Department of Information and Service Economy

Towards service modularity – Service and business model development

Mervi Rajahonka

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Aalto University
School of Business
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Abstract

The proportion of services in the economy is increasing. One of the unresolved challenges is how to reach a balance between efficiency in service production and fulfillment of customers' diversified needs – in other words, a balance between efficiency and effectiveness. This research focuses on a concept that has been used for decades to tackle this challenge in the context of physical products and their manufacturing. This concept is modularity.

The research literature on modularity applied to services is still scarce. This research aims at theory building and studies the applicability of modularity principles in the service context, particularly related to logistics services. The aim is to strengthen our understanding about whether and how modularity can be applied in the service context, to clarify the essence and meaning of service-related modularity, and to study whether the development of efficient and effective services and service business models can be promoted with the help of modularity.

The thesis consists of an introduction and six research papers. The research methodology includes literature reviews and case studies in the logistics industry.

The empirical part of this research shows that logistics service providers (LSPs) are familiar with the concept of modularity, but using the concept in practice is not always easy. Moreover, as a theoretical concept, service modularity is not easy to define. The research on product modularity has often divided modularity into product, process and organizational perspectives. Services have many of the same characteristics as processes, and therefore service modularity is more complex than product modularity and, as a concept, it is closer to process modularity than to product modularity.

It is possible to avoid some of the theoretical and practical difficulties, if the core concept of modularity is clearly detached from adjacent concepts. Therefore, this research studies the relationship between modularity and customization, and presents a matrix framework separating these concepts.

This thesis discusses the applicability of the modularity concept to the service context and offers definitions of service-related modularity. The frameworks developed clarify the relationship between modularity and related concepts, and help to analyze services, service processes and organization (i.e. service business models) related to modularity. The business model concept is used to build a holistic framework combining modularity concerning service products, processes and organizational issues. This research offers new views on some of the basic principles, as well as practical examples of using modularity in the service context. In the future, the use of modularity principles to create different kinds of efficiently produced services, meeting diversified customer needs in a variety of service industries, will open up a wide range of further research opportunities.

Keywords modularity, logistics services, logistics service providers, LSPs, service strategies, business models, service models, customization, mass customization, services, processes, organizational networks

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Tekijä
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Väitöskirjan nimi
Modulaarisuusajattelu palvelujen ja liiketoimintamallien kehittämisessä

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Tutkimusala Logistiikka

Tiivistelmä

Palvelujen osuus taloudessa kasvaa. Haasteena on kuitenkin tasapainon saavuttaminen palvelutuotannon tehokkuuden ja asiakkaiden erilaisten tarpeiden täyttämisen (vaikuttavuuden) välillä. Tämä tutkimus keskittyy käsitteeseen, jota on käytetty vuosikymmeniä tähän haasteeseen vastaamisessa tuotteisiin ja niiden valmistukseen liittyen. Tämä käsite on modulaarisuus.

Palveluihin liittyvää modulaarisuustutkimusta on vähän. Tässä tutkimuksessa modulaarisuusajattelua pyritään soveltamaan palveluihin, erityisesti logistiikkapalveluihin. Tavoitteena on selkiyttää palveluihin liittyvän modulaarisuuden olemusta ja merkitystä ja lisätä ymmärrystä siitä, miten modulaarisuusajattelua voidaan soveltaa palveluihin. Lisäksi tavoitteena on tutkia, voidaanko modulaarisuuden avulla kehittää tehokkaita ja vaikuttavia palveluja ja palveluliiketoimintamalleja.

Tässä väitöskirjassa on johdantokappale ja kuusi tutkimuspaperia. Tutkimusmenetelminä on käytetty kirjallisuuskatsauksia ja tapaustutkimuksia logistiikkapalvelualalta.

Empiirinen osa tutkimuksesta osoittaa, että logistiikkapalvelujen tarjoajat tuntevat modulaarisuuden käsitteenä, mutta sen soveltaminen käytännössä ei ole aina helppoa. Lisäksi palvelumodulaarisuutta ei ole helppo määritellä teoreettisena käsitteenä. Tutkimuskirjallisuudessa tuotteisiin liittyvä modulaarisuus on usein jaettu tuote-, prosessi- ja organisaatiomodulaarisuuteen. Palveluilla on monia samoja ominaisuuksia kuin prosesseilla. Siitä syystä palvelumodulaarisuus on monimutkaisempi kuin tuotemodulaarisuus ja käsitteenä lähempänä prosessi- kuin tuotemodulaarisuutta. Joitakin teoreettisia ja käytännön haasteita on mahdollista välttää, jos modulaarisuus ja siihen liittyvät käsitteet erotetaan selvästi toisistaan. Siitä syystä tämä tutkimus käsittelee modulaarisuuden ja räätälöinnin suhdetta ja esittelee nämä käsitteet erottelevan viitekehyksen.

Tämän tutkimuksen kohteena on modulaarisuuskäsite ja sen soveltaminen palvelujen yhteydessä. Tutkimuksessa kehitetään määritelmiä palveluihin liittyvälle modulaarisuudelle. Tutkimus selkeyttää modulaarisuuden ja siihen liittyvien käsitteiden suhteita ja auttaa analysoimaan palvelu-, palveluprosessi- ja organisaatiomodulaarisuutta (eli palveluliiketoimintamallien modulaarisuutta). Liiketoimintamallin käsite muodostaa kokonaisvaltaisen viitekehyksen, jonka avulla palvelutuotteita, palveluprosesseja ja organisatorisia kysymyksiä koskeva modulaarisuus voidaan yhdistää. Tutkimus tuo uusia näkökulmia peruskäsitteisiin sekä tarjoaa käytännön esimerkkejä modulaarisuuden soveltamisesta palveluissa. Tehokkaasti tuotettujen ja monipuolisesti asiakkaiden tarpeisiin vastaavien palvelujen toteuttaminen modulaarisuusperiaatteiden avulla eri palvelualoilla sisältää runsaasti tutkimusmahdollisuuksia myös tulevaisuudessa.

Avainsanat modulaarisuus, logistiikkapalvelut, logistiikkapalveluyritykset, palvelustrategia, liiketoimintamallit, palvelumallit, räätälöinti, massaräätälöinti, palvelut, prosessit, organisaatioverkostot

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As a logistics major, I could seek comparisons from logistics to describe this process. I could say that the truck has taken a bumpy road. There have been delays and detours, as well as reloading and changes of transport modes. I could also say that there has sometimes been a real risk of losing the goods altogether, and that they have occasionally stayed in the warehouse for periods without any significant value added services. However, as the delivery is now almost complete, I can also see that this has been an educational journey and there have been more than one *condiciones sine quibus non* affecting.

The most significant of them has been my supervisor, Academy of Finland postdoctoral researcher Anu Bask, to whom I would like to express my deepest gratitude. Without her this thesis would not have been possible. She has been – among others – an encouraging teacher, an ingenious co-author, a genuinely sunny co-worker, a strict boss, the best supervisor in the world, and a dear friend.

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The empirical part of this work would not have been possible without several experts in the logistics organizations who were interviewed during this process. I thank them for their positive attitude and genuine interest in research in general and in this research in particular.

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Science seems to have a wrapping paper made of patience. More than one of the deadlines that I set for myself have passed – including the most significant and final one, the end of the world! The world did not end in December 2012, after all, and now it seems that I may have the blessing of completing this work. Thank you, God.

Helsinki, March 2013
Mervi Rajahonka

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2) Rajahonka M. (2013), “Views of logistics service providers on modularity in logistics services”, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, Vol. 16, No. 1, pp. 34-50.
3) Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2011), ”Framework for modularity and customization: service perspective”, *Journal of Business & Industrial Marketing*, Volume 26 Issue 5, pp. 306-319.
4) Bask A., Tinnilä M. and Rajahonka M. (2010), ”Matching Service Strategies, Business Models and Modular Business Processes“, *Business Process Management Journal*, Vol. 16, Issue 1, pp. 153-180.
5) Rajahonka, M., Bask, A. and Lipponen, M. (201x), “Modularity and customisation in LSPs’ service strategies”, Accepted in: *International Journal of Services and Operations Management*, Vol. X, No. Y, pp. xxx (forthcoming).
6) Rajahonka, M. and Bask, A. (201x), “Development of outbound logistics services in the automotive industry – case SE Mäkinen”, paper has been sent for review.

PART I: Overview of the dissertation

1. Introduction

Modular products or services are built of modules. From the consumer's point of view, an air transport service may be seen as consisting of the following modules: check-in and baggage drop, security check, shopping, boarding, flying, arrival, baggage pick-up, customs formalities (in international flights), etc. An air transport service is an example of a service where the service modules are consumed consecutively, whereas a shopping mall, for example, is a service in which there are many choices of consumable service modules at any point in time (Voss and Hsuan, 2009). These service modules are seldom produced by the same company, but by many parties, some of whom may have an official status (security check, customs, etc.). To manage this complexity and to be able to respond to divergent customer needs, it is essential to identify service modules and interfaces in a multi-actor service setting (Hyötyläinen and Möller, 2007).

The modularity concept is not new. Throughout history there have been products that have been assembled from subassemblies. However, Martin K. Starr presented modular production as a new concept almost 50 years ago (Starr, 1965 and 2010). Since then, modularity has become a popular concept in operations management. Thus the current research base on modularity related to physical products and their production is extensive (Salvador, 2007; Campagnolo and Camuffo, 2010). However, research on modularity in the service context is still rather rare, because applying modularity principles to services is new (Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009; Bask et al., 2010a).

This dissertation is focused on researching service modularity and modular business models in the service context. The current scarcity of

such research and the fact that it is becoming increasingly relevant constitute the main research motivations. The issue can be summarized as follows: Firstly, as the importance of services in the economy grows, service research becomes increasingly relevant. Nowadays services account for the major part of GDP in developed countries, and we are moving towards a global service-based economy (Spohrer and Maglio, 2008). Therefore service research is extremely pertinent to the success of economies. Service efficiency and effectiveness are becoming critical parameters, and are generating a growing interest in exploring new means of developing innovative service business models, effective service offerings and efficient service production. Secondly, operations management tools are well developed in manufacturing industries. Modularity is one of the approaches used in manufacturing industries to respond to challenges similar to those facing service providers today. It has been regarded as a tool for achieving a wide product range for divergent customer needs using a limited and manageable number of rather standardized components or product modules (Pine, 1993; Salvador, 2007). Thirdly, although modularity can be seen as a promising approach for service development, and it has been argued that modularization could bring many advantages in services (Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009; de Blok et al., 2010), the concept of modularity is far from clear (Salvador, 2007; Campagnolo and Camuffo 2010). Research on the practical applications of modularity is rare in general, and especially related to services (Starr, 2010). Starr (2010) even claims that it is possible that most present applications of modularity have been adopted non-systematically, on a hit-or-miss basis. Thus, a stronger theoretical basis and more case examples illustrating the usage of modularity principles in the service context in practice are needed. The fourth motivation behind this research is to build a more holistic view for service modularity research; until now, modularity has been researched at the product, process and organizational levels, but these avenues of research have been dealt with in isolation for the most part, and no proper "big picture" has yet been depicted.

1.1 Modularity research and services

The early service literature concentrated on defining the differences between products and services (Araujo and Spring, 2006). Consequently, the literature related to the special characteristics of services is quite extensive. One of the most common acronyms used when describing the differences between services and products is "IHIP" standing for the "Intangibility, Heterogeneity, Inseparability and Perishability" of services (Zeithaml et al., 1985). Sundbo (1994) lists four core elements of services

according to “the Service Management School”: service products cannot be stored, the producer has to be in direct contact with the customer, the service must be produced at the moment of consumption, the service is particular to a single customer. Voss and Hsuan (2009) in their article on service modularity maintain that it is important to consider the similarities and differences between services and products. Among the special characteristics mentioned by them related to services is that services are produced and consumed at the same time and the service product can often be the service process as well. They conclude that one of the dilemmas of service design is the question of whether a service product or a process is being designed (Voss and Hsuan, 2009).

The divergence of services is vast, and so is the scope of service research. Services are continuously spreading into new industries. Even the previous sharp division between manufacturing and service industries is becoming more blurred, as the proportion of services increases in former manufacturing industries. This has led to the introduction of new concepts such as PSS (product service systems) (Baines et al., 2007; Maussang et al., 2009) or the “servitization” of manufacturing (Baines et al., 2009). The recent literature emphasizes the similarities between product and service characteristics more often than the differences (Sundbo, 1994; Araujo and Spring, 2006), or treats service as a perspective rather than an activity (Grönroos, 2008). An important recent research path leading in this direction is the service-dominant or S-D logic introduced by Vargo and Lusch (2004). S-D logic, rather than distinguishing between goods and services, distinguishes between direct (“services”) and indirect (i.e. through goods) service provision (Vargo, 2009). Furthermore, it can be maintained that the challenges confronted nowadays in both manufacturing and service production are basically similar. Both require increased efficiency but at the same time also the capability to effectively satisfy diverse customer needs (Sundbo, 1994; Bask et al., 2010a). Offering variety to customers creates new business opportunities, but, on the other hand, creates a need for business models that can manage this diversity of demand cost-efficiently. Sundbo (1994) lists the trends that lead to, as he calls it, “modulization”. They are the increase of possibilities and competition, price as a competition factor, pressure for productivity and demand for quality, awareness of the importance of strategy and innovation, technological development, internalization, and mergers and acquisitions.

