subsidiary)	June 5, 2015	35			X
Director, Product Business (area)	October 16, 2014	88	X	X	X
Director, Solution Business	October 28, 2014	80		X	X
Manager, R&D	March 16, 2015	48	X	X	X
Director, Solution Business	March 16, 2015	65			X
Sales Support, Product Business (local subsidiary)	May 29, 2015	57	X	X	X
Director, Solution Business	October 12, 2015	35		X	X
Director, Solution Business	October 25, 2015	55		X	X
Salesperson 1	August 2, 2018	17			X
Salesperson 2	June 27, 2018	20			X
Salesperson 3	June 27, 2018	23			X
Salesperson 4	June 27, 2018	15			X
Salesperson 5	May 22, 2018	25			X
Salesperson 6	April 23, 2018	43			X
Total		*37 h 42 min*	*19*	*17*	*19*
Other material	*Years*	*n*			
Participant observation	2011–2016	72 months		X	X
Meetings with participant observer	2013–2016	19 meetings		X	X
Confidential company documents	2015–2017	9 pages		X	X
Marketing communications material	2006–2018	36 pages	X	X	X

Table I. Catalogue of data sources used in the analysis

Three phases of development shaped the investigated period, and research methods were adjusted accordingly:

(1) In the first development phase, spanning from the beginning of 2006 to the end of 2010, the case firm established its integrated solutions offering. During this period, the research focused on the implementation of this strategic initiative, identifying the constituents of the transition process from traditional manufacturing orientation to service-focused solution business. Interviewing focused on the key managers associated with the change process.

(2) In 2011, the case firm began a concerted effort to build a modular solution approach by establishing a new solution business unit. Hence, the second phase of the study, from the beginning of 2011 to the beginning of 2013, investigated how the modular solution was framed and designed in the organization. During this phase of the research, one of the authors worked at the organization, taking part in the initiative to develop a modular solution as a participant observer. This phase included collection of company documents, notes and an in-depth observation of the case, which form an essential part of the data set. The participant observer maintained memos detailing important milestones in the transformation process and the debates that surrounded major decisions. Based on the observations, a timeline of key events was prepared. This provided a unique vantage point into the process of modularizing the solution, which was instrumental in increasing the validity of the study (Westbrook, 1995).

(3) From 2013 to 2015, the study examined how the case firm developed the through-chain capabilities needed for the provision of modular solutions. During this phase, the perspective was expanded to cover the key supply network partners. In total, 18 semi-structured interviews were conducted with selected managers and experts representing different actors in the supply network, considered as the key informants within the production system, to gain their perspectives on the transition to modular solutions. Also, meetings with experts representing different units within the case organization were held to discuss the implementation of the modular solution approach and the associated challenges with the key informants. Extensive notes were taken in these meetings.

In addition to the primary interviews with managers and experts representing different functions within the case organization, an extensive set of company documents, memos, communication material, correspondence, brochures and bulletins was collected with permission from the case company to verify the findings related with the theme of the interview. All items in the data were produced in the daily operations of the case firm (i.e. not for the purposes of this research). The data supported the analysis of the three phases with "factual" and more objective data. Table I outlines the data used in the analysis and identifies the units of data that contribute to each of the three phases that emerged from the analysis.

Due to the richness and heterogeneity of the data, the analysis procedures focused on identifying events and instances, across the data set, describing the development of various capabilities directly associated with modularization, and more broadly the organizational changes and activities supporting modularization. Instances relevant to the research question were identified, and the observations were arranged into thematic blocks and arranged chronologically. The analysis followed the basic principles of constant comparison (Eisenhardt, 1989; Glaser and Strauss, 1965); within-group analyses were first done for each functional group (see Table III in Section 5.2, "Managerial implications"), and then a cross-functional comparison was performed (arriving at the overview presented in Figure 2, in the next section). Various measures to limit retrospective bias were taken when using

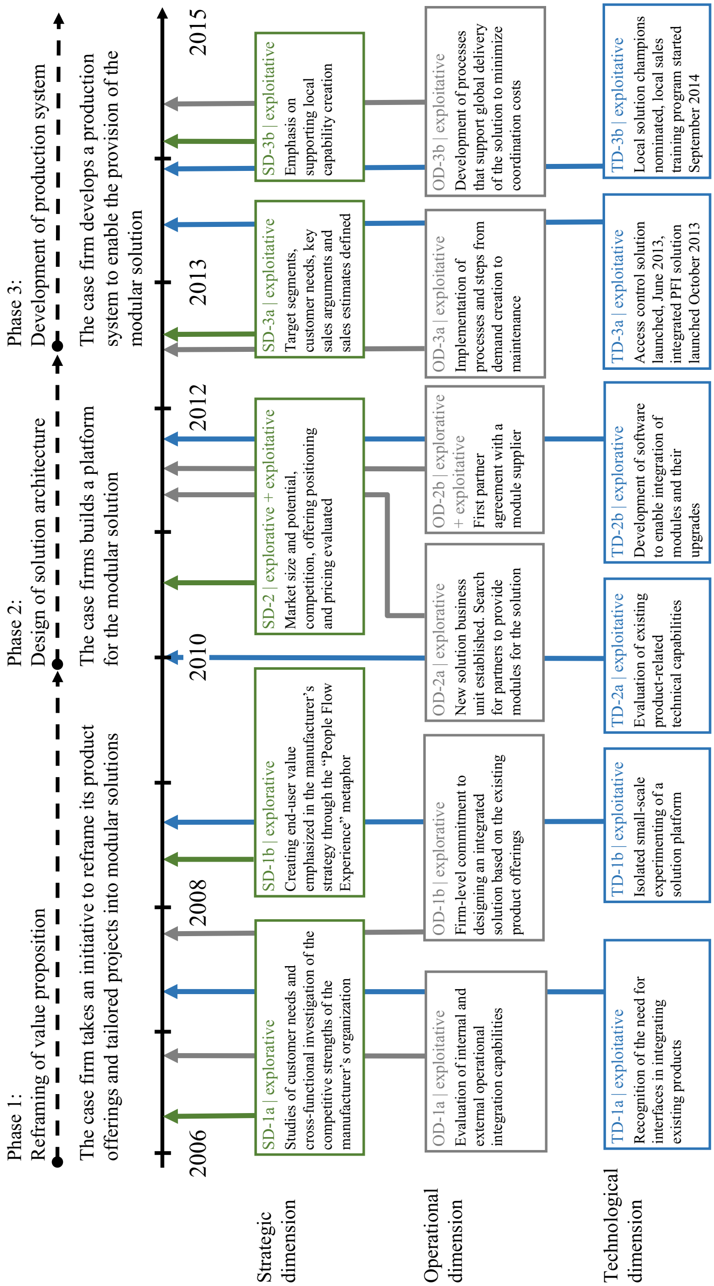

Figure 2.
Key development tasks identified in Kone's transformation to modular solutions business

participant observation in the focal organization. In particular, the focus remained on factual elements rather than subjective interpretations of the investigated phenomena in the case. Access to the material provided by the company allowed for the development of a detailed longitudinal understanding of the evolution of the case.

4. Case analysis and findings

Kone Corporation is a Europe-based provider of elevators, escalators, automatic doors and related services. Kone is among the global top 4 manufacturers in the industry, with annual net sales of €8.9bn in 2017. Service provision and new equipment sales account for equal amounts of its turnover.