Many kinds of tools have been developed in manufacturing to manage the challenges of divergent customer demands, including, for example, mass customization by means of modularization. The basic idea of mass customization is that standardized products or product modules are mixed

and matched to meet heterogeneous customer needs, while simultaneously maintaining efficiencies of scale in production (Pine, 1993; Lampel and Mintzberg, 1996; Duray et al. 2000). This idea has been qualified by Duray et al. (2000). They note that *"modularity restricts the range of choice* [in order] *to decrease the possible variety of components",* and in that way sets limits on the customization of the product. Thus, using mass customization and modularity principles can lead to affordable products that meet almost all individual desires. Service research has emphasized customer experiences as an important element in effective services (Millard, 2006; Meyer and Schwager, 2007). However, there is not yet much research on whether the idea and logic of achieving mass customization with the help of modularity applies in the service context (de Blok et al., 2010). Moreover, the general research on modularity related to services and service operations is still rather limited (Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009). Thus, there is a need to strengthen the theoretical basis of modularity and mass customization issues focused on the service perspective.

Logistics services aim at altering the state of physical products, typically by transporting them from one place to another. The Council of Supply Chain Management Professionals defines logistics management as *"that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements"* (CSCMP Supply Chain Management). Compared to many other services, logistics services have special features that make studying them in relation to modularity fruitful. The first of these features is linked to the fact that logistics services have a special connection to manufacturing because they are *supportive services* for physical production (Hofer and Knemeyer, 2009), and because increasing the degree of modularity in manufacturing has an impact on modularity in logistics services. The second feature is the *wide variety of services* in logistics. In many services customers participate in the service processes, and are essential to the co-creation of value with service providers (Vargo and Lusch, 2004; Grönroos, 2008; Spohrer and Maglio, 2008; Uzkurt, 2010). However, this kind of close customer relationship between service provider and customer has not been typical in logistics; in fact, the customer may even be geographically distant from the service provider, because the purpose of the service is to transport goods from the direct customer (i.e. the factory) to the customer's customer (i.e. a retail store) via a chain of service providers. This situation is partly changing today, as the manufacturing stages have also increasingly been outsourced

to logistics service provides, LSPs (Coyle et al., 1992; Peters et al., 1998; van Laarhoven et al., 2000; Persson and Virum, 2001). In recent decades, outsourcing has led to an extension in the range and scope of logistics services, and an increased emphasis on customized BtoB logistics services. Consequently, a multitude of business models is available in the logistics service market for LSPs in different strategic positions, thus expanding their scale and scope of operations (Selviaridis and Spring, 2007).

The third feature relates to the fact that logistics typically involves *multiple interdependent actors* that have sophisticated roles, interact with each other and engage in tradeoffs. Networked business models have increased, and logistics tasks have rapidly become more complex (Hofer and Knemeyer, 2009). This demands integration of the supply chain across functions and companies, constituting a major challenge for supply chain managers (van Hoek, 2000a, b). At the same time the increased network and service complexity opens up more opportunities to achieve competitive advantage through a modular approach to business models. This is a new perspective, because the business models of logistics service providers have not yet been studied from the perspective of modularity in the research literature.

As there is growing interest in how methods developed in manufacturing industries can benefit service research and service providers, but only limited literature available on modularity concerning service business models, services and service operations, this constitutes the research gap that this dissertation aims to fill by increasing the theoretical and practical knowledge of service-related modularity. The logistics industry is a fruitful research field for modularity research. Logistics services provide empirical examples of both modular and non-modular business models. Therefore, this research focuses mainly on logistics services. The perspective of this study is mainly that of the logistics service providers (LSPs). However, in building and applying theoretical frameworks, illustrative examples from other industries will also be used.

1.2 Building a holistic view of modularity by using a business model framework

Modularity has been discussed in the existing product-related literature at three levels – at the product, production, and organizational levels (Pekkarinen and Ulkuniemi, 2008; Bask et al., 2010a; Campagnolo and Camuffo, 2010). This categorization will also be used in this research on service modularity, with the addition of one more level – the level of the business model – in order to build a holistic framework.

The concept of the business model has become popular in the last decade

(Pateli and Giaglis, 2003; Osterwalder et al., 2005). There are several definitions. A business model can be described as the firm's logic for creating and commercializing value (Osterwalder, 2004), as the conceptual and architectural implementation of a business strategy and the foundation for the implementation of business processes (Osterwalder and Pigneur, 2002), or as a reflection of the firm's realized strategy (Casadesus-Masanell and Ricart, 2010 and 2011). The business model offers a comprehensive description of the firm by presenting the firm's offering, operations, relationships, resources and financial structure in a single framework (Osterwalder, 2004; Rajala and Westerlund, 2007). Many researchers understand a business model as a modular representation of the business logic of a firm. For example Afuah and Tucci (2000) describe a business model as a system that is made up of components, linkages between the components, and the dynamics between them. This description resembles the modular system as presented by Baldwin and Clark (2000), consisting of architecture, interfaces and standards. Osterwalder's framework (e.g. Osterwalder, 2004; Osterwalder and Pigneur, 2009) also presents a business model consisting of nine building blocks. These building blocks can be seen as business model modules.

The business model perspective is used in this research to provide a holistic view of the research conducted on services and their modularity. The business model encompasses all the basic elements of the firm, and can be used as a framework for obtaining a holistic view of modularity; in other words, the business model view makes it possible to describe in a single framework all aspects of a firm – including its service products, processes, and organization – that can be modularized. The continuous evolution of business models, and their consequent need for flexibility, become more important as the business environment becomes more turbulent. A modular view of business models enhances business model flexibility. However, the current literature treats business models as rather static, meaning that once a business model is defined, the modules are fixed. This research takes a contrary view in which the modularity approach can be used as a design principle, even at the level of business models. Business model modularity encompasses the issues connected to modularity in the literature, namely product, process and organizational modularity. The underlying idea is that, as long as the firm's service products, processes and organization are modular, this view of business model development should allow mixing and matching of the modules of the business model and ensure flexibility also at the level of the business model.

1.3 Research objectives and research questions

This dissertation aims at theory building and studies the applicability of modularity principles in the service context, particularly related to logistics services. The aim is to strengthen understanding about whether and how modularity can be applied in the service context, to clarify the essence and meaning of modularity in relation to services, and to study whether development of efficient and effective services and service business models can be promoted with the help of modularity. Finally, the aim is to build a single framework combining the essential elements of service modularity research.

The research questions of this dissertation can be formulated as follows:

A. Understanding the concept of modularity in theory and practice

1) How is the concept of modularity defined in the literature in general? Which special features should be taken into account when defining the concept in the context of services?
2) How is the concept of modularity understood in practice, particularly by logistics service providers (LSPs)? Is the modularity approach used currently by LSPs and what are its current applications? What are the probable future developments concerning modularity in logistics and services in general?

B. Theory building and illustrations of modularity in the service context

3) What is the theoretical relation between the concepts of modularity and customization?
4) What are the interconnections between services, service production, service organizations, and business models in relation to modularity? What is the relevance of the match between service strategies, business models, and modular service and process designs?

C. Applications of modularity in the logistics service context

5) How can LSP strategies be classified based on the literature and empirical data? How do different LSPs, having different service strategies, use modularity and customization in implementing their strategies, and are there differences in usage related to their service offerings, service production processes and service production networks?
6) How do the case company's services for the automotive industry reflect modularity and customization? How and why has the service model of the case company been developed over time, and how has the case company used modularity in its service model development?

Modularity as a concept has been used in many contexts and therefore defining the concept has proved to be demanding. It can however be assumed that service providers recognize the concept. But it has not been studied before, and no clear picture has been formed as to the kinds of challenges there are in understanding or exploiting the concept in real business life. There are certain adjacent concepts that have regularly been linked to modularity in the literature, and one of these is customization. It could be expected that making a clear distinction between these concepts would make both of these concepts less obscure, and assist in their applicability in practice. As stated before, the business model of a firm encompasses the services, processes and organizational structures of the firm. An interesting topic to study is how modularity at each of these levels is reflected at other levels, and what the relevance of reaching a match between the levels is. Another issue worth studying is whether modularity built into business models can increase flexibility and help to create competitive advantage for firms.

1.4 Outline of the study

This dissertation consists of two parts: Part I presents an overview of the dissertation, and Part II consists of six original research papers. The original research papers in Part II in this dissertation are:

1) Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2010), ”The Concept of Modularity: Diffusion from Manufacturing to Service Production”, *Journal of Manufacturing Technology Management*, Vol. 21, No. 3, pp. 355-375.
2) Rajahonka M. (2013), “Views of logistics service providers on modularity in logistics services”, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, Vol. 16, No. 1, pp. 34-50.
3) Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2011), ”Framework for modularity and customization: service perspective”, *Journal of Business & Industrial Marketing*, Volume 26 Issue 5, pp. 306-319.
4) Bask A., Tinnilä M. and Rajahonka M. (2010), ”Matching Service Strategies, Business Models and Modular Business Processes“, *Business Process Management Journal*, Vol. 16, Issue 1, pp. 153-180.
5) Rajahonka, M., Bask, A. and Lipponen, M. (201x), “Modularity and customisation in LSPs’ service strategies”, Accepted in: *International Journal of Services and Operations Management*, Vol. X, No. Y, pp. xxx (forthcoming).

6) Rajahonka, M. and Bask, A. (201x), "Development of outbound logistics services in the automotive industry – case SE Mäkinen", paper has been sent for review.

Paper 1 builds the basis for this dissertation as it presents a literature review of the key modularity-related themes. Paper 2 explores how the concept of modularity is understood and used in practice among Finnish LSPs. In Paper 3 a theoretical framework is constructed based on the literature on modularity and customization. Paper 4 describes how frameworks presented in the literature at the strategic, business model and business process levels can be used in analyses of modularity. Paper 5 analyzes whether the service strategies that LSPs use are reflected in their approaches towards modularity and customization in service offerings, processes and networks. The aim of paper 6 is to study how modularity has been reflected in the service model of a case company through its history.

The focus of the papers in relation to the research questions is presented in Table 1.

Table 1. Focus and research questions of the papers.

	Paper	Focus	Research questions
1	The Concept of Modularity: Diffusion from Manufacturing to Service Production	UNDERSTANDING: Concepts and definitions Service products, production processes and organization and networks	How is the concept of modularity defined in the literature in general? How should it be defined in the context of services?
2	Views of Logistics Service Providers on Modularity in Logistics Services	UNDERSTANDING: Concepts and definitions Service products, production processes and organization and networks	How is the concept of modularity understood in practice, particularly by logistics service providers? Is the modularity approach used currently by LSPs and what are its current applications? How does modularity show in the current services, processes and company networks of logistics service providers? What are the probable future developments concerning modularity in logistics and services in general?
3	Framework for modularity and customization: service perspective	THEORY BUILDING: Concepts and definitions Service products, production processes and organization and networks	What is the theoretical relation between the concepts of modularity and customization?
4	Matching Service Strategies, Business Models and Modular Business Processes	THEORY BUILDING: Strategies, business models Service production processes	What is the interconnection between services, service production, service organizations, and their business models in relation to modularity? What is the relevance of the match between service strategies, business models, and modular service and process designs?
5	Modularity and customization in LSPs' service strategies	APPLICATIONS: Strategies, business models Service products, production processes and organization and networks	How can LSP strategies be classified based on the literature and empirical data? How do different LSPs, having different service strategies, use modularity and customization in implementing their strategies, and are there differences in usage related to their service offerings, service production processes and service production networks?
6	Development of outbound logistics services in the automotive industry – case SE Mäkinen	APPLICATIONS: Strategies, business models	How do the case company's services for the automotive industry reflect modularity and customization? How and why has the service model of the case company been developed over time, and how has the case company used modularity in its service model development?

The remainder of this overview in Part I is structured as follows. Chapter 1, section 1.5 discusses the research methodology. Chapter 2 reviews the relevant theoretical literature, with the framework combining the essential elements of service modularity research, and the positioning of the papers in it, being presented in section 2.8. Chapter 3 presents a summary of the findings. Finally, chapter 4 contains the conclusions, and discussion on the contribution and limitations of the research, and future research avenues.

In the following literature review and analysis of service modularity, the research on modularity has been classified into product, process and organizational modularity. This classification is based on the earlier research on modularity (Pekkarinen and Ulkuniemi, 2008; Campagnolo and Camuffo, 2010; Bask et al., 2010a). Product modularity is the most concrete type of modularity, but modularity principles have also been connected to the earlier research on manufacturing processes, organizations and partner networks. In paper 1 of Part II these concepts are discussed based on the literature, and in paper 2 empirically, based on interviews of Finnish LSPs.

Modularity has been seen as a means of mass-customization, and the concepts of modularity and customization are conceptually inter-connected. This interlinking is discussed in paper 3. Business models and their relationship to strategies and processes are discussed in paper 4. Paper 5 studies LSPs that reflect different logistics strategies, and whether these LSPs use modularity and customization differently in their services, processes and network structures. Paper 6 presents a case study of a service provider offering a wide variety of modular logistics services.