Kone has developed several breakthrough innovations that have changed the industry norms for elevator technologies, such as an elevator design without machine rooms. However, the increasingly matured industry encompasses competitive pressure, as the technological gap between Kone and its competitors has diminished and innovations rapidly diffuse among competitors. In 2007, Kone launched its vision of providing the "best people flow experience," moving beyond the traditional product-centric approach into supporting user experience by providing solutions that enable efficient, safe and comfortable moving in buildings.

During the studied ten-year period, Kone transitioned from the project-specific integration of solutions into comprehensive solution offerings based on efficiently produced modules. The detailed analysis of the transformation process explored the implementation of modularity principles and platform development to integrate the modular solutions, and in particular, the needed strategic, operational and technical capabilities both at Kone and its entire production system consisting of selected partners.

The next sections explain three maturity phases in the evolution of the business toward modular solutions as identified in the data: the development of modular offering, the design of the solution architecture to implement modular solutions and development of the production system to exhibit "through-chain" modularity. As illustrated in Figure 2, the main development activities identified in each phase are arranged by strategic, operational and technical domains of capability development.

4.1 Phase 1: reframing of the value proposition (2006–2010)

The first phase, from 2006 to 2010, featured a strategic shift toward integrated solutions business. In the expanding business, Kone's solutions included abundant integration work at customer sites. The R&D department started to develop a future vision conceptualized as the "Kone solution platform": a modular offering architecture to connect the components and reduce on-site integration work. To exploit its manufacturing resources in the solution business, Kone strengthened its core capabilities for the solution provision. Explorative capability development activities emerged in the strategic domain and evolved to address operations, whereas the technological domain operated efficiently in an exploitative mode (see Figure 2).

Strategic domain. During this explorative phase, Kone conceptualized its modular solution offering, choosing the value experience of the end user as a strategic priority. The modular approach to solutions was viewed as a key enabler of this strategy. The management of the solution business operations at Kone believed that a modular design would facilitate value creation through solutions that better respond to current and future customer needs. It would also capitalize on efficient operations.

The informants used modularity as a cognitive frame to describe the intended solution design:

> […] we have to create the solution [customizable] – so that it, in terms of costs and the possibility to implement technologically, it's possible to include it as part of the volume business. Then we can […] deliver it with every elevator in a specific basic module, which enables us to turn it on if needed. (Manager, R&D)

First, the definition of the solution reframed the existing offering for individual designers and managers responsible for the solution initiative, but it also required collective framing by which the stakeholders understood the objectives and priorities of the initiative. Kone conducted studies of customer needs to support and direct the initiative (step SD-1a in Figure 2).

Second, the informants emphasized the role of clear understanding and ownership of the underlying solution architecture in developing the modular solution capabilities. Understanding this architecture is based on Kone's vision of an effective "people flow experience" in buildings and the products and services needed to support that (SD-1b, as above).

Operational domain. For office buildings, Kone provided smart solutions that recognize the users and their access rights, and guide them to their destination without having to press buttons or open doors. Seamlessly integrated subsystems included an access to stored user profiles, and destination control allocated passengers to the elevators; information panels provided guidance; and real-time monitoring allowed scrutiny the people flow. In addition to serving the users of a building, the functionality offered benefits for the facility owners and operators. These one-off integrated solutions were provided by a separate project business unit.

Prior to implementing the modular solutions concept, Kone ran its operations efficiently in an exploitative mode. Despite this, the operational level implications of modularity were already being considered:

> […] the solution – should be divisible into modules. That's something you just have to accept, it's hard but you have to be able to do it – you have to integrate it into all those production management systems. (Manager, Business Development)

From the outset, it was understood that the capabilities to create seamless people-flow service solutions for the end-users and to communicate this re-designed value proposition to the essential stakeholders surpassed the traditional manufacturers' scope of expertise. Kone identified the needed capabilities and located capable resources internally and externally (OD-1a, respectively). Kone then began searching for strategic partners to become the suppliers of modules to complement the value proposition with external contributors.

A firm-level commitment to the user value-focused approach was established (OD-1b), and Kone began improving its internal capabilities to sell, deliver, install, maintain and upgrade the solutions.

Technological domain. In this phase, Kone re-evaluated its technical capabilities based on building standalone systems that were integrated on-site (TD-1a). Customer needs may change during the installation's life cycle, and the architecture of the offering must accommodate to later modifications and upgrades. These objective were met more easily if the solution architecture was based on modularity, and the solution platform allowed changes and extensions. A key step in the exploitation of the existing product components and production resources was the identification of the core modules to be combined and their interfaces.

The R&D team exploitatively developed the interfaces required for the use of existing product components in the new modular solution concept (TD-1b). Despite broad enthusiasm over the modular vision, Kone focused on the office buildings market where integrated solutions were already in use:

> Well, we probably would have had enough enthusiasm to enlarge the solution on a wider scale. But – we have had to decide – what to focus on, to stick to some kind of schedule – So […] I really must give the crew credit for having been able to keep it realistic […] (Manager, R&D)

Thinking of the solution as a modular offering distinguishes Kone's offering from a mere product extension and *ad hoc* integration of systems in customer projects. Some respondents described how a competitor offers an automated gate that recognizes a user and makes an automatic elevator call to the desired floor. In their view, the design of this offering is not

based on a long-term vision of a modular, platform-based solution, as it was created by extending an elevator with an access control system and destination control unit. The resulting system is difficult to extend later with other modules for a more complete user experience. Thus, although the customer perceives these two solutions as providing an integrated whole, their different design principles impact the long-term development of the user experience. The experts representing R&D at Kone stressed that efficient customization requires software-based features, enabling Kone to update new features and turn on additional applications when requested by the customers.

4.2 Phase 2: designing the solution architecture (2010–2013)

From 2010 to 2013, Kone began developing its technical platform for the modular solution. Although the strategic focus was on exploiting the production resources, platform architecture development and module selection both required explorative capability development.

Strategic domain. The strategic development of the solution concept progressed in an explorative mode, while the initiative for the new modular solution architecture aimed to improve the efficiency of exploiting the production resources. For these purposes, the development of the solution architecture required important design choices (SD-2). The key informants at Kone emphasized that limiting the selection of standardized modules for efficiency in the solution architecture does not decrease the capability to meet the variety in customers' needs. On the contrary, controlled customization was expected to lower production costs, which was believed to provide the customers with clear options that would eventually increase the value for those customers.