1.5 Research methodology and methods

This section first discusses paradigms and research approaches. Next, as one of the aims of this dissertation is theory building, there is a brief discussion on theory building in logistics, followed by a more general discussion on research methods. Finally, a summary of the discussion and its implications for this research is presented.

1.5.1 Paradigms and research approaches

A paradigm is a researcher's world-view or mental model (Frankel et al., 2005). It contains three elements: ontology, epistemology, and methodology. Ontology deals with the nature of reality, and whether there is an objective reality or not; epistemology discusses the relationship between the researcher and the reality; methodology outlines how knowledge about the world can be generated (Healy and Perry, 2000; Näslund, 2002; Frankel et al., 2005). Ontological and epistemological

assumptions influence methodological decisions, as the methodological choices depend on the ontological and epistemological beliefs of the researcher, and in the end the paradigm also guides the researcher in defining research topics, research questions and methods (Frankel et al., 2005; Vafidis, 2007).

There are different classifications for research paradigms. At one end of the continuum lies the classical tradition of western science, namely the positivistic tradition. According to positivism there is one universal absolute truth, the world is external and objective, so that research can be conducted objectively. Consequently, the researcher should focus on facts and look for causality. (Mentzer and Kahn, 1995; Kovács and Spens, 2007; Golicic and Davis, 2012). Positivistic research seeks law-like theories that can be tested by analyzing empirical data. (Kovács and Spens, 2007). Counter-balancing positivism are, for example, hermeneutics (Arlbjørn and Halldórsson, 2002) or interpretivism (Mentzer and Kahn, 1995). Their aim is not to look for truth, but to present a variety of subjective impressions, where the researcher and the phenomenon become mutually interactive. There is even less consensus about what lies between the two extreme paradigms. One of the suggested intermediate paradigms is critical realism. (Kovács and Spens, 2007). Critical realism accepts the existence of reality, but emphasizes that knowledge of reality is relative and always theory-dependent (Aastrup and Halldórsson, 2008). Healy and Perry (2000) also point out that realism emphasizes the building of a theory rather than the statistical testing of the generalizability of a theory. Another intermediate paradigm is pragmatism, which claims that the central aspect of scientific discoveries is not the truth, but theories that work well in practice (Vafidis, 2007). This appraisal of the pragmatic value of a theory can also be seen in the case of critical (or scientific) realism (Kovács and Spens, 2007). Without limitations, pragmatists may also use any philosophical and methodological approach that works for a particular research problem (Golicic and Davis, 2012).

The two prime approaches in scientific knowledge creation are the inductive and deductive research approaches. The deductive approach starts from a theory or generalization and tries to test whether the theory applies to specific cases. The inductive approach starts from observations on specific cases from which generalizations can be made, and aims at theory building. A third intermediate approach has also been introduced, namely the abductive approach. The abductive research process may start with “puzzlement”, i.e. an observation that cannot be explained using established theory, or with the deliberate intention of applying an alternative theory – for example by borrowing theories from other

disciplines – to explain a phenomenon. Typical of abductive research is a creative iterative negotiation process between theory and empirical study, and application of the initial theoretical findings in a different empirical study before making final conclusions. (Kovács and Spens, 2005; Spens and Kovács, 2006) Using an abductive approach, existing phenomena can be examined from a new perspective, and this may lead to new insights (Kovács and Spens, 2005).

Within any scientific discipline, competing paradigms usually exist alongside each other (Arlbjørn et al., 2008). It has been claimed that positivism is the predominant research paradigm in logistics (Mentzer and Kahn, 1995; Kovács and Spens, 2007), and that logistics research usually follows the hypothetico-deductive research approach (Mentzer and Kahn, 1995; Arlbjørn and Halldórsson, 2002; and Näslund, 2002; Kovács and Spens, 2007). It has also been observed that logistics researchers only rarely discuss research paradigm, approach or methodology issues – at least if they do not deviate from positivism and the deductive approach (Kovács and Spens, 2005). Lately, requests for more explicit statements of the research approach have been expressed (Gammelgaard, 2004; Spens and Kovács, 2006). However, logistics is also gravitating towards more diversified research approaches (Kovács, 2006; Aastrup and Halldórsson, 2008), in that the dominance of the deductive approach is decreasing, while the amount of abductive, inductive, and combined inductive and deductive research is increasing. Diversified approaches are necessary in order to enhance the evolution of a discipline (Spens and Kovács, 2006). Based on Nesher (2002), Kovács and Spens (2007) argue that relying on only one research approach may impoverish the discipline, because different research approaches have different tasks in relation to theory: while the abductive approach is the most effective approach in postulating new concepts and theories – even generating scientific revolutions – the inductive approach can be used for evaluating and further developing these concepts and theories, and the deductive approach for testing and establishing them.

1.5.2 Theory building in logistics

An important objective of scientific research is to build new theories or modify existing ones (Arlbjørn and Halldórsson, 2002). Theory building is vital for any discipline. Logistics is a relatively new and practice-oriented research discipline (Stock, 1997; Kovács and Spens, 2005; Sachan and Datta, 2005; Aastrup and Halldórsson, 2008), and there is no unified theory or in-depth tradition of theory development (Stock, 1997; Kovács and Spens, 2007). The lack of unified theory also applies to supply chain

management (SCM) research (Halldórsson et al., 2007). Theories are needed for a discipline to mature (Defee et al., 2010), and theory building is relatively more important for an emerging young discipline (Kovács and Spens, 2007).

A significant shortcoming in the discussion on theory building is that there actually seems to be no consensus about what really constitutes a theory (Vafidis, 2002). Hunt (1991) defines a theory as a systematized structure capable of explaining and predicting phenomena. According to DiMaggio (1995), there is more than one kind of good theory: theories can be law-like generalizations describing the world as we see it, or enlightening paradoxical surprise machines, or narratives, i.e. accounts of social processes emphasizing empirical tests. However, DiMaggio (1995) claims that many of the best theories are hybrids that combine the best qualities of the law-like, enlightenment, and process approaches. A good theory also balances between clarity vs. defamiliarization, focus vs. multidimensionality, and comprehensiveness vs. memorability. Kovács and Spens (2007) point out that knowledge can be described as a multilevel abstraction of reality; the base consists of data which, after organizing, becomes information. Analyzed and processed information, for its part, can lead to generalizations and insights, which can lead to formulation of concepts used as tools for thinking, analysis and discussion. Finally, concepts create the basic elements for building theory. Sometimes models, frameworks and concepts are labeled theories (Kovács and Spens, 2007). Meredith (1993) argues that one way of forming theories is compiling previous frameworks into meta-frameworks, and, as a framework is a pre-theory, it may in many ways substitute for a theory.

Building valid theories requires empirical testing and, typically, reiteration of the research cycle (Meredith, 1993). Empirical research, especially case studies, can be used inductively or abductively in theory building (Eisenhardt, 1989; Ellram, 1996; Kovács and Spens, 2005; Eisenhardt and Graebner. 2007). It is particularly well-suited to new research areas (Eisenhardt, 1989). Eisenhardt (1989) has described the process of building theories from case study research as an iterative process tied with empirical evidence, requiring cross-case comparison, and maybe redefinition of the research questions, and including tension between the divergence of ideas and convergence towards theoretical frameworks (Eisenhardt, 1989). However, another essential feature of theory building is the comparison of the emergent concepts, theory, or hypotheses with the existing literature (Eisenhardt, 1989). Eisenhardt also mentions the risks concerning theory building from case studies. These include building overly complex or too narrow theories.

A useful technique for theory building is borrowing theories from another discipline. This way of accelerating knowledge creation by learning from others and avoiding “reinventing the wheel” has been discussed and encouraged by several researchers in the area of logistics and supply chain management research (Stock, 1997; Arlbjørn and Halldórsson, 2002; Halldórsson et al., 2007; Kovács and Spens, 2007). Arlbjørn and Halldórsson (2002) propose four types of logistics knowledge creation, namely the storytelling and/or quantitative testing of known concepts, generating new concepts, refining the existing knowledge base, and expanding the knowledge base. As an example of the last-mentioned, Arlbjørn and Halldórsson (2002) mention borrowing from other theories as suggested by Stock (1997). However, Arlbjørn and Halldórsson (2002) also remark that borrowing theories from other disciplines may involve risks, because these theories may be founded on different research paradigms. By merely copying words without proper reflection, the discipline may drift away from its "hard core".

Defee et al. (2010) made an inventory of the theories used in logistics and SCM research, and found that theory was explicitly mentioned in only about 53 per cent of the sampled articles. They discovered that over 180 specific theories had been used, the vast majority of which originated in other disciplines. In their inventory, Defee et al. (2010) classified the theories used in the literature into 13 categories, and found that the competitive theory category included over 20 per cent of the theoretical incidences. It is worth mentioning that Defee et al. found applications of “modularity theory”, and classified it under competitive theory.

1.5.3 Research methods

The choice of research methodology is also influenced by issues other than the researcher's philosophical stance, i.e. paradigm. These issues include the research goals and objectives, the type of research questions (what, who, how, why, etc.), and the nature of the research problem and phenomenon under study (Ellram, 1996; Näslund, 2002; Frankel et al., 2005; Kovács, 2006). Research methodologies range from quantitative to qualitative styles. Research methods are specific data collection techniques (Frankel et al., 2005), and tools for making and interpreting empirical observations systematically (Vafidis, 2002). At a general level, research methods can also be described as qualitative or quantitative (Frankel et al., 2005). Positivism has often been associated with a hypothetico-deductive research approach and quantitative research methods, while hermeneutics or interpretivism has been connected to an inductive research approach and qualitative methods (Kovács, 2006; Vafidis, 2007). However, an

inductive approach can also be used in positivism and a deductive approach in interpretivism, and, in general, a particular research approach does not indicate any particular research method (Spens and Kovács, 2006; Kovács and Spens, 2007). For its part, critical realism has been linked with an abductive research approach and pluralistic methods (Kovács and Spens, 2007; Aastrup and Halldórsson, 2008).

It has been argued that logistics has normally relied on quantitative methods, but that it is necessary to apply both quantitative and qualitative methods to advance logistics research (Näslund, 2002). The rationale behind this argument is that logistics problems are often ill-structured, complex, messy, real-world problems (Näslund, 2002). In fact, it has been observed that the percentage of qualitative research methods, such as case studies, has increased (Sachan and Datta, 2005), and that there has been a clear emphasis on qualitative research, especially case studies, in Nordic research (Vafidis 2002; Arlbjørn et al., 2008). It has even been suggested that *"case studies have a role to play in logistics, but case research struggles against (a myth of) a prevailing positivism"* (Aastrup and Halldórsson, 2008).

Qualitative researchers study things in their natural settings, using a wide range of interconnected methods such as case studies, interviews, observations and texts. (Näslund, 2002). Qualitative research methods are suitable in the early description and concept development phases of research, when there is a lack of understanding of real-world events, and a need to create meanings or explanations for phenomena, and generate or test theories (Eisenhardt, 1989; McCutcheon and Meredith, 1993; Voss et al., 2002; Sachan and Datta, 2005; Frankel et al., 2005; Eisenhardt and Graebner, 2007; Golicic and Davis, 2012).

The research methods used in this thesis include a systematic literature review combined with illustrative examples, and multiple and single case studies of Finnish LSPs. According to Tranfield et al. (2003), systematic literature reviews differ from traditional reviews by adopting a scientific, replicable and transparent process. The use of the case study approach has been discussed lately related to logistics and operations management research (Voss et al., 2002; Aastrup and Halldórsson, 2008). Case studies have been seen as a means of creating the new insights needed for developing new theories, as well as having high validity with practitioners (Voss et al., 2002). Although case studies have sometimes been automatically classified as qualitative research, they may in fact use both quantitative and qualitative data collection methods and analyses (Eisenhardt, 1989; Ellram, 1996; Näslund, 2002; Spens and Kovács, 2006). It has also been pointed out that a case study is not actually a research

method, but a research strategy (Eisenhardt, 1989; Näslund, 2002). Case studies combine data collection methods from primary and secondary sources such as interviews, questionnaires, archives and observations (Eisenhardt, 1989; McCutcheon and Meredith, 1993; Voss et al., 2002). They can be used for a variety of research purposes such as exploration, description, theory building, testing and extension or refinement (Eisenhardt, 1989; Voss et al., 2002). Healy and Perry (2000) point out that a case study can be either intrinsic, where the case itself is the focus, or instrumental, where the case is used for the purpose of understanding a phenomenon. This also illustrates how case studies are used differently in constructivism and realism (Healy and Perry, 2000).