In this phase, securing resources for platform development was crucial. Seizing the benefits of controlled customization requires that the sales people are trained to match the available solution configurations with their customers' needs. Sometimes external impetus was needed to justify the development of the solution architecture:

> I wish that our competitors would do really exciting things in this area […] it's a lot easier for me to justify it to the product development managers – when I can ask them to look at [our] competitors. (Manager, Business Development)

A solution offering using the new platform architecture was launched in 2013. It is marketed under the brand concept People Flow Intelligence (PFI). Managers in both R&D and marketing recognized the benefits of resource efficiency of the platform-based solution and the concept-oriented marketing approach:

> […] we decided that we're not going to bring this in like one gadget at a time and then name them and brand them and launch them separately one at a time, like – gimmicks. Instead, we decided to build a framework that will broaden people's thinking about what we do. – for years to come, we will be able to add new products to that framework. – We need a framework where I can always see that there will be a new generation coming. (Director, Marketing)

Operational domain. The need to ground solutions on modular design principles for a sufficient degree of industrial efficiency in the deployment of the PFI concept became ever more obvious. Derivative offerings based on one-off integration efforts would become too expensive and operationally complex to be implemented on a larger scale as part of the highly standardized processes of Kone's ongoing operations. In 2011, the firm established a new solution business unit with the purpose of developing a platform-based solution offering (OD-2a). This allowed exploring new ways to conduct solution business, inducing learning in different areas of solution development. For example, a platform-based approach to solutions enabled Kone to take advantage of externally sourced solution components, while utilizing its established competences in selling, delivering, installing and maintaining

the solution offerings (OD-2b). Thus, the operational priorities included technical connectivity and remotely manageable designs:

> We are focusing especially on developing the platform for our solution the way that it will provide connectivity between the modules. Also, it will include an ability to manage the whole [solution] remotely, – from a remote location, to be able to update the new stuff – it will provide a real platform for various types of applications which can be imported easily onto it. (Manager, R&D)

To develop a platform-based offering, the solution architecture that connects the modules to the solution platform was defined first. The subsystems that would connect to the existing core offering of elevators, escalators and doors were selected. Since the externally provided subsystems would be sold and maintained under Kone's PFI solution brand, mutually agreed legal and business practices were established among the partners in detailed negotiations (OD-2b). Initiating these partnerships required a shared sense of purpose for the solution. For Kone, it was to enhance its market offering, and for the partners, typically operating in more fragmented industries, Kone offered an additional channel to market as part of a mass-marketed solution.

Technological domain. In developing the solution architecture, explorative activities, such as designing new interfaces between the modules, were structurally separated from the activities that took an exploitative approach, like the ones that aimed at improving the module production and delivery processes (TD-2a). For the technical architecture, Kone focused on a modular design built on pre-defined interfaces between the subsystems. To develop the solution platform that ties the entire solution together, Kone initiated R&D projects focused on the development of standardized interfaces connecting the selected subsystems to Kone's core platform (TD-2b). As compared with the traditional *ad hoc* integration of parts into a solution, it became clear that true modularity requires elements designed for compatibility:

> […] – when we bring in the physical access control [module] into the elevator – we need to implement the card reader as part of the solution [before its delivery to the customer site]. And that requires that the signalization team must do that work, modify the operating panel to include the card reader. – our service contract structure supports that the customer gets service not only for Kone elevators but also for the access control module. (Manager, R&D)

Significant cross-learning opportunities were perceived, as Kone and its partners operated in different, but complementary fields:

> […] luckily enough – the project manager at the time, by using his personal qualities and sociability – [engaged] the elevator software people and PFI software people – [in] informal exchanging of thoughts and benchmarking, and then maybe this sort of more traditional group of people who at first maybe thought that we know how to do this thing – saw that – it's [ok to] do it like that as well. Then we did them some favors, as they had scarce resources, so, there was a certain feeling that we could do that from our side. And then, as our main [solution] architect was also – well known among the key developers. So there was a good amount of – interaction. (Manager, R&D)

In this vein, the R&D function explored the platform technology to connect solution components seamlessly. The module development was based on exploitative learning, focusing on utilizing the specific capabilities possessed by the actors dedicated to developing the subsystems.

4.3 Developing through-chain modularity in the production system: 2013–

From 2013 onwards, the solution provider exhibited exploitative learning not only in the strategic domain but also at the operative and technical domains of capability development. Capability development in the case centered on exploiting the production resources at the operative level, and implementing the technical boundary resources that tied the modules together.

Strategic domain. In the third phase, Kone defined the heterogeneous and changing needs of the customers (SD-3a). Essential tasks included clarification of the offering concept, and communicating it with customers through the marketing communications the way that customers understood the modules as add-on features attached to the new solution framework:

> […]when we created the concept – this whole People Flow Intelligence offering. It's divided into names [of products] that are already familiar to people. So there's Access, Destination, and then there's Information and Monitoring. And all of them already included some finished products we have had before, but the point is that we – created a framework that people recognized, one which included words that were familiar to people. (Director, Marketing)

Next, Kone placed strategic emphasis on developing its networked production system with its partners that are specialized in providing the subsystems to the solution as modules (SD-3b). The management of Kone deemed that for combined efficacy and variability of the solution, the most sensible approach to develop the new solution offering further should include better interfaces with partners. As a result, the entire production system is modular by design. That is, when customers request for additional solution elements, Kone works with a network of selected external component providers, strategic partners, to develop and connect the elements as modules in the solution. This enables Kone to concentrate on its core business capabilities around elevators, escalators and doors, while external providers bring in the needed complementary capabilities.

In the aggregate, the activities by Kone and its partners are designed to ensure the competitiveness of the modular production system. This included choosing partners that were able to jointly develop interfaces with Kone for their modules to be effectively added to the solution. Developing strategic partnerships for the networked production system was a strategic concern:

> Building the partnerships is surprisingly slow, as the legal issues need to be planned upfront. In general, finding a suitable partner, who is interested in exactly this kind of a partnership, takes time. On the other hand, even though we could develop the required competences in-house, it just does not fly without the industry expertise. (Manager, R&D)

During the development of the solution platform, Kone discovered that some external providers of the key subsystems represent highly fragmented industries and industry standards, that would enable "plug and play" integration of these external subsystems to Kone's core platform, were rare. Also, purchasing the modules from the selected suppliers was different from the competitive tendering practiced in the production of project-based solutions. Thus, Kone established new types of supplier agreements and practices that allowed collaborative development of the modules in the platform. The modules acquired from strategic partners were integrated into the downstream supply chain the way that they were supported and served by Kone:

> It is, of course, the case with all those components […] and with the supply chain. The supply chain is […] a greater challenge than the technology. […] The technological solution needs to be cost-effective enough, and it needs to fit in that space both physically and technically. […] If we have a solution in the machine room […] where these technological gadgets are going to be placed during the installation. But then this supply chain […] the order form should have these certain options. And when the vendor ticks in the option boxes, they should really be delivered to the site, and our installation staff needs to have enough know-how to install them. The same goes for the service organization. (Manager, R&D)

Operational domain. The management of Kone felt that, in the context of, for example, office buildings, improved customer value could be created by integrating subsystems that create an enhanced people flow experience from the point of entry to the building and ending at the arrival to proprietary office spaces. That is, the building solution was implemented

using the existing product components equipped with interfaces to make them compatible with the solution platform (OD-3a).

The production system was designed to meet the heterogeneous and changing needs of the customers. It was essential to clarify the offering concept, and communicate it through the marketing communications the way that customers understood the modules as add-on features attached to the new solution framework:

> […] then we started enriching the content, which means that we bring in new modules – which means [for example] signalization. – And we started to expand that box and said that our framework – that by adding intelligence to it and by utilizing new technologies we are, in fact, very strong in this area. (Director, Marketing)

At the same time, despite a shift to platform-based solutions designed and delivered in collaboration with a select group of strategic partners (OD-3b), Kone maintains an ability to deliver solutions as projects to integrate subsystems from local suppliers falling outside of these strategic partnerships. Such solutions entail project-specific integration efforts raising costs and operational complexity, but sometimes an optimal solution to customer needs requires a tailored approach. For instance, a customer with global operations may wish to utilize a specific access control provider in all of its global locations.