According to Ellram (1996), one of the essential questions in case study analysis is to determine whether to use single or multiple cases, and how many cases are necessary to ensure the adequate generalizability of results. She notes that a single case study tends to be specific, but multiple case study results may be more generalizable. She also argues that single cases and multiple cases serve different purposes; multiple cases can be used in the development of theoretical frameworks, whereas single cases are appropriate if the case exposes a previously unstudied phenomenon, is an extreme or unique case, or is critical in testing a well-formulated theory. Voss et al. (2002) remark that the fewer the case studies, the greater the chance for in-depth observations. According to them, single in-depth case studies are often used in longitudinal research. If multiple cases are used, the next important questions concern how many cases to use, case selection and sampling. Ellram (1996) argues that, in most situations, six to ten cases should provide enough evidence to support or reject initial propositions. Eisenhardt (1989) proposes four to ten cases. Cases can be randomly selected, but this is not necessary (Eisenhardt, 1989).Theoretical sampling is used when typical, exceptional, or contrasting cases are sought (Voss et al., 2002). Thus, cases may be selected to strengthen previous cases, to fit theoretical groupings, or to extend emergent theory (Eisenhardt, 1989).

Aastrup and Halldórsson (2008) have raised the question of the epistemological role of case studies in logistics in relation to the critical realist view. They comment that it is rather unclear whether the case study approach can fulfill generalizability (or external validity) criteria, and that the term generalization must be questioned, because of its positivistic origin. Much logistics research is based on a best practice approach, and thus easily tends to exaggerate the generalizability of the findings; if more account were taken of transferability and contextualism than of generalizability, the applicability of the findings in other contexts could be more easily evaluated by the reader (Halldórsson and Aastrup, 2003).

Healy and Perry (2000) also argue that realism research tends to develop a family of answers that cover different contexts, rather than searching for causal impacts or generative mechanisms. Dubois and Gadde (2002) point out that learning from a particular case in its context should be considered a strength of case studies rather than a weakness, because the relationship between the phenomenon and its context can be best understood through in-depth case studies. Furthermore, critical realism has an implicit logic that extensive and intensive research complement each other; thus, case studies cannot be justified purely by their complementary role, but by their primary role in logistics knowledge creation (Aastrup and Halldórsson, 2008).

1.5.4 Summary of the methodological discussion and implications for this research

This thesis aims at theory building, introduces frameworks and illustrates them with examples and qualitative case studies. For the theory building purpose the thesis also borrows approaches, theories and frameworks from other disciplines. With the help of case studies and illustrations the aim is to modify and further develop these theories in the service context, particularly in the logistics services context. The implications of the modularity approach for service industries, and particularly for logistics, are discussed in all the papers of this dissertation. Because of the limited amount of previous research on service modularity, qualitative methods are well justified (Eisenhardt, 1989; McCutcheon and Meredith, 1993; Voss et al., 2002; Sachan and Datta, 2005; Frankel et al., 2005; Eisenhardt and Graebner, 2007; Golicic and Davis, 2012), and used.

Paper 1 (“The Concept of Modularity: Diffusion from Manufacturing to Service Production”) presents a literature review of the key modularity-related themes. The literature review in paper 1 is conducted using the integrative literature review method, in which past research is summarized by drawing overall conclusions from separate studies (Cooper, 1989). In an integrative review, reviewers present the state of knowledge regarding a particular topic and try to find issues that the research has not dealt with. The stages of a systematic review are: 1) planning the review (the need for a review, proposal for a review, and the review protocol), 2) conducting the review (selection of studies, evaluation of data, synthesis), and 3) reporting and dissemination (Cooper, 1989; Tranfield et al., 2003). For paper 1, three searches were conducted in two journal databases, the search term “Modularity” being used in Emerald and ProQuest, and the search string ”Modularization OR Modularisation” being used in Emerald. These searches resulted in about 1000 articles, among which the most relevant

were selected for further inspection. The first screening was done by the research group members by reviewing the article abstracts, and after that by voting about the relevancy of each article. The final decisions about relevancy were made after going through these articles. After this procedure 33 articles were selected and studied in more depth. In addition, a few "classics" of the field and a few recent, highly relevant articles were reviewed. These were articles that, for some reason, were not included in our searches and/or selections, and they were included to assure the quality of the research.

Paper 2 ("Views of Logistics Service Providers on Modularity in Logistics Services") is empirical and the paper focuses on how the concept of modularity is understood and used in practice among Finnish LSPs. The interviews for paper 2 were conducted in 2009, and 25 Finnish LSPs were interviewed. The sample of companies selected for the interviews contained companies that were different in terms of size, geographical range, services, and operations, for example. The interview questions included both open-ended questions and structured statements (on a scale of 1=totally disagree to 7=totally agree). Structured statements were used to achieve better generalizability of the findings in cross-case analyses. Modularity themes found in the literature were used in preparing the questions. These themes included definitions of modularity, the applicability of modularity, the benefits and disadvantages of modularity in logistics, and the future development of modularity in logistics.

In Paper 3 ("Framework for modularity and customization: service perspective") a theoretical framework is constructed based on the literature on modularity and customization. The framework makes it possible to analyze different levels of modularity and customization related to e.g. the service product, processes and organization, and reveals four key combinations of modularity and customization. The framework is also used to present examples from the automotive industry, chosen to illustrate the logic of the framework, i.e. how different business models can be distinguished within the framework.

Paper 4 ("Matching Service Strategies, Business Models and Modular Business Processes") describes modules at three levels: the strategic, business model and business process levels. To increase the understanding of how these frameworks can be used in analyzing services, a qualitative research strategy is used. Thus, examples of selected logistics services and a company case study are presented. The single case study of Itella Corporation combines data collection methods from several sources such as the Internet, interviews, questionnaires, and internal company material.

Paper 5 ("Modularity and customization in LSPs' service strategies") classifies service strategies that LSPs apply, and analyzes whether the service strategies that the LSPs use are reflected in their approaches to modularity and customization from three perspectives: service offerings, service production processes and service production networks. An analysis of the structured statements played an important role in this paper. Five case examples chosen from the year 2009 interviews are used to describe the types of LSP strategy, and to show how modularity and customization are used in implementing these strategies. The cases are presented using the framework developed in paper 3. The findings show that different service strategies are also reflected in differences related to modularity and customization in the service offerings, processes and networks.

Paper 6 ("Development of outbound logistics services in the automotive industry – case SE Mäkinen") uses a single case study approach. The case company, SE Mäkinen, is an LSP offering services for the automotive supply chain. The in-depth information regarding the case company has been collected from company interviews, public sources (e.g. the Internet) and internal company material. In this paper the case study is used to increase the understanding of the service model and service development throughout the history of the case company.

The thesis is based on the paradigm of critical realism, with mainly an abductive research approach. Kovács and Spens (2005) describe the abductive process as an iterative process moving back and forth between theoretical and empirical research and consisting of five phases: 0) prior theoretical knowledge, 1) deviating real-life observations, 2) theory matching (iterative process between theory matching and real-life observations), 3) theory suggestion, and 4) application of conclusions. As a whole, the research process of the thesis follows an abductive research approach (see Table 2). The use of this approach is also supported by a suggestion of Kovács and Spens (2007) to the effect that borrowing theories from other disciplines may initiate an abductive research process. Additionally, the abductive approach is used explicitly in paper 5, where the systematic combining approach, originally presented by Dubois and Gadde (2002), is used in an iterative negotiation process between the LSP theories and the characteristics of the case companies observed in the empirical investigation. Dubois and Gadde present systematic combining as a process where matching between theory and reality, and direction and redirection of the study are continuous. An abductive approach can also be found in the research reported in paper 3 because, after discovery of an inadequate theory, there followed an iterative process of framework building and matching examples with the framework.

A summary of the research phases and methods used in the research papers is presented in Table 2.

Table 2. Summary of the research phases and methods used in the research papers.

	Paper	Phase of the abductive process	Methods
1	The Concept of Modularity: Diffusion from Manufacturing to Service Production	THEORETICAL: Prior theoretical knowledge Matching modularity theory in the service context	Integrative literature review Illustrations of modularity in logistics services
2	Views of Logistics Service Providers on Modularity in Logistics Services	(THEORETICAL AND) EMPIRICAL Real-life observations (Matching modularity theory in the service context)	Multiple cases (25) among Finnish LSPs Interviews and questionnaire
3	Framework for modularity and customization: service perspective	THEORETICAL AND EMPIRICAL: (Deviating real-life observations) Theory suggestion Application of conclusions	Literature review Framework building Illustrative examples of framework usage
4	Matching Service Strategies, Business Models and Modular Business Processes	THEORETICAL AND EMPIRICAL: Theory suggestion Application of conclusions in logistics services	Literature review Framework building Illustrative examples of framework usage Single case study
5	Modularity and customization in LSPs' service strategies	(THEORETICAL AND) EMPIRICAL: (Real-life observations Matching LSP theory) Application of conclusions about modularity and customization framework in logistics services	Literature review Multiple cases (23) among Finnish LSPs Interviews and questionnaire Applying the framework developed in paper 3
6	Development of outbound logistics services in the automotive industry – case SE Mäkinen	EMPIRICAL: Application of conclusions about modularity theory in logistics services	Single case study (interviews, internet, internal company material etc.)

This thesis uses a combination of methods: A systematic literature review method is combined with usage of illustrative examples and single and multiple case studies based on interviews, questionnaires, and other material. These methods are used because they complement each other. Literature reviews build theoretical understanding, illustrative examples act as "rehearsal opponents", single cases bring in-depth understanding about causal or other kinds of relationships in definite contexts, and multiple cases bring generalizable perspectives. A slightly pragmatist view of research methods has been adopted, i.e. using a combination of approaches that works best for the research problem under study (Golicic and Davis, 2012). In particular, the more than 20 cases of the multiple case design is justifiable because the aim has been to achieve versatile perspectives by simultaneously collecting in-depth qualitative data through interviews and observations, and quantifiable data through structured questionnaires.

The iterative structure of the theory building process in this research is illustrated in Figure 1.

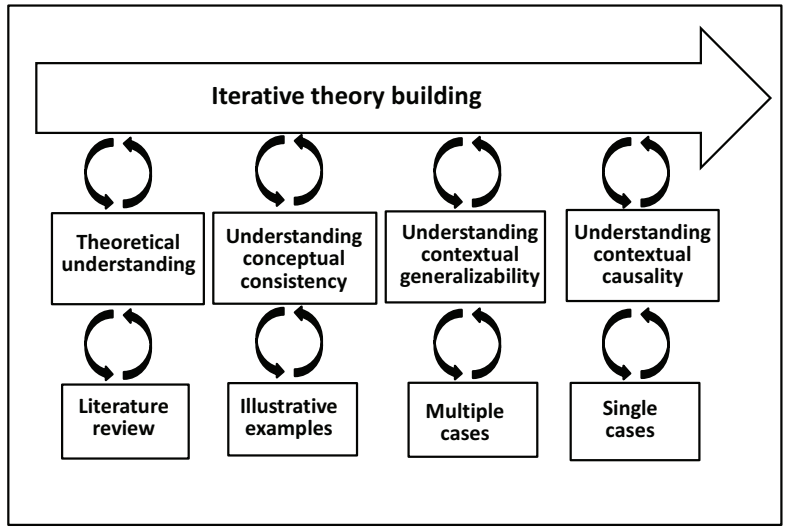

Figure 1. The iterative structure of the theory building process in this research.

Theory building in this research relies on the analysis of case studies, borrowing theories and approaches from other disciplines (interdisciplinary), and meta-framework building. The borrowed approaches include modularity and business model approaches and service strategy literature. Following the paradigm of critical realism, any theories or frameworks presented in this thesis should be evaluated mainly in terms of their practicality (Kovács and Spens, 2007).

Chapter 4 contains a discussion of the research limitations, validity and reliability.

2. Literature review

Modularity has been a popular concept in the research literature related to physical products and their production for decades. It has also been argued that modularization brings many benefits. Despite this, the modularity concept related to physical products is still vague and lacks a universal definition (Salvador, 2007; Campagnolo and Camuffo 2010). Starr (2010) even claims that modularity is "a splintered concept", and, citing the "Blind men and the elephant" story, remarks that modularity means many different things in different contexts and terms. The remark is all too true related to modularity in the service context, which has been studied far less than modularity in the product context. In the literature, there is quite widespread agreement that modularity is a systems concept describing the relationships between components in the system. Another issue that is widely accepted is that modularity is a matter of degree; i.e., that the modularity of a system may range from non-existent (when the system is highly integral) to highly modular (Schilling, 2000; Brusoni and Prencipe, 2001; Mikkola and Skjøtt-Larsen, 2004; Salvador et al., 2004; Ernst, 2005; Voss and Hsuan, 2009). In other respects, the concept has been defined and conceptualized in various ways.

2.1 Defining modularity and related concepts

Just to mention some of the several definitions, Hölttä-Otto (2005) defines a module in the context of modular product platforms as "an independent building block of a larger system with a specific function and well-defined interfaces". Baldwin and Clark (2000) define a module as "a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units". The latter definition has been referenced frequently in the literature since then (Schilling and Steensma, 2001; Ernst, 2005; Arnheiter and Harren, 2005 and 2006; Fredriksson, 2006; Lau et al., 2007). Baldwin and Clark (1997 and 2000) also claim that modularization requires making a distinction

between visible design rules and hidden design parameters; the hidden parameters are encapsulated in the modules, but the visible rules are shared between companies.

Table 3 presents a list of contexts, characteristics and definitions related to modularity mentioned in the earlier literature.