Technological domain. Facilitating effective integration of the modules, Kone's solution platform connected the existing core product offerings in elevators, escalators and doors through software interfaces. In addition to providing a technical architecture for derivative solutions, the platform concept gave Kone a technical backbone for its value proposition, an effective people flow experience solution, which included complementary product components. To support the local units' technological readiness to offer platform-based customer solutions, Kone nominated solution champions.

Informants at Kone emphasized that producing one-off solutions that offer the same functionality as Kone's integrated offering was not difficult. The difficulty lies in maintaining the solution platform in such a manner that derivate offerings can be sold, manufactured, delivered, installed and maintained using the firm's existing organizational competences. Therefore, pre-existing products needed to be compatible with the platform for them to become modules in the new solution (TD-3a):

> […] in [the first version of the integrated solution], we have some solutions that are actually built on that platform. […] The monitoring system […] should be ported to this platform and […] and renewed as well. […] Then [we are building] this new Kone Access […] right from the beginning on that platform […] [that is] delivered […] based on quite a heavy server hardware. […] we need […] a considerably more cost-efficient model in order to include it as part of these volume elevator deliveries. (Manager, R&D)

Thus, to both create and capture value, Kone's solutions need to be designed in the same way as the firm's existing product offering following the principles of platform thinking. The existing product offering in elevators, escalators and doors forms the solution framework, and Kone attempts to minimize variance in the complementary subsystems for access control, destination, information, and monitoring that connect to the core offering through standardized interfaces. Moreover, continuous development efforts are needed to streamline the platform offering and to make it scalable to lighter-weight "bulk" solutions. This involved launching a sales training program with locally operating solution champions (TD-3b).

5. Discussion

5.1 Conclusions and propositions

The single-case research design enables logical, but not statistical generalization of the findings (Flyvbjerg, 2006). Therefore, this section develops necessary condition -type

propositions (cf. Hak and Dul, 2010) that summarize the main conclusions drawn from the empirical evidence.

The longitudinal analysis of Kone's development of its modular approach to solutions identified three competitive capabilities that developed through the strategic, operational and technological design activities. Table II summarizes the main observations concerning the development of the modularization capabilities for integrated solutions business in the case firm.

First, the capability of framing the value proposition as a modular offering based on a market-oriented vision enabled the firm to justify its new extended solution concept and to address the key development challenges related to the high amount of customer solution specific integration work. In the first phase, Kone exploited its core technical and operational capabilities in the provision of integrated solutions while it developed required capabilities to start delivering the modularized offering.

Second, the competitive capability of designing the modular solution architecture enabled a technology-focused approach, which was essential in practical solution platform development that required various R&D-related capabilities. In the second phase, the emphasis was on operational capabilities such as the orchestration of the supply network, recruiting, subcontracting, solution marketing and offering development.

Third, the capability to set up a modular production system developed as Kone focused on its supply chain and redesigned organizational collaboration and interfaces to integrate resources effectively. Among the development areas were solution sales capabilities and sales support, sourcing and maintaining contracts with the core module suppliers, and system support for the configuration and delivery of customer-specific solutions. The study, therefore, puts forward *P1* considering the main development activities leading to the modular solutions capability:

P1. Determinants of the successful development of competitive capabilities for modular solutions include a vision of the modular value proposition; modular design of the

Maturity of the solution offering	Phase 1: solutions based on *ad hoc* integration	Phase 2: smart solutions based on modular design	Phase 3: through-chain modularity
Modularization capability	Framing the value proposition as a modular offering	Designing the modular solution architecture	Developing the modular solution production system
Focus	Extension of the existing offering	Redesign of the existing offering	Redesign of organizational collaboration and interfaces
Orientation	Market-focused approach	Technology-focused approach	Supply chain-focused approach
Main challenges	Amount of solution-specific integration on-site Justifying the need for a modular design	Securing resources for the solution platform development	Integrating resources in the production system for competitive performance
Areas of development	Developing a future vision and concept for the modular offering architecture Establishing firm-level commitment Emphasis on core technical and operational capabilities in the provision of integrated solutions Identification of potential module suppliers	Emphasis on operational capabilities Development of R&D-related capabilities, recruiting and subcontracting Solution marketing and offering development Orchestrating the supply network	Emphasis on supply chain capabilities Development of sourcing, sales support and solution sales capabilities Maintaining contracts with the core module suppliers Establishing system support for the configuration and delivery of solutions

Table II.
Evolutionary phases in the development of capabilities for the modular solution

solution architecture and development of the modular production system that permits exploitative learning in the production of components as parts of the modular offering.

The case shows that large-scale implementation of a modular solution requires technological capabilities far beyond technical solution development and implementation: requirements for engineering extend from the offering level to cover the organizational system and the external component suppliers, and include designing interfaces, contracts and skills. Moreover, mastering the process requires strategic competences ranging from the visionary framing of the value proposition as a modular offering to supporting local capability creation. The study thus develops *P2* concerning the intertwined dimensions of the process leading to the modular solutions capability:

P2. Development of competitive capabilities for modular solutions is a multi-faceted process involving experimentation in the interconnected dimensions of strategic, operational and technological competences.

The case analysis reveals that in its evolutionary process, Kone flexibly combined explorative and exploitative modes of learning to build the required competitive capabilities. Variability in the end-customer requirements and contexts of use required the ability to design the modular solution the way that it supports the effective delivery of different component configurations. The vision of the benefits of modularity triggered explorative learning at the strategic level, which was shortly followed by operative and technical levels of development, as the development of the interfaces between components required explorative capability development. Conversely, at the more advanced level of modular solutions production, Kone exhibits exploitative learning in generating customer-specific configurations using pre-defined interfaces between the modules. This pattern repeated itself in the longitudinal analysis (cf. Figure 2). Thus, the final mode in which modular solution offerings are produced demonstrates ambidextrous performance, combining the benefits of explorative and exploitative learning. Thus:

P3. The development of modular solutions capabilities proceeds through development phases that constitute alternating explorative and exploitative learning activities; therefore modular solutions capability demonstrates ambidextrous performance.

5.2 Research implications

The study discovers that the industrial movement known as servitization does not stagnate after the firm establishes its integrated solutions offerings, but proceeds further toward modular solutions and through-chain modularity as firms strive toward higher resource efficiency. The analysis demonstrates how a "servitized" provider of complex product-service-systems, Kone, moves from industrial solutions based on tailored, project-based integration (i.e. the first generation industrial solutions) to a modular solutions structure (the second generation) and further on spreads the modular design approach to its network suppliers. This makes a novel discovery on servitization research, as pre-existing studies have focused on the developmental shift that enabled companies to provide solutions in general, without a specific focus on the modularization that followed the move into service business in the studied company. The study thus identifies the implementation of modular solution architectures as a key competitive capability and a major development step in the industrial solutions business.

Pre-existing research has been criticized for representing servitization as a forward-unidirectional process (Finne *et al.*, 2013; Kowalkowski *et al.*, 2015). Despite this, in the case of Kone, the shift was forward-unidirectional in the long-run. The competitive capabilities and practices develop over time through explorative and exploitative learning. Firm-specific

paths from traditional integrated solutions to modular solutions may differ in the level of detailed development activities to efficiently design, produce and integrate industrial service solutions as each firm is a unique context for capability development. Exploitative learning in the development of production capabilities balances exploration, as the industrial manufacturing of the solution components requires efficiency for scale advantages. Exploitative learning also contributes to the efficient delivery of the integrated offerings.

This study departs from prior research concerning technology firms' servitization capabilities (Löfberg *et al.*, 2016), which has focused on the development of capabilities at the early maturity levels of the solution business. Earlier servitization research has emphasized organizational and cultural shifts (Luoto *et al.*, 2017) and depicted a strong contrast between the product and service orientations (Oliva and Kallenberg, 2003; Smith *et al.*, 2014). The ability of Kone to move swiftly between the explorative and exploitative mode indicates organizational agility that could explain why organizational tensions did not play a major role in its servitization journey. Also, cultural changes are biggest in the transition from product orientation to service orientation (Brax, 2005; Lenka *et al.*, 2018; Oliva and Kallenberg, 2003), which takes place during the shift to first generation solutions, and the study continued to follow the firm long afterwards.

Apart from the brief case observations by Baines and Lightfoot (2014) in one of their cases, the pre-existing servitization literature has not investigated the role of modularization in developing complex industrial service offerings. Earlier research on modular solutions comes from the modularity research stream and has investigated the mass-customization capability (Staudenmayer *et al.*, 2005; Tu *et al.*, 2004), the influences of modularity on intra-organizational networking (Jacobides and Winter, 2005; Sturgeon, 2002), and the organizational performance effects of modularity-based flexibility (Jacobs *et al.*, 2011; Pil and Cohen, 2006; Worren *et al.*, 2002). To enable solution providers to simultaneously pursue operational efficiency and effectiveness in serving diverse customer needs, a more comprehensive understanding of exploiting modular designs in integrated solutions business is needed.

Contributing to this gap, this study portrayed how a solution provider balances explorative activities with exploitation, demonstrating ambidextrous performance. Here, ambidexterity in the production of solutions refers broadly to the capability of pursuing disparate goals concurrently, such as exploitation and exploration (March, 1991), efficiency and flexibility (Adler *et al.*, 1999) and industrialization and variability (Davies *et al.*, 2006, 2007). Previous studies of ambidextrous performance (e.g. De Clercq *et al.*, 2013; Jansen *et al.*, 2012) emphasize the accessibility and integration of specific resources needed in the firm's operations. Developing these arguments further, this study suggests that incorporating external resources effectively into a solution calls for a planned solution structure based on the principles of modularity in the design of the solution and the production system (cf., Pil and Cohen, 2006).

The bibliographic study of modularity literature across 25 years by Frandsen (2017) finds only five studies that focus on capabilities. Taking the capability development perspective, this study contributes to the literature of modular solutions by identifying the types of capabilities and organizational learning that modularity necessitates at each maturity level of solution development. The competitive combining of capabilities requires both explorative and exploitative learning that focuses on the improvement of efficiency by reducing transaction costs among the providers of the solution components. Conversely, a call for the variability of the solution compels the integrator to learn continuously about market opportunities, potential new components, versions of the existing components and their integration mechanisms. Therefore, understanding the expandability of the solution improves the sustainability of the solution.

This case analysis adds to the current knowledge of the integration mechanisms of solutions in multi-actor settings (e.g. Kowalkowski *et al.*, 2011; Morris, 1983) by providing insights into three levels of integration: to implement modularity advantageously, the solution

integrator needs to develop capabilities in the strategic, operational and technical domains. It needs to build and communicate the vision of the modular solution (strategic domain capabilities), maintain an optimal structure of the solution, consisting in core and peripheral components (operational domain), and manage the technical interfaces between the modules (technical domain), as well as the inter-organizational ties among the key component suppliers (operational domain). The study highlights that long-term competitiveness in the provision of modular solutions requires effective orchestration of the production system. The findings support earlier research in that the strategy of providing integrated solutions requires coordination of complex production systems (e.g. Johnson and Mena, 2008). Integration of the resources possessed by different actors occurs in the operational domain, whereas the crucial interfaces for the integration between the modules will be realized in the technical domain. The provider of modular solutions may achieve this by strengthening the ties among the actors that provide the core components to the solutions while maintaining a network of other partners for the flexible variability of the solutions.

Moreover, previous research has shown that opposing resource demands can destabilize ambidextrous organizations (cf., De Clercq *et al.*, 2013). Current findings suggest that effective integration of resources in the solution provider's partner network can support a non-monolithic approach to solution deployment. This may help solution providers to increase their internal stability. In particular, strategic exploration of the benefits of modularity in the solution business model is required to guide the development of competitive capabilities for modular solutions. Such development includes phases of framing the value proposition as a modular offering, designing the modular solution architecture and developing the production system to implement modularity in the solution business profitably.

Furthermore, this case reveals that the network of module-specific actors, providing technical expertise and market-related knowledge of the solution components, is vital to facilitate the competitiveness of the solution. This supports previous research which finds that much of the competitiveness in solution business is subject to the effectiveness of the integration of the components provided by the network partners (Mikkola, 2003; Schilling, 2000). The application of modularity can enable a solution provider to make better use of the resources provided by its network partners. However, the ability to do so is contingent on the development of sufficient organizational and technical interfaces (Kusiak, 2002; Staudenmayer *et al.*, 2005), which requires active management of the network relationships for resource integration. Consequently, it is proposed that successful deployment of modular solutions requires the central integrator to reshape its partner network purposefully to enable replacing the *ad hoc* integration of components with modules that had pre-designed interfaces that enable connecting the module to the whole effectively.

5.3 Managerial implications

Baines *et al.* (2017) recently assessed priorities for servitization research and called for studies to provide roadmaps for practitioners. Whereas Figure 2 arranges the analysis across the years followed thereby providing a roadmap, Table II rearranges the development activities across the main organizational functions and identifies the required operational capabilities in the functional level to provide modular solutions at Kone (Table III).

Beyond road mapping, the analysis reveals important implications of modularity to solution development and the management and organization of solution business. The findings assert that the development of integrated solutions extends beyond technology innovation to the design of business models encompassing inter-firm collaboration. The modular design of the solution enables the solution provider to extend the reach of the solution on capabilities that are external to the service provider's organization.

While firms have few mechanisms to combine exploratory and exploitative learning, they can succeed in doing so through an intentional and active orchestration of their

Domain	Marketing and offering development	R&D	Sourcing	Sales support	Sales
Strategic	A vision of the modular solution emphasizing the value of the entire solution for the end-user	Ability to create a solution design that supports the modular offering	Component supplier selection Longer-term commitment	Governing local resources to support key component sales	Comprehending the "big picture" of the value-focusing offerings
Operational	Ability to communicate the through-life benefits of the solution	Modular structure of core (make) and peripheral (buy) elements	Contracting based on frame agreements	Guidelines for the integration and implementation of the product family	Integration with new stakeholder groups Sales process management when components sold over a period of time
Technical	Branding Combining third party elements into the offering	Support for the derivative solutions by the platform Interfaces	Bidding criteria Safeguarding the conformance of the components with the platform	Knowledge of and support for third-party elements	Sales configuration tools to manage readily available options

Table III.
Cross-functional mapping of main tasks in the development of operational capabilities for modular solutions

business network. The case shows that deepening the collaboration between the core component providers can extend the exploitation-oriented sphere to the partner network and reduce the transaction costs among the key actors.