The difficulties of defining the concept of modularity result at least partly from the fact that several research fields have defined and applied the concept for their own purposes. Thus, the concept has been used in many contexts (Campagnolo and Camuffo, 2010; Starr, 2010), at different levels of abstraction, and in different disciplinary areas (Salvador, 2007). Based on his thorough analysis, Salvador (2007) even questions the existence of a single concept of modularity, and concludes that the concept may encompass a number of different, but interrelated, concepts.

Campagnolo and Camuffo (2010) summarized 125 research contributions on modularity in the current literature, and found three main streams of literature. They clustered these around three units of analysis, that is (1) product design modularity, (2) production system modularity, and (3) organizational design modularity. In the literature on product-related modularity, the concept of modularity has been discussed at three levels: the product, production process, and organizational levels. (Pekkarinen and Ulkuniemi, 2008; Bask et al., 2010a).

Another observation made in the literature is that the definition of a module has often been linked to, and confused with, the benefits sought from modularity (Hölttä-Otto, 2005). The benefits of modularity identified in the literature include managing complexity, enabling parallel processes, and reducing uncertainty (Fine, 2000; Baldwin and Clark, 2000), enhancing customization, product postponement, and outsourcing (Voss and Hsuan, 2009), and a wider variety of products, flexibility, and cost savings (van Liere et al., 2004; Jose and Tollenaere, 2005; Pekkarinen and Ulkuniemi, 2008). Some of the benefits mentioned in the literature are presented in the Appendix.

Table 3. Features and definitions presented in the earlier literature on modularity.

Author (s)	Con-text	Characteristics mentioned	Definition connected to modularity
Starr (1965)	Manufact uring	Maximum productive variety	"Modular" or "combinatorial" productive capacities are capacities to design and manufacture parts which can be combined in numerous ways
Ulrich (1995)	Manufact uring	Architecture Interfaces Function mapping	In a modular architecture, interfaces between components are de-coupled and there is a one-to-one mapping between physical components and functional elements
Baldwin and Clark (2000)	Product	Architecture Interfaces Standards	The visible design rules consist of three dimensions: architecture specifies what modules will be part of the system and what their functions will be; interfaces describe in detail how the modules will interact, including how they fit together and communicate; and standards test a module's conformity to design rules and measure its performance relative to other modules. Modularization involves the partitioning of information into visible design rules and hidden design parameters. The visible information is widely shared and communicated whereas the hidden parameters are encapsulated within the modules and need not be communicated beyond the boundaries of the module.
Hölttä-Otto (2005)	Product	System Function Interfaces	A module is an independent building block of a larger system with a specific function and well-defined interfaces
Mikkola (2006)	Product	Standard components Standardized interfaces Degree of coupling among components Substitutability	Four key elements should be considered when assessing the degree of modularity in physical product systems: 1) types of components (ranging from standard to unique), 2) interfaces (whether they are well specified and standardized or not), 3) degree of coupling (i.e. the tightness of coupling among components), and 4) substitutability (i.e. the extent the unique components can be substituted across product families).
Voordijk et al. (2006)	Product	Independence of components: interchangeability, autonomy, loose coupling, individual upgradeability Standardized interfaces Function mapping	In a modular product architecture, components are interchangeable, autonomous, loosely coupled, individually upgradeable and interfaces are standardized. There is clear mapping between functions and components. For a modular product, two factors are thus of major importance: independence of components and interfaces.
Voordijk et al. (2006)	Process	Loose coupling in time and place	Low coupling between the process components in time (production spread over multiple time intervals) Low coupling between the process components in place (production takes place at dispersed locations)
Voordijk et al. (2006)	Supply chain	Non-proximity Substitutability	High degree of non-proximity of elements (geographical, organizational, cultural, electronic); modular supply chains permit "substitution" of different versions of functional components for the purpose of creating supply chain variations with different functionalities or performance levels.
Jacobs et al. (2007)	Product	Disaggregation Re-combinability	Modularity is a systems concept defining the degree to which components may be disaggregated and recombined into new configurations
Lau et al. (2007)	Product	Separateness / dis-assembleablity and re-combinability Specificity (in function) Transferability / Re-usablity	Product modularity is a continuum, describing separateness, specificity and transferability of product components in a product system: *1) "Separateness"* = degree to which a product can be disassembled and recombined into new product configurations without loss of functionality. 2)*"Specificity"*= degree to which a product component has a clear, unique and definite product function with its interfaces in the product system. 3) *"Transferability"* = degree to which product components in a product system can be handed over and reused by another system.
Salvador (2007)	Product	Component commonality Component combinability Function binding Interface standardization Loose coupling	Perspectives of modularity: *1) "Component commonality"*:a standard kit of components to be used in a number of applications; modular product design consists of using standard parts and subassemblies in a variety of products. *2) "Component combinability"* (probably the most commonly understood meaning of product modularity): different product configurations can be obtained by mixing and matching components taken from a given set. *3) "Function binding"*: product modules embed the capacity to perform specific functions. *4) "Interface standardization":* focuses on the interface, a set of design parameters describing how two objects mutually interact. *5) "Loose coupling"*: a modular system can be broken down into smaller units, or modules. Remarks: none of the past researchers dealing with product modularity has combined in a single framework all of these perspectives.
Voss and Hsuan (2009)	Service	Standardized interfaces	There are five important dimensions associated with the study of modularity: interfaces, degree of coupling, components and systems, commonality sharing, and platform.
de Blok et al. (2010)	Service	Combinability Customization	With modular services are final services or service packages that can be combined for customers in many ways from one or several distinct components. In this way, customization takes place.
Starr (2010)	General	Substitutability, interchangeability of parts	Generic modularity is easy substitution of one thing for another; services built into goods can be viewed in the same light as modular parts.

Section 2.2. below discusses the relationship between modularity and customization. This issue is also discussed in papers 3 and 5 – from the theoretical and framework building perspective in paper 3, and empirically applying the framework in five cases in paper 5. Sections 2.3-2.6 analyze product, process, organizational and service modularity in order to identify the central issues of modularity. These concepts are also discussed in papers 1 and 2 – paper 1 being theoretical and paper 2 empirical, based on interviews of Finnish LSPs. The following section 2.7 deals with the connections between strategy, business models and modularity at the product, process and organizational levels. These issues are under observation in papers 4, 5 and 6. Finally, section 2.8. presents a summary and concluding remarks on the literature review.

2.2 Modularity in relation to customization

One of the concepts or benefits sought through modularity, that has regularly been linked to modularity, is customization. Customization has become more important in recent years as customer needs have become more divergent. Modularity has been seen as a means of enhancing "mass customization" (Pine, 1993; Duray et al., 2000). Pine (1993) defines mass customization as *"a strategy enabling the low-cost production of high-variety, even individually customized goods and services"*. Mass customization is applied in order to achieve economies of both scope and scale while offering customized products (Pine, 1993; Mikkola and Skjøtt-Larsen, 2004), or, in other words, to *"employ flow-shop production efficiencies while delivering customized products to customers"* (Starr, 2010). The logic behind this interconnection is that modularity linked with commonality and standardization (of modules, but in particular the interfaces) often refers to the benefits achievable though the combinatorial element of modularity, in which modules can be mixed and matched to create new variants of a product for divergent customer needs. The difference between mass-customized and pure-customized products is that modularity restricts the range of possible customer choices and the degree of customization (Duray et al., 2000; Duray, 2002).

Many of the proposed features and definitions related to modularity implicitly, or even explicitly, seem to interconnect modularity with customization. For example Sundbo (1994) states that "modulization" means that "services are created out of standard elements - modules - that can be combined for the individual customer at the moment of purchase". According to Salvador (2007), probably the most commonly used meaning of product modularity is "component combinability", which

means that products are modular if different product configurations can be obtained by mixing-and-matching components taken from a given set. This same idea is referred as “combinatorial customization” by Voss and Hsuan (2009). The interconnection of the concepts of modularity and customization has also led to confusion. There have been only a few attempts to separately study the modularity and customization aspects. One of these is the article by Duray et al. (2000). Duray et al. (2000) present a framework that separates modularity and customization, thus distinguishing between different mass customizer types, and arguing that the customization level depends on the involvement of the customer in the production.

2.3 Product modularity

Product modularity is the most concrete type of modularity. Most of the definitions presented in Table 3 refer explicitly or implicitly to product modularity. The meaning of modules in products is easy to understand intuitively at a general level, since products are often composed of components and subassemblies. Nevertheless, a small consensus on a definition of product modularity has emerged (Jacobs et al., 2007; Salvador, 2007). A module can be seen as a group of components that can be removed from the product non-destructively as a unit (Jacobs et al., 2007).

An important issue related to product modularity is flexibility. Standardized and interchangeable components or units enable the configuration of a wide variety of end products. (Jacobs et al., 2007). Modular architecture is flexible because different product variations can be achieved by substituting different modular components into the product architecture without having to redesign other components. Such “loose coupling” allows 'mixing and matching' of modular components within modular product architecture and provides the potential for a large number of product variations. The upgrading of products throughout their life cycle is also possible. (Sanchez and Mahoney, 1996; Brusoni and Prencipe, 2001). The critical element in unit standardization is the interface (Sanchez and Mahoney, 1996).

Based on a literature review of over 100 articles, Salvador (2007) lists the commonly used definitional perspectives of product modularity as “component commonality”, “component combinability”, “function binding”, “interface standardization”, and “loose coupling. Salvador concludes that none of the articles in the literature review provided a framework capable of merging the different definitional perspectives.

In summary, the key issues mentioned in relation to product modularity are the loose coupling of standardized and interchangeable components having the same functional purpose in different systems. These issues can be seen as defining most of the features connected to product modularity.

2.4 Process modularity

Process modularity enables a process to be broken down into standard sub-processes and customization sub-processes, and enables the customization sub-processes to be postponed in order to achieve flexibility (Tu et al., 2004). Postponed manufacturing makes it possible to shift the final modular assembly to distribution centers or customer sites. This in turn makes it easier to respond quickly to changing customer requirements. In modular assembly lines, workstations and units can be flexibly added, removed, or rearranged to create different process capabilities (Tu et al., 2004).

The relationship between product and process modularity has frequently been discussed in the literature. Modularity in production and processes has sometimes been seen as an almost inevitable result of increased product modularity (Brusoni and Prencipe, 2001). The computer industry has been the leader in successfully applying modular production principles (Tu et al., 2004), and, according to Campagnolo and Camuffo (2010), it seems that this may have led to the belief that all industries are tending towards more modular structures. They remark that this kind of generalization may be too simple.

The key issues defining production modularity include sub-processes or production steps that are loosely coupled, standard interfaces between sub-processes, and the opportunity to mix and match the elements in the production system. However, as manufacturing processes involve humans and independent companies, standardizing the interfaces between process modules may require more coordination mechanisms and platforms than is the case with products. Examples of these are information systems and contracts.

2.5 Modularity of organization and supply chain

Schilling and Steensma (2001) argue that outsourcing functions and using organizational components that lie outside the firm lead to a situation where the entire production system becomes increasingly modular. They also claim that organizational systems are becoming increasingly modular. According to Schilling and Steensma (2001), contract manufacturing, alternative work arrangements, and alliances are the three primary

methods of loose coupling that are used by firms. Dimensions of geographical, organizational, cultural, and electronic proximity have also been used to describe supply chain modularity (Fine, 1998; Voordijk et al., 2006). Thus, a modular supply chain consists of *"geographically dispersed actors that have autonomous managerial and ownership structures, diverse cultures and low electronic connectivity"* (Voordijk et al., 2006).

The relationship between product and organizational modularity has been discussed a lot in the literature. "Loosely coupled", modular product architecture has been described as an enabler of the division of labor and outsourcing of tasks across firms, the modularity of supply chains, and modular structures even at the industry level (Sanchez and Mahoney, 1996). Sanchez and Mahoney (1996) argue for strong dependency between product and organizational modularity, as they state that *"products design organizations"*. They also claim that modularity leads to a high degree of independence or "loose coupling" between components, and this kind of product architecture requires little coordination between the manufacturers of different components. In other words, modularity could lead to "embedded coordination" that reduces the extent to which management coordination or intervention is required (Galvin and Morkel, 2001). Conversely, some authors have been skeptical of whether modular products actually lead to modular organizations (Hoetker, 2006). Salvador et al. (2004) maintain that, if anything, production of modular products leads to tight linkages and high integration between a final assembler and its suppliers. Likewise, Brusoni and Prencipe (2001) maintain that, in fact, the increased division of labor resulting from modularity requires close cross-company interaction and conscious efforts at coordination. Standards, protocols, agreements, and rules are part of the coordination activities in supply chains (van Liere et al., 2004).