The provision of complex industrial solutions involves explorative activities such as the search and integration of peripheral components to maintain the compatibility of the solution with varied customer needs. Yet, locally tailored parts of the solution can still be addressed through project-based integration. Such a project-based integration will not cease, as the providers of integrated solutions desire to safeguard their existing market share and profit margins by customer-specific configurations that extend beyond the modular platform. Although the possibility of "unique tailoring" has been considered a strength in the integrated solution business, solution providers need to develop the productivity of the solution business.

The management had a pivotal role in investing in the organizational capability development and integration of knowledge needed in the provision of the modular solution. Also, inter-firm networks became an important resource for the effective development and delivery of solutions. However, actors in the network should maintain their responsibility and autonomy to improve the efficiency of the deployment of the modules in the exploitative learning mode; through continuous improvement of their own processes, knowledge and capabilities.

5.4 Limitations and avenues for future research

While the Kone case proved to be a gold mine of information on the contingencies of modularity in solution business, the study is not free from limitations. The network orchestration was studied from the perspective of the focal actor, focusing on the relationships between the core component providers, as the data collected from the case provided a good view of the production system from the case firm's perspective, including the agreed-upon practices and economic aspects of the transactions. However, the observation of integration mechanisms could have been enriched by including the peripheral component suppliers' perspectives to the analysis.

Concerning methodology, the researchers controlled the threat of retrospective bias when using participant observation in data collection: they focused on factual elements

rather than on subjective interpretations of the investigated phenomena, and compared data with the secondary data collected from the case. Also, the data draws from multiple informants and different data sources, ensuring triangulation which reduces the risk of bias arising from individual informants' perspective and retrospection (cf. Maitlis and Lawrence, 2007).

Yet, the analysis could not capture the long-haul performance implications associated with the modularity of the solution at the network level due to the evolutionary phase of the solution. Therefore, further research on the long-term influences of modularization from the perspectives of economic and market performance is recommended (cf. Campagnolo and Camuffo, 2010), especially at the level of the entire production system.

Finally, the single-case research design portrays competitive capabilities associated with the development and delivery of modular solution in the investigated context. The study by Salonen and Jaakkola (2015) compared firm boundary decisions in two firms, Wärtsilä and Kone, and found that Wärtsilä grew its business based on resource internalization, whereas Kone relied on collaboration with its external resources. Correspondingly, the current analysis identified an emphasis on developing the component supplier network at Kone during the third phase. Yet, since Kone is following the external resource integration approach, the study by Salonen and Jaakkola (2015) indicates a further research question about the role of modularization in firms that adopt the internal resource integration as they advance their solution business. Thus, all generalizations of the findings are theoretical, requiring confirmatory research in various contexts. In-depth comparative multi-case studies should investigate alternative paths and maturity stages of modular solutions offerings, whereas large sample surveys should examine the mechanisms through which modularity of the solution influence the efficiency and effectiveness of solution provision.

References

Adler, P.S., Goldoftas, B. and Levine, D.I. (1999), "Flexibility versus efficiency? A case study of model changeovers in the toyota production system", *Organization Science*, Vol. 10 No. 1, pp. 43-68.

Anderson, J.C. and Narus, J.A. (1995), "Capturing the value of supplementary services", *Harvard Business Review*, Vol. 73 No. 1, pp. 75-83.

Auh, S. and Menguc, B. (2005), "Balancing exploration and exploitation: the moderating role of competitive intensity", *Journal of Business Research*, Vol. 58 No. 12, pp. 1652-1661.

Baines, T. and Lightfoot, H.W. (2014), "Servitization of the manufacturing firm: exploring the operations practices and technologies that deliver advanced services", *International Journal of Operations & Production Management*, Vol. 34 No. 1, pp. 2-35.

Baines, T., Lightfoot, H., Benedettini, O. and Kay, J.M. (2009), "The servitization of manufacturing: a review of literature and reflection on future challenges", *Journal of Manufacturing Technology Management*, Vol. 20 No. 5, pp. 547-567.

Baines, T., Lightfoot, H.W., Smart, P. and Fletcher, S. (2013), "Servitization of manufacture: exploring the deployment and skills of people critical to the delivery of advanced services", *Journal of Manufacturing Technology Management*, Vol. 24 No. 4, pp. 637-646.

Baines, T., Bigdeli, A.Z., Bustinza, O.F., Shi, V.G., Baldwin, J. and Ridgway, K. (2017), "Servitization: revisiting the state-of-the-art and research priorities", *International Journal of Operations & Production Management*, Vol. 37 No. 2, pp. 256-278.

Baldwin, C.Y. and Clark, K.B. (2000), *Design Rules. Vol. 1: The Power of Modularity*, The MIT Press, Cambridge, MA.

Baldwin, C.Y. and Clark, K.B. (2006), "Modularity in the design of complex engineering systems", in Braha, D., Minai, A.A. and Bar-Yam, Y. (Eds), *Complex Engineered Systems*, Springer, Berlin and Heidelberg, pp. 175-205.

Baldwin, C.Y. and Woodard, C.J. (2009), "The architecture of platforms: a unified view", in Gawer, A. (Ed.), *Platforms, Markets and Innovation*, Edward Elgar, Cheltenham, pp. 9-44.

Barney, J.B. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No. 1, pp. 99-120.

Bastl, M., Johnson, M., Lightfoot, H. and Evans, S. (2012), "Buyer-supplier relationships in a servitized environment: an examination with cannon and perreault's framework", *International Journal of Operations & Production Management*, Vol. 32 No. 6, pp. 650-675.

Brax, S.A. (2005), "A manufacturer becoming service provider – challenges and a paradox", *Managing Service Quality*, Vol. 15 No. 2, pp. 142-155.

Brax, S.A. and Jonsson, K. (2009), "Developing integrated solution offerings for remote diagnostics: a comparative case study of two manufacturers", *International Journal of Operations & Production Management*, Vol. 29 No. 5, pp. 539-560.

Brax, S.A. and Visintin, F. (2017), "Meta-model of servitization: the integrative profiling approach", *Industrial Marketing Management*, Vol. 60 No. 1, pp. 17-32.

Brax, S.A., Bask, A., Hsuan, J. and Voss, C. (2017), "Service modularity and architecture – an overview and research agenda", *International Journal of Operations & Production Management*, Vol. 37 No. 6, pp. 686-702.

Campagnolo, D. and Camuffo, A. (2010), "The concept of modularity in management studies: a literature review", *International Journal of Management Reviews*, Vol. 12 No. 3, pp. 259-283.

Collis, D.J. (1994), "Research note: how valuable are organizational capabilities?", *Strategic Management Journal*, Vol. 15 No. S1, pp. 143-152.

Davies, A. and Brady, T. (2000), "Organizational capabilities and learning in complex product systems: towards repeatable solutions", *Research Policy*, Vol. 29 Nos 7-8, pp. 931-953.

Davies, A., Brady, T. and Hobday, M. (2006), "Charting a path toward integrated solutions", *Mit Sloan Management Review*, Vol. 47 No. 3, p. 39.

Davies, A., Brady, T. and Hobday, M. (2007), "Organizing for solutions: systems seller vs systems integrator", *Industrial Marketing Management*, Vol. 36 No. 2, pp. 183-193.