There are indications that modular production, instead of automatically leading to modular organizational structures, often requires an integrated supply network. However, it may be argued that the discussion on dependencies between product-level and organizational-level modularity is connected to the definitions of the concept of organizational modularity. It has been rather common to describe modular organizational structures as "arm's-length", or "market-based" as opposed to integral structures (Brusoni and Prencipe, 2001; Ernst, 2005; Jacobides, 2005). Thus, "loosely coupled" modular product architecture may allow the division of labor and the outsourcing of tasks across firms. However, it can also be asserted that modular products are not always produced by modular organizations. Increasing modularity at the product level may require working in integral organizational networks – thus decreasing modularity at the organizational

level. In his seminal article, Starr (1965) maintained that fundamental changes in the enterprise will be needed for managing a new kind of productivity, and that an appropriate organizational structure in the modular world would provide greater responsiveness to the market. Starr (1965) concludes that to achieve such results, a much higher level of functional integration is called for.

For example it could be stated that supplier parks used by some automotive manufacturers indicate rather integral – and not modular – organization network structures, because there are tight rather than "loose" relationships between network partners. Jacobs et al. (2007) conducted a study focusing on first tier suppliers to the "Big Three" automobile original equipment manufacturers in North America. They found that a product modularity strategy directly and positively affected quality and cycle time, but the only way a company could fully realize the benefits of a product modularity strategy for flexibility performance was by combining it with an integration strategy related to design, manufacturing, and supplier relationships. Thus, it may be concluded that modularity at the product level can – at least in some cases – only be fully exploited if there is a certain level of integration at the organizational level. It is also important to note that organizational issues evolve over time, meaning that the development of new and complex modular products and the launching of production may require more integral organizational forms and tighter cooperation than continuous production of simple modular products in established exploitative networks (Chesbrough and Prencipe, 2008).

2.6 Modularity in services

Service modularity is a rather new theme in the literature. Mostly, the research literature on modularity has concentrated on discussing products and product design. In the product design literature the discussion has expanded to process and organizational issues related to the manufacturing and delivery of physical products, and finally to supply chains and service networks. On the other hand, service modularity research has its roots in the software industry where, in recent years, the discussion has dealt with service-oriented architecture (SOA) (Janssen and Joha, 2008; Frandsen, 2012). These perspectives have gradually converged and become overlapping.

Some relevant research on service modularity (excluding the papers presented in Part II of this thesis) is summarized in Table 4.

Table 4. Relevant research literature on service modularity.

Author(s)	Objectives	Method	Main conclusions / contribution
Sundbo (1994)	To investigate whether innovation theories from the manufacturing apply to the service sector, and if there is a tendency towards modulization in services	Multiple case studies Danish service firms from several industries	Tendency towards modulization in service production was found. Modulization means that the service products will be standardized; modules can be combined by the customer. Service and manufacturing organizations are becoming similar, understood in terms of the same model - modulization of products, systematization of production process and separation of production and marketing organization
Miozzo and Grimshaw (2005)	To explore the lessons for modularity that can be drawn from outsourcing of knowledge-intensive business services	Empirical study (IT outsourcing in the UK and Germany)	IT outsourcing is accompanied by transformations in clients' production technologies. This results in the need for knowledge and organizational coordination. Conflicts between clients and suppliers may present obstacles to innovation.
Voordijk et al. (2006)	To assess the applicability of Fine's modularity concept: alignment of product, process, and supply chain architectures	Multiple case study Construction industry	Fine's modularity concept works well for descriptive purposes, but it needs refinement when it is used for analytical purposes.
Hyötyläi-nen and Möller (2007)	To develop solutions for managing this complexity in the field of ICT services	Action research-based case study (ICT service provider)	A service architecture framework for creating a modularized offering and system for complex business services. Complex ICT services can be redesigned through integrating methods of industrialization, tangibilization and blueprinting. The service provider can reduce products and functions to fulfill the same differentiated customer needs.
Janssen and Joha (2008)	To identify critical management issues in developing service-oriented arrangements (shared service organizations (SSO) or service-oriented enterprises (SOE))	Single case study ICT service provider	Critical management issues: strategy, redesign of activities and roles, standardization of processes, IT architecture, and involving all stakeholders. A staged approach should be adopted when implementing SSO or SOE.
Pekkarinen and Ulkuniemi (2008)	To employ the idea of modularity into the business services context	Abductive logic: theoretical pre-understanding and elaborating it empirically	Model showing how the business service providers can use modularization in platform approach to develop and deliver new services; Platform model including four modularity dimensions: service, process, organizational and customer interface.
Voss and Hsuan (2009)	To develop the concepts of service architecture in service design and innovation	Modeling service architecture Measuring degree of service architecture modularity Illustrative examples	A decomposition approach to architecture modeling allowing organizations to understand their service architecture. Suggestions of ways in which service architecture can be conceptualized: a hierarchy (four levels from industry to service components); a platform; the concept of modularity, which can be presented with SMF, a mathematical model, measuring the degree of modularity.
de Blok et al. (2010)	To show how modularity manifests in a service context, specifically in the care and services to independently living elderly	Four case studies Independently living elderly	Late client involvement allows for adaptation of components resulting in a higher level of customization. Theory should distinguish between offering modular care provision versus modular goods production, since the findings are the exact opposite as compared to manufacturing modularity.
de Blok (2010)	To advance knowledge on modularity in long-term care for the elderly.	Conceptual study, pilot study and four empirical studies Long-term care	Modularity aspects and practices contribute to the provision of demand-based care packages in all phases of the long-term care process.; To make modularity work in a long-term care setting, a dynamic view on modularity seems a prerequisite
Rahikka et al. (2011)	To find out how service modularity influence on the value perception of the customer in the professional services field	Single case study Professional services (construction, engineering, project management)	Service offering modularity helps the customer evaluate the service outcome (effectiveness for customers). Modular processes influence on business customer's quality expectations. Organizational modularity helps project implementation. Service modularity concept is a tool for developing services internally in a service company.
Böttcher and Klingner (2011)	To provide a method for shaping formerly monolithic services into separate modules	Literature review Three use cases (industrial, service)	A method to modularize services. Approaches and concepts of modularization in industrial and software engineering are adapted and transferred into the field of service engineering.
Lin and Pekkarinen (2011)	To develop framework combining quality function deployment design, house of quality technique and modular logic	Literature review Single case study (LSP)	QFD and modularity as design principles can ensure service design quality at three layers (service, process, activity) and help in designing logistics services with high quality and a large service variety.
Tuunanen and Cassab (2011)	To propose the concept of service process modularization; study its influence on customer trial	Two experimental studies (289 and 375 individual participants)	Modularization increases both the perceived utility and the likelihood of trial for service extensions. However, the effect of modular reuse vs. variation is dependent on the base service task complexity.
Frandsen (2012)	To study conceptualizing and measuring modularity of service processes	Single case study Financial service provider	Conseptualization and measurement of service process modularity through the use of the service modularity function; Dynamic understanding of the process of modularization, not only intended outcomes but also unintended consequences
Tuunanen et al. (2012)	To develop a typology for modular service design.	Literature review	A typology for modular service design. Review of engineering, manufacturing, and service research literature. Three key concepts for service modularization: service module, service architecture, and service experience.

Voss and Hsuan (2009) point out that there has been little application of the concepts of *"modularity"* or *"architecture"* in the design of services. According to them, the reasons for this could be the differences between products and services, i.e. the heterogeneity of services, the role of people in service personalization and customization, and the nature of services as both products and processes. The interfaces in services consist of people, information, and rules that describe the flow of information (Voss and Hsuan, 2009). In the framework presented by Pekkarinen and Ulkuniemi (2008), the 3Ds of modularity are defined: 1) modularity in services; 2) modularity in processes; and 3) modularity in organization. Thus, modularity and its effects related to services – like modularity and its effects related to physical products – can be discussed at the same levels that have been used in the categorization of product-related modularity.

In the following, the different levels of modularity discussion will be integrated into a single holistic research framework through the concept of business model modularity. Therefore the concept of business models must be discussed next.

2.7 Business models, strategies, processes, and modularity

Using the business model framework, the business logic of a firm can be described in a simple and concrete way, and that is why the concept of the business model has become popular in the last decade (Pateli and Giaglis, 2003; Osterwalder et al., 2005). However, there are issues that must be discussed along with the business models. Corporate strategy and business processes have not generally been in the focus when discussing business models. Osterwalder (2004) points out that strategy, business models, and process models address similar problems at different business levels. Strategy focuses on the corporate/group and planning level, business models on the business unit and architectural level, and business processes on the functional and implementation level. According to Osterwalder (2004), business models include a description of the firm's logic for creating and commercializing value, and business processes focus on implementing business. For example, Casadesus-Masanell and Ricart (2007, 2010 and 2011) maintain that *"a company's strategy results in a particular set of choices, which, together with their consequences, constitutes a business model"*. Consequently, they regard business models as a reflection of strategy. The business model is a more concrete description of the operations of the company than the business strategy. Business processes for their part describe the actual operations. Thus, it can be concluded that business models are positioned between business strategy and business processes, and understanding all these levels is

necessary.

In the literature there are various attempts to define and describe business models. According to Chesbrough (2003), a business model encompasses six functions; value propositions, market segments, value chain structure, revenue mechanism and costs, positioning of the company, and competitive strategy. Rajala et al. (2001) include a product development model, a revenue logic model, a sales and marketing model and a servicing and implementation model into the business model. One of the most popular business model analysis frameworks is Osterwalder's (2004) business model building blocks framework. Osterwalder's model offers a useful framework for analysis of the different elements of the business model, as it contains many of the elements essential at the architectural level of business. The basic elements of the model are nine business model building blocks consisting of four pillars: Pillar 1: Product/Offer (value proposition), Pillar 2: Customer interface (target customer, distribution channel, relationship), Pillar 3: Infrastructure Management (value configuration, capability, partnership), Pillar 4: Financial aspects (cost structure and revenue model). Osterwalder's framework does not refer specifically to business processes, but to the "arrangement of activities and resources" which is included in value configuration and is very similar to process thinking.

In the literature, there are several representations of the strategic positioning of service providers. Nowadays in logistics there is a divergence of logistics services, ranging from basic low-cost service providers to value-added service providers (Tinnilä and Vepsäläinen, 1995; Bask et al., 2010b). In recent years researchers have also made several attempts to categorize LSPs based on their service strategies. Berglund et al. (1999) distinguishes between "service providers" which offer low cost simple services to many clients, and "solution providers" which offer customized and complex services to a few key customers. Persson and Virum (2001) group LSPs into "logistics operators", "third-party logistics operators", "logistics agents" and "logistics integrators", based on their attitude towards service offerings and resources. For their part, Hertz and Alfredsson (2003) present four categories of third-party LSPs according to their problem solving ability and customer adaptation.

The SPA (Service Process Analysis) model, originally developed by Apte and Vepsäläinen (1993) and Tinnilä and Vepsäläinen (1995), offers a useful tool for graphical representation of service positioning, as the SPA model describes efficient ways to connect the delivery channel of the service (type of channel) with the type of service. In the SPA model, efficient service processes are seen as combinations of service characteristics and service

delivery channels. Service types range from mass transactions and customized services to contingent relationships, while service delivery channels range from internal hierarchies to open networks. The service outputs that are located on the diagonal of the matrix represent efficient combinations of services and their service delivery channels.

Modularity in processes can be accomplished by conceptualizing and categorizing business processes and designing "averaged" processes for an organization (Stoddard et al., 1996). Modularity in processes enhances the application of reusable process steps which can be combined in different ways ("mixed and matched") with the aim of meeting a variety of customer requirements in service implementation. As processes build an important part of a business model, modular business models are based on modular business processes.

The following section presents some summarizing remarks on the literature review.

2.8 Concluding remarks on the literature review and positioning of the research

Based on the literature review it can be concluded that there is a need to systemize the concept of modularity. The concept of modularity has been used in divergent application areas, and that is one reason why it has no single definition. Another reason for the vagueness of the concept is that the prerequisites and expressions of modularity, or the benefits or competitive advantages gained from it, have not been clearly distinguished from each other. The discussion on modularity related to services has been greatly influenced by the earlier discussion on product modularity. However, the extent to which the principles and concepts developed for the analysis of product modularity are useful in service-related research and practice is a question worth studying. An essential difference between product and service modularity seems to be that service modularity has many characteristics of process modularity. We may argue that service modularity is more complex than product modularity and that, as a concept, it is closer to process modularity than to product modularity. It can also be maintained that research on service modularity has many interconnections with process research. Another essential feature related to services is that the interfaces between service modules are more often "soft" / human interfaces than they are in the case of products. The concept of modularity and how to define it in the context of services is discussed in papers 1 and 2.

An attempt to distinguish between some examples of prerequisites, expressions, benefits and competitive advantages of modularity is

presented in Table 5 as a simplified cause-and-effect diagram. The competitive advantages that can be achieved through modularity principles constitute strategic targets that companies generally have.

Table 5. Prerequisites and expressions of modularity, and benefits and competitive advantages sought and/or gained.