De Clercq, D., Thongpapanl, N. and Dimov, D. (2013), "Shedding new light on the relationship between contextual ambidexterity and firm performance: an investigation of internal contingencies", *Technovation*, Vol. 33 Nos 4-5, pp. 119-132.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Eisenhardt, K.M. and Graebner, M.E. (2007), "Theory building from cases: opportunities and challenges", *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.

Ethiraj, S.K. and Levinthal, D. (2004), "Modularity and innovation in complex systems", *Management Science*, Vol. 50 No. 2, pp. 159-173.

Finne, M., Brax, S. and Holmström, J. (2013), "Reversed servitization paths: a case analysis of two manufacturers", *Service Business*, Vol. 7 No. 4, pp. 513-537.

Flyvbjerg, B. (2006), "Five misunderstandings about case-study research", *Qualitative Inquiry*, Vol. 12 No. 2, pp. 219-245.

Frandsen, T. (2017), "Evolution of modularity literature: a 25-year bibliometric analysis", *International Journal of Operations & Production Management*, Vol. 37 No. 6, pp. 703-747.

Galbraith, J.R. (2002), "Organizing to deliver solutions", *Organizational Dynamics*, Vol. 3 No. 1, pp. 194-207.

Gebauer, H. (2011), "Exploring the contribution of management innovation to the evolution of dynamic capabilities", *Industrial Marketing Management*, Vol. 40 No. 8, pp. 1238-1250.

Gebauer, H., Paiola, M. and Saccani, N. (2013), "Characterizing service networks for moving from products to solutions", *Industrial Marketing Management*, Vol. 42 No. 1, pp. 31-46.

Gebauer, H., Edvardsson, B., Gustafsson, A. and Witell, L. (2010), "Match or mismatch: strategy-structure configurations in the service business of manufacturing companies", *Journal of Service Research*, Vol. 13 No. 2, pp. 198-215.

Glaser, B.G. and Strauss, A.L. (1965), "Discovery of substantive theory: a basic strategy underlying qualitative research", *The American Behavioral Scientist (pre-1986)*, Vol. 8 No. 6, p. 5.

Hak, T. and Dul, J. (2010), "Theory-building with cases", in Mills, A.J., Durepos, G. and Wiebe, E. (Eds), *Encyclopedia of Case Study Research*, Sage, Thousand Oaks, CA, pp. 933-937.

Hayes, R.H., Pisano, G., Upton, D.M. and Wheelwright, S.C. (2005), *Operations, Strategy, and Technology: Pursuing the Competitive Edge*, John Wiley and Sons, Hoboken, NJ.

Helfat, C.E. and Winter, S.G. (2011), "Untangling dynamic and operational capabilities: strategy for the (N)ever-changing world", *Strategic Management Journal*, Vol. 32 No. 11, pp. 1243-1250.

Holmström, J., Brax, S.A. and Ala-Risku, T. (2010), "Comparing provider-customer constellations of visibility-based service", *Journal of Service Management*, Vol. 21 No. 5, pp. 675-692.

Jacobides, M.G. and Winter, S.G. (2005), "The co-evolution of capabilities and transaction costs: explaining the institutional structure of production", *Strategic Management Journal*, Vol. 26 No. 5, pp. 395-413.

Jacobs, M., Droge, C., Vickery, S.K. and Calantone, R. (2011), "Product and process modularity's effects on manufacturing agility and firm growth performance", *Journal of Product Innovation Management*, Vol. 28 No. 1, pp. 123-137.

Jansen, J.J.P., Simsek, Z. and Cao, Q. (2012), "Ambidexterity and performance in multiunit contexts: cross-level moderating effects of structural and resource attributes", *Strategic Management Journal*, Vol. 33 No. 11, pp. 1286-1303.

Jansen, J.J.P., Van Den Bosch, F.A.J. and Volberda, H.W. (2006), "Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators", *Management Science*, Vol. 52 No. 11, pp. 1661-1674.

Johnson, M. and Mena, C. (2008), "Supply chain management for servitised products: a multi-industry case study", *International Journal of Production Economics*, Vol. 114 No. 1, pp. 27-39.

Jose, A. and Tollenaere, M. (2005), "Modular and platform methods for product family design: literature analysis", *Journal of Intelligent Manufacturing*, Vol. 16 No. 3, pp. 371-390.

Kowalkowski, C., Kindström, D. and Brehmer, P.-O. (2011), "Managing industrial service offerings in global business markets", *Journal of Business & Industrial Marketing*, Vol. 26 No. 2, pp. 181-192.

Kowalkowski, C., Gebauer, H., Kamp, B. and Parry, G. (2017), "Servitization and deservitization: overview, concepts, and definitions", *Industrial Marketing Management*, Vol. 60, pp. 4-10.

Kowalkowski, C., Windahl, C., Kindström, D. and Gebauer, H. (2015), "What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies", *Industrial Marketing Management*, Vol. 45, pp. 59-69.

Kraaijenbrink, J., Spender, J.C. and Groen, A.J. (2010), "The resource-based view: a review and assessment of its critiques", *Journal of Management*, Vol. 36 No. 1, pp. 349-372.

Kristal, M.M., Huang, X. and Roth, A.V. (2010), "The effect of an ambidextrous supply chain strategy on combinative competitive capabilities and business performance", *Journal of Operations Management*, Vol. 28 No. 5, pp. 415-429.

Kusiak, A. (2002), "Integrated product and process design: a modularity perspective", *Journal of Engineering Design*, Vol. 13 No. 3, pp. 223-231.

Lavie, D. (2006), "The competitive advantage of interconnected firms: an extension of the resource-based view", *Academy of Management Review*, Vol. 31 No. 3, pp. 638-658.

Lenka, S., Parida, V., Sjödin, D.R. and Wincent, J. (2018), "Towards a multi-level servitization framework: conceptualizing ambivalence in manufacturing firms", *International Journal of Operations & Production Management*, Vol. 38 No. 3, pp. 810-827.

Lightfoot, H.W., Baines, T. and Smart, P. (2013), "The servitization of manufacturing: a systematic literature review of interdependent trends", *International Journal of Operations & Production Management*, Vol. 33 Nos 11-12, pp. 1408-1434.

Löfberg, N., Aichagui, V., Johansson, E., Witell, L. and Lagerholm, B. (2016), "A longitudinal study of servitisation and dynamic capabilities in SMEs", *Spring Servitization Conference 2016, Aston Business School, Manchester, May 16-17*.

Luoto, S., Brax, S.A. and Kohtamäki, M. (2017), "Critical meta-analysis of servitization research: constructing a model-narrative to reveal paradigmatic assumptions", *Industrial Marketing Management*, Vol. 60, pp. 89-100.

Maitlis, S. and Lawrence, T.B. (2007), "Triggers and enablers of sensegiving in organizations", *Academy of Management Journal*, Vol. 50 No. 1, pp. 57-84.

March, J.G. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.

Mathieu, V. (2001a), "Product services: from a service supporting the product to a service supporting the client", *Journal of Business & Industrial Marketing*, Vol. 16 No. 1, pp. 39-58.

Mathieu, V. (2001b), "Service strategies within the manufacturing sector: benefits, costs and partnership", *International Journal of Service Industry Management*, Vol. 12 No. 5, pp. 451-475.

Matthyssens, P. and Vandenbempt, K. (2010), "Service addition as business market strategy: identification of transition trajectories", *Journal of Service Management*, Vol. 21 No. 5, pp. 693-714.

Menor, L.J., Roth, A.V. and Mason, C.H. (2001), "Agility in retail banking: a numerical taxonomy of strategic service groups", *Manufacturing & Service Operations Management*, Vol. 3 No. 4, pp. 273-292.

Mikkola, J.H. (2003), "Modularity, component outsourcing, and inter-firm learning", *R&D Management*, Vol. 33 No. 4, pp. 439-454.

Morris, P.W.G. (1983), "Managing project interfaces: key points for project success", in Cleland, D.I. and King, W.R. (Eds), *Project Management Handbook*, Van Nostrand, New York, NY, pp. 16-55.

Neely, A. (2008), "Exploring the financial consequences of the servitization of manufacturing", *Operations Management Research*, Vol. 1 No. 2, pp. 103-118.

Oliva, R. and Kallenberg, R. (2003), "Managing the transition from products to services", *International Journal of Service Industry Management*, Vol. 14 No. 2, pp. 160-172.

Paiola, M., Saccani, N., Perona, M. and Gebauer, H. (2013), "Moving from products to solutions: Strategic approaches for developing capabilities", *European Management Journal*, Vol. 31 No. 4, pp. 390-409.

Patton, M.Q. (1989), "A context and boundaries for a theory-driven approach to validity", *Evaluation and Program Planning*, Vol. 12 No. 4, pp. 375-377.

Pil, F.K. and Cohen, S.K. (2006), "Modularity: implications for imitation, innovation, and sustained advantage", *Academy of Management Review*, Vol. 31 No. 4, pp. 995-1011.

Rabetino, R., Harmsen, W., Kohtamäki, M. and Sihvonen, J. (2018), "Structuring servitization-related research", *International Journal of Operations & Production Management*, Vol. 38 No. 2, pp. 350-371.

Roehrich, J.K. and Caldwell, N.D. (2012), "Delivering integrated solutions in the public sector: the unbundling paradox", *Industrial Marketing Management*, Vol. 41 No. 6, pp. 995-1007.

Rosenzweig, E.D., Roth, A.V. and Dean, J.W.J. (2003), "The influence of an integration strategy on competitive capabilities and business performance: an exploratory study of consumer products manufacturers", *Journal of Operations Management*, Vol. 21 No. 4, pp. 437-456.

Roth, A.V. and Jackson, W.E. III (1995), "Strategic determinants of service quality and performance: evidence from the banking industry", *Management Science*, Vol. 41 No. 11, pp. 1720-1733.

Saccani, N., Visintin, F. and Rapaccini, M. (2014), "Investigating the linkages between service types and supplier relationships in servitized environments", *International Journal of Production Economics*, Vol. 149, pp. 226-238.

Salonen, A. and Jaakkola, E. (2015), "Firm boundary decisions in solution business: examining internal vs external resource integration", *Industrial Marketing Management*, Vol. 51, pp. 171-183.

Sanchez, R. and Mahoney, J.T. (1996), "Modularity, flexibility, and knowledge management in product and organization design", *Strategic Management Journal*, Vol. 17 No. S2, pp. 63-76.

Sandström, S., Edvardsson, B., Kristensson, P. and Magnusson, P. (2008), "Value in use through service experience", *Managing Service Quality*, Vol. 18 No. 2, pp. 112-126.

Schilling, M.A. (2000), "Toward a general modular systems theory and its application to interfirm product modularity", *Academy of Management Review*, Vol. 25 No. 2, pp. 312-334.

Sirén, C.A., Kohtamäki, M. and Kuckertz, A. (2012), "Exploration and exploitation strategies, profit performance, and the mediating role of strategic learning: escaping the exploitation trap", *Strategic Entrepreneurship Journal*, Vol. 6 No. 1, pp. 18-41.

Smith, L., Maull, R. and Ng, I.C.L. (2014), "Servitization and operations management: a service dominant-logic approach", *International Journal of Operations & Production Management*, Vol. 34 No. 2, pp. 242-269.

Staudenmayer, N., Tripsas, M. and Tucci, C.L. (2005), "Interfirm modularity and its implications for product development*", *Journal of Product Innovation Management*, Vol. 22 No. 4, pp. 303-321.

Storbacka, K. (2011), "A solution business model: capabilities and management practices for integrated solutions", *Industrial Marketing Management*, Vol. 40 No. 5, pp. 699-711.

Storbacka, K., Windahl, C., Nenonen, S. and Salonen, A. (2013), "Solution business models: transformation along four continua", *Industrial Marketing Management*, Vol. 42 No. 5, pp. 705-716.

Sturgeon, T.J. (2002), "Modular production networks: a new American model of industrial organization", *Industrial & Corporate Change*, Vol. 11 No. 3, pp. 451-496.

Tu, Q., Vonderembse, M.A., Ragu-Nathan, T.S. and Ragu-Nathan, B. (2004), "Measuring modularity-based manufacturing practices and their impact on mass customization capability: a customer-driven perspective", *Decision Sciences*, Vol. 35 No. 2, pp. 147-168.

Tukker, A. (2004), "Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet", *Business Strategy & the Environment*, Vol. 13 No. 4, pp. 246-260.

Ulrich, K.T. (1995), "The role of product architecture in the manufacturing firm", *Research Policy*, Vol. 24 No. 3, pp. 419-440.

Van Liere, D.W., Hagdorn, L., Hoogeweegen, M.R. and Vervest, P.H.M. (2004), "Embedded coordination in a business network", *Journal of Information Technology*, Vol. 19 No. 4, pp. 261-269.

Vervest, P., Preiss, K., Van Heck, E. and Pau, L.-F. (2004), "The emergence of smart business networks", *Journal of Information Technology*, Vol. 19 No. 4, pp. 228-233.

Voordijk, H., Meijboom, B. and Haan, J.D. (2006), "Modularity in supply chains: a multiple case study in the construction industry", *International Journal of Operations & Production Management*, Vol. 26 No. 6, pp. 600-618.

Wernerfelt, B. (1984), "A resource-based view of the firm", *Strategic Management Journal*, Vol. 5 No. 2, pp. 171-180.

Westbrook, R. (1995), "Action research: a new paradigm for research in production and operations management", *International Journal of Operations & Production Management*, Vol. 15 No. 12, pp. 6-20.

Windahl, C. and Lakemond, N. (2006), "Developing integrated solutions: the importance of relationships within the network", *Industrial Marketing Management*, Vol. 35 No. 7, pp. 806-818.

Winter, S.G. (2003), "Understanding dynamic capabilities", *Strategic Management Journal*, Vol. 24 No. 10, pp. 991-995.

Worren, N., Moore, K. and Cardona, P. (2002), "Modularity, strategic flexibility, and firm performance: a study of the home appliance industry", *Strategic Management Journal*, Vol. 23 No. 12, pp. 1123-1140.

Yin, R.K. (1994), *Case Study Research. Design and Methods*, Sage, Thousand Oaks, CA.

Yusuf, Y.Y., Sarhadi, M. and Gunasekaran, A. (1999), "Agile manufacturing:: the drivers, concepts and attributes", *International Journal of Production Economics*, Vol. 62 Nos 1-2, pp. 33-43.

Corresponding author
Saara A. Brax can be contacted at: saara.brax@lut.fi