Prerequisite	Expression	Benefit	Competitive advantage
function binding, i.e. defining functions of modules; module standardization	commonality, i.e. using same modules in different products and/or product families	economies of scale, faster development by replications (of new products, services, processes, organizational structures)	efficiency
interface standardization	loose coupling of modules, combinability i.e. allowing mixing and matching of modules	mass customization (of products and services), customer participation (co-creation)	effectiveness, customer satisfaction
defining the system architecture	descriptions, maps, charts	system structure is easy to communicate, manage, replicate, develop, and change	transparency, flexibility

The concept of customization is an extremely important issue to discuss in relation to services that are often co-created with customers or adapted to the needs of individual customers or customer groups, because these concepts have been closely linked together in the literature. It seems to be true that services also differ from products in their relation to customization. Duray et al. (2000) argue that identifying the point of customer involvement is crucial for concluding the degree of customization of products: the deeper is the customer involvement in the production cycle, the higher is the degree of customization. However, at least some services may have a different logic: de Blok et al. (2010) maintain that, in care production, client involvement late in the production cycle allows for components to be adapted on the basis of client needs (high customization), whereas early client involvement allows for only a combination of standard components (low customization). Furthermore, they state that, in manufacturing modularity, client involvement is typically a one-time event, whereas, in care provision, the client is involved in needs specification as well as, and especially during, delivery. The above discussion shows why the relationship between modularity and customization is worth investigating more thoroughly, especially in the service context. The relationship between modularity and customization is the focus of paper 3.

Considering *organizational* modularity, it can be noted that the concept has been used in the literature in two strikingly contradictory ways; on one hand, modularity has been seen as market-like “arm’s length” relationships between organizational units or network partners, usually connected to

"loosely coupled" modular product architecture that allows for a division of labor and the outsourcing of tasks across firms (Brusoni and Prencipe, 2001; Ernst, 2005; Jacobides, 2005). However, on the other hand, some authors (e.g. Doran, 2005) seem to connect product modularity and organizational modularity automatically, and mention close cooperation in, for example, the supplier parks of car manufacturers between suppliers and manufacturers as a good example of a modular organizational structure. In other words, this is yet another example of the ambivalence of the concept of modularity.

It may be argued that modularity should be defined in a consistent manner regardless of the level of analysis: product-level, process-level or organizational level. At the same time it should be remembered that the degrees of modularity are almost always different at these three levels in particular cases. It could almost be claimed that, in at least some cases, there is a certain amount of modularity ("a bucket of modularity"), that can be placed at different positions or levels, and that if modularity is increased at the product level, for example, this is reflected at least temporarily in a decrease in modularity (i.e. increase in integrality) at the organizational level in order to maintain coordination in the system (Starr, 1965). However, the overall modularity may be raised at all the levels over time as the system develops towards modularity, and more coordination can be built into the system. Another interesting example of the right "positioning" of modularity is mentioned by Starr (2010), when he claims that outsourcing, and particularly off-shoring, has removed the need for modularization in the production of products, as it has been replaced by the modularity of service production – or to be more exact, of organization.

As Chesbrough and Prencipe (2008) state, there are at least two modes of technological progress, i.e. progress within one particular architecture, and progress from one architecture to another. Components and interfaces within an existing architecture can be codified and shared, enabling price mechanism and market transactions. This enables experimentation and incremental improvements within the existing architecture. However, when a technological ceiling is reached, another architecture will be required. New architectures require new systems knowledge (Henderson and Clark, 1990). Brusoni and Prencipe (2001) maintain that, in the long term, modular product architecture is in fact static, because it only allows components to change within a predefined range of variation. Thus, in the long term, a modular architecture can fail to adapt to changes.

With respect to manufacturing industries, modularity has often been presented as a design strategy that stimulates innovation, as it enables the division of labor, specialization and concurrent engineering (Fine, 2000;

Jose and Tollenaere, 2005). However some authors, for example Galvin and Morkel (2001), suggest the opposite. They state that if modularity is adopted widely and strictly in an industry, the industry may fragment, and that in the worst case this fragmentation will lead to a situation of stagnation where innovations that could change product architectures and component interfaces will be extremely difficult to roll out. According to Galvin and Morkel (2001), the bicycle industry displays characteristics of this kind of development.

The literature review shows that the existing research literature has recognized different contexts in which modularity has been studied. Yet there have not been any serious attempts to build a holistic framework for modularity-related issues. Through the concept of the business model it is possible to present a holistic framework combining divergent fields of modularity research. The business model framework encompasses all the essential elements of a firm. Thus it also encompasses the issues connected to modularity in the literature and dealt with earlier in this chapter, namely product, process and organizational modularity. The relationship between strategy, business models and processes, and modularity is further discussed in papers 4, 5 and 6.

Business model modularity can be defined as the *"combining of a stable business model platform with customer- or situation-specific and interchangeable business model modules to accomplish flexibility to serve different customers and offer different services in the most efficient and profitable ways"* (see paper 4). Business models as presented in the literature consist of modules (for example, Osterwalder's model has nine building blocks), but it can be argued that the current research on business models still seems to miss the essence and benefits of the modular approach. Another example that indicates this is the modular approach to business models presented by IBM in its so-called "component business model" (IBM, 2005). IBM's "component business model" defines the structure of the business components an enterprise should contain. These components represent the internal and external specialization of the firm. The components have a loose coupling of links between each other, and this loose coupling provides flexibility, adaptability and responsiveness, as some components may be outsourced to partners while other components may be executed by the firm itself. (IBM, 2005) Flexibility issues, such as the change processes used to transform business models into new models, have rarely been discussed in business model research (Tikkanen et al., 2005; Osterwalder et al., 2005; Aspara et al., 2011).

This research suggests that flexibility can be added to the discussion of business models by combining the business model and modularity

approaches. As the business model connects elements of service products and offerings (customer relationship), processes (internal and external workflow), and organization (internal and external resources and roles), the modular approach to business models should allow flexibility by mixing and matching optional business model modules.

Based on the discussion in this chapter it can be concluded that there are two reasons why this research takes a business model modularity perspective. The first reason is that the modularity of business models offers a holistic view of modularity, as it encompasses all the views of modularity presented in the literature. A related argument is that, by using the business model framework, it is possible to reveal potential research gaps and to open future research avenues for modularity research. The second reason is that the modularity of business models offers insights into how flexible business models can be designed, and how the transformation processes from old to new business models can be managed. An analysis of the evolution of a part of a business model, i.e. a service model, in a case company is illustrated in paper 6.

Figure 2 illustrates elements of the theoretical framework and literature used in this research – i.e. the modularity, business model and service strategy literature. Figure 2 also shows that the business model forms a platform for studying modularity by integrating the existing modularity literature concerning service products, production processes and organizational issues. As a business model is a conceptual and architectural implementation of a business strategy (Osterwalder and Pigneur, 2002), the strategy steers the development of business models over time.

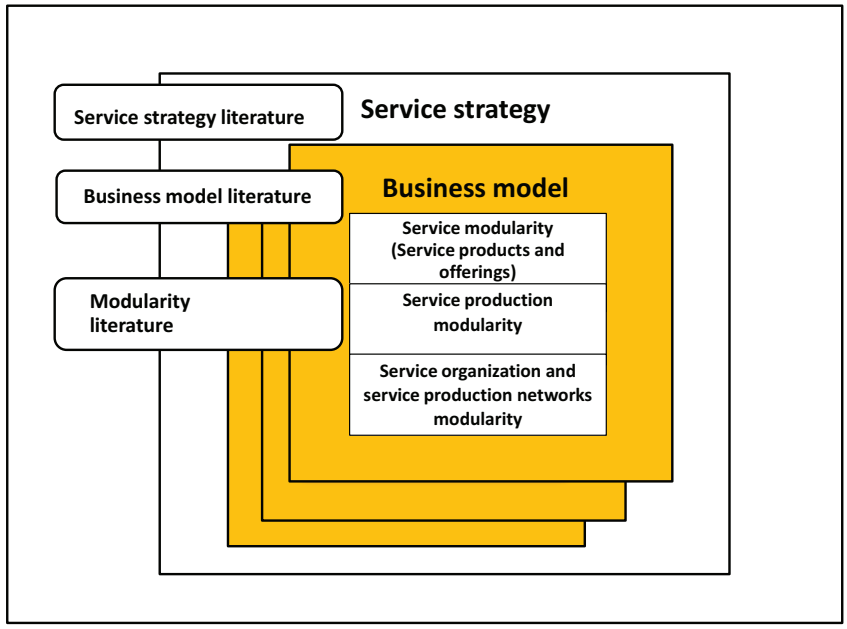

Figure 2. The literature used in this research and the elements of the theoretical framework. A business model forms a platform for studying modularity.

Figure 3 shows the positioning of the research papers in the theoretical framework and in the modularity research field. The idea behind Figures 2 and 3 is that modularity (and customization) can be inspected at the levels of service, service production, service organization and networks, and, consequently, business models. Strategic targets such as efficiency, effectiveness and flexibility can be pursued using modularity principles. Combinations of modularity and customization in the right proportion enhance the building of efficient and effective flexible service strategies that ensure sustainable competitive advantage for service providers.

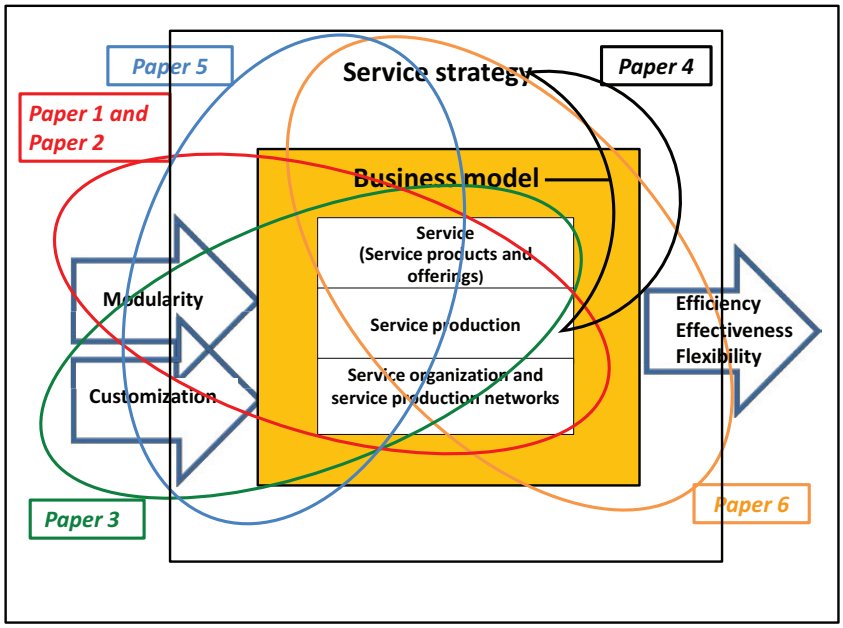

Figure 3. Positioning of the papers in the theoretical framework.

Papers 1, 2 increase our understanding of the concept of modularity in theory and in practice, and present definitions and concepts. Paper 3 builds a framework for modularity and customization, and paper 4 for strategy, business models and processes. Papers 5 and 6 apply the frameworks and theories developed in the other papers to strategies and service and business models, and thus provide further examples of modularity in the logistics service context. Paper 4 aims to illustrate how modularity principles affect strategy, business models and processes. Paper 5 discusses how modularity and customization are applied by logistics service providers (LSPs) that have different service strategies. Paper 6 presents an analysis of service model evolution over time in a case company, thus illustrating how a modularity perspective gives flexibility to business models and service strategies.

3. Review of the results

In general, the growth of service industries has led to a growing interest in analyzing services. Also many traditional manufacturing industries have increased the amount of services in their offerings. Service modularity is a rather new research theme. There are both conceptual and practical challenges in applying modularity to services. The papers of this research aim to respond to these challenges.

3.1 Overview of the papers and results

Paper 1 *("The Concept of Modularity: Diffusion from Manufacturing to Service Production")* studies and creates definitions of modularity for services. The definition of service modularity is still far from clear. The purpose of paper 1 is to identify the relevant concepts related to the modularity theme and to gain a better understanding of these issues. The paper categorizes the existing research on modularity into key themes, based on what they mean in the context of services. A systematic review (Cooper, 1989; Tranfield et al., 2003) of journal articles is executed to find relevant categories, and some examples of current applications of modularity in logistics services are presented. The formulation of definitions of modularity in the service context contributes to an understanding of the concept, and the illustrative applications provide insights into how service modularity can be implemented in practice.

Examples of the practical application of modularity in the service context are still rare in the literature (Voss and Hsuan, 2009; Starr, 2010). Therefore, Paper 2 *("Views of logistics service providers on modularity in logistics services")* contains an analysis of how the theoretical definitions found and elaborated in paper 1 stand up in practical business cases. Modularity principles have been used in the physical product context without relying on academic rigor for planning and modeling (Starr 2010), and it can be assumed that this has also happened in the service context. This paper fills this research gap by illustrating the applicability of

modularity to the service setting and by presenting empirical findings of how modularity principles are used by Finnish logistics service providers (LSPs). The purpose of the paper is to present an analysis of how LSPs understand the concept of modularity – whether they see modules in logistics (in service offerings, processes or organizations, etc.) or use modularity thinking in their own work, and whether they consider modularity thinking beneficial or not.

One of the challenges related to the modularity concept is how the relationship between modularity and customization can be understood. This is particularly significant when discussing definitions and applications of modularity in the context of services. Paper 3 *("Framework for modularity and customization: service perspective")* aims at theory building by discussing the relationship between the concepts of modularity and customization. In the earlier literature these concepts have often been treated as interconnected (Fixson, 2006; Jacobs et al., 2007). The intertwining of the concepts has led to both theoretical and practical challenges. Separating the concepts opens up new avenues both theoretically and practically. In addition, the mass customization strategy adopts the right position in relation to other possible strategies. The key objective of the paper relates to theory building, i.e. creating a framework for the systematic analysis of modularity and customization from the service perspective. The framework reveals combinations of modularity and customization that lead to strategies other than mass customization. Examining the business models of companies in a framework is worthwhile. These models are presented from three perspectives, i.e. the service offering, service production and production network perspectives, by using the automotive industry as an example. This illustrates how the same examples can vary with respect to the degree of modularity and customization when examined from these three perspectives.

After discussing the definitions of modularity in papers 1-3, papers 4-6 shift to discussions of the potential effects of modularity on business models and service strategies. Paper 4 *("Matching Service Strategies, Business Models and Modular Business Processes")* discusses the relationship between service strategies, business models and processes, in relation to the concept of modularity. Strategy focuses on the corporate / group and planning level, business models focus on the business unit and architectural level, and business processes focus on the functional and implementation level. More research is needed on the interconnections between these three levels and this paper aims to fill this research gap. The objective of this paper is to increase the understanding of the relationship between strategic-level service positioning, service-related business models

and modular business processes. The aim is to interconnect these three approaches and also to connect them to the modularity approach. Examples of selected logistics services and a company case study are presented with a view to increasing our understanding of how the different frameworks developed for these different levels can be used in analyses of services.

Paper 5 *("Modularity and customisation in LSPs' service strategies")* analyzes the different approaches that LSPs with different service strategies use regarding modularity and customization. Modularity and customization are examined, using the framework developed in paper 3, from three perspectives: service offerings, service production processes and service production networks. The five case studies illustrate the different strategies implemented by LSPs, and their approach to modularity and customization. The findings show that different service strategies also imply differences in approach to modularity and customization in service offerings, processes and networks.

Paper 6 *("Development of outbound logistics services in the automotive industry – case SE Mäkinen")* describes a case in which an LSP offers services connecting automotive manufacturers with their dealers. The objective is to describe the evolution of the company service model, i.e. changes in service offerings, while taking into account how modularity affects the automotive supply chain. The customer relationships of the case company, and possible future developments, are also discussed. Paper 6 shows that a modular approach to business models – service models included – brings more flexibility to both business models and service strategies.

3.2 Concept of modularity and its implications for logistics – paper 1

Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2010) "The Concept of Modularity: Diffusion from Manufacturing to Service Production", Journal of Manufacturing Technology Management, Vol. 21, No. 3, pp. 355-375.

Paper 1 presents a literature review of the key modularity-related themes. Based on the findings, modularity has been discussed mostly from the physical product perspective, and has been connected with production, organizational, and supply chain modularity. Until recent times, there has only been limited literature dealing with modularity focused on services. It can be also argued that the impacts and possibilities of modularity in the service context have not yet been fully understood or used. The concept of modularity is manifold, and useful definitions of modularity are needed both in research and for service providers.

Service modularity – like modularity related to physical products – can be

discussed at different levels, for example at the service product level, at the service production or process level, and at the organizational, supply chain or service industry level and at the network level. An important theoretical finding is that service modularity has many characteristics of process modularity, because services are often described as processes. Interfaces between service modules are often "soft". Service modularity is thus a more complex entity than product modularity, meaning, for example, that service modules cannot be mixed and matched as freely as modules in physical products.

Some of the characteristics of service-related modularity are presented in In Table 6 (adapted from Bask et al., 2010a).

Table 6. The key themes in modularity of services.

	Module	Interface	Architecture
Service	service characteristics, service type, function	specification of division of labor, interface between service modules, interface between customer and service, "soft" / human and "hard"/technological interface, "plug-and-play" interface, loose coupling	service blueprint
Service process/ Service production	sub-process, process step, service business model module	specification of division of labor, interface between processes, "soft" / human and "hard"/technological process interfaces, loose coupling	process map
Service organization/ Service supply chain	member of service supply chain, organizational unit, SBU, service business model module	interface between organizations/ organizational units, mainly "soft"/human interfaces, standard, contract, service/quality level, loose coupling	organization chart, supply chain structure

Summarizing the literature review of modularity, paper 1 defines a modular system as *"a system built of components, where the structure ("architecture") of the system, the functions of the components ("elements", "modules"), and the relations ("interfaces") of the components can be described so that the system is replicable, the components are replaceable, and the system is manageable"*. Figure 4 illustrates this definition.

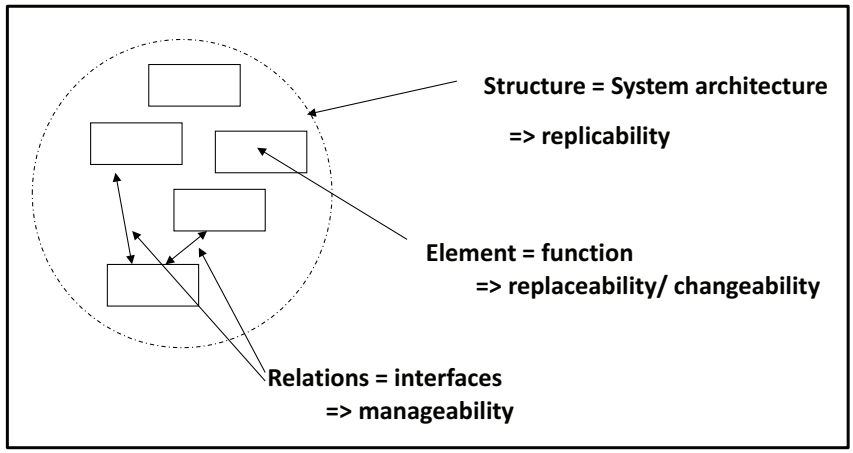

Figure 4. A modular system defined.

Examples of current applications of modularity in the logistics services presented in paper 1 show that the development of product and production modularity has greatly influenced manufacturing industry structures and networks. Modularity facilitates a variety of services and a division of tasks within networks. The trend for outsourcing has given rise, for example, to new types of logistics services, namely value-added logistics operations that provide postponed manufacturing. Postponement can lead greater flexibility in meeting customer demands with lower inventories. LSPs increasingly offer different types of value-added services that rely on customization of sub-processes, e.g. final assembly and ticketing of products.

As the proportion of services in the economy increases, there is growing interest in how to increase the efficiency and effectiveness of services. Modularity-related discussion can offer new perspectives for service research and service providers.

3.3 Empirical views on modularity – paper 2

Rajahonka M. (2013), Views of logistics service providers on modularity in logistics services, International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management, Vol. 16, No. 1, pp. 34-50.

Paper 2 discusses themes related to modularity in the practical context of the logistics service industry. Practitioners in the logistics field were asked how they understood the concept of modularity. The aim was also to examine whether the companies used the modularity approach in their work and whether and how modularity thinking could be applied in

logistics. The themes of the interviews included definitions of modularity, applicability of modularity in services, and its benefits and disadvantages, applications of modularity in service products, processes, organizations and organizational networks, and the future development of modularity.

In practice, the concept of modularity seems to be intuitively familiar to people, and at first sight simple and straightforward (Starr 2010). This could also be observed in the interviews. The interviewees also seemed to think that modularity is a useful approach in logistics and in services in general. However, the multidimensionality of the concept makes discussions with practitioners challenging. As the company representatives formulated their own definitions of modularity, they brought up various themes and levels of abstraction. Modularity and standardization were often linked together in these definitions. Service modularity also has a characteristic that makes discussions more challenging, namely the product-process duality, and, as a result, the interviewed LSPs often used "a service (product)" as a synonym of "a service process". It can be argued that service products and processes cannot be strictly separated in practice.

The results show that, even today, the services and service processes of Finnish LSPs can be considered rather modular. Their services are often based on a basic logistics service, on which more features can be added, or which can be combined into different service packages. The service processes are mainly repetitive and routine standard processes that can be divided into separate sub-processes or process modules. Organizational modularity – alternative work arrangements or subcontracting and partner networks (alliances) – are rather popular among Finnish LSPs. However, in practice, modularity at the organizational level is not used to an extreme extent. The partner networks seem to be rather stable. These relationships are not "market-based" or "arm's length" (Brusoni and Prencipe, 2001; Ernst, 2005; Jacobides, 2005), as is claimed to be typical of extreme modular relationships.

Finnish LSPs do not think that their services are standardized, although widespread customization seems to be rather unusual. Customized value-adding services such as the ticketing of products and country-specific packing (adding manuals, etc.) are offered by LSPs. Companies aim to achieve cost-efficiency and economies of scale by using process modularity and repetitive standard process modules. It can also be argued that, from the LSPs' perspective, logistics processes are typically more customized at the beginning and end of the process, and standardized in the middle of the process. Thus, in transportation, it is usually the first or last mile that is customized, while the trunk haulage in the middle is the same for most customers. Mass customization cannot usually be reached in logistics

simply by using postponement strategies, as in manufacturing.

According to practitioners the benefits of modularity include more options for the customer to choose from, rapid development of customer solutions, and greater efficiency and cost savings. The disadvantages could be a consequence of excessive use of the modularity approach, expressed, for example, in inflexibility or disregard of the customer's needs.

LSPs seem to believe that the modularity approach will become more common in the future. The reason is that services will become more diverse and the demands for customization more common, and also that service production networks will become more complex. It can also be argued that the modularity approach may become extremely beneficial in the future, because both the complexity of the business environment and the requirements for a higher degree of customization of services will increase. Modularity perspectives are useful for analyzing, planning, developing and testing services, production processes and organizational networks. In other words, modularity thinking will be a useful tool for the logistics industry in responding to future challenges. The whole potential of the modularity approach has not been exploited, yet.

The multidimensionality of the modularity concept can be seen not only in the research literature, but also in the interviews with the LSPs. As a consequence, any definition of modularity should be broad enough not to stifle the discussion too much. In paper 2 a definition of a module is presented: a module is *"a relatively independent part of a system with a specific function and standardized interfaces, where the system can be, for example, a service, a service production process, or an organization or a network of organizations"*.

3.4 Relationship between modularity and customization – paper 3

Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2011) "Framework for modularity and customization: service perspective", Journal of Business & Industrial Marketing, Volume 26 Issue 5, pp. 306-319.

Paper 3 combines modularity and customization in one theoretical framework. These concepts have proven to be a source of continuous confusion for both researchers and practitioners. Using a matrix framework we present four extreme categories of modularity and customization: non-modular regular, modular regular, modular customized and non-modular customized. By doing this, we make it possible to look at modularity and customization in a more comprehensive way. The extreme categories help us to illustrate different strategies in services. In other words, there are more strategies available to the service provider than merely combining

modularity and customization. If, for example, a service offering from the customer perspective is modular and regular, the alternatives consist only of standard modules, but in the non-modular customized category, the product, service or their combination is fully customized for the customer.

The following measurements are used for modularity: from the customer perspective, the product variants that are offered with different modules and service levels; from the production perspective, modularity principles that are used in production; from the service production network perspective, the responsibilities that the suppliers have.

The following measurements are used for customization: in the service offering, the profundity of the customization experience for the customer; in service production, the degree of customer involvement; and in the service production network, the degree of dedication in supplier relations.

We also discuss illustrative cases from the perspectives of service offerings, service processes and organizations. By doing this, we observe that the same case examples may belong to different categories in relation to these perspectives. In other words, modularity and customization at the customer interface is reflected in modularity and customization in production or in the network, but this is not a straightforward interconnection.

Paper 3 shows that it is fruitful and enlightening to separate the concepts of modularity and customization. Different strategies related to the degrees of modularity and customization can be right for different types of business environments – i.e., other than mass customization strategies are also feasible.

3.5 Service strategies, business models, processes and modularity – paper 4

Bask A., Tinnilä M. and Rajahonka M. (2010), "Matching Service Strategies, Business Models and Modular Business Processes", Business Process Management Journal, Vol. 16, Issue 1, pp. 153-180.

Paper 4 analyzes the relationships and matches of frameworks for analysis of service strategies, business models and business processes. The aim is to connect the modular business process approach to frameworks for business models and service strategies. The presented meta-framework coordinates three levels of business frameworks at the implementation level, the architectural level and the planning level.

Business model research has gained increased attention in the last decade. Although the benefits of business model thinking are clear, business model frameworks do not provide any tools for analyzing the efficient delivery of services. The SPA (Service Process Analysis) model helps to bridge this gap

and connects the business model framework with the mix of efficient service outputs by facilitating the analysis of efficient delivery channels.

Paper 4 presents a case example, the Itella Group, to illustrate the use of the framework. First, using the SPA model, an analysis of strategic service positioning is applied to the case of the Itella Group's logistics services. Itella offers standard services, e-post services, several types of contract logistics services, and even customized total solutions. Four of the services are chosen for an analysis by means of Osterwalder's (2004) model. The analysis of building blocks reveals inconsistencies within the business model. Finally, three Itella business processes are described. The focus in this analysis is the business models for e-post, letter, package and contract logistics services. The three processes that are presented are the customer relationship management process, the customer service management process and the logistics service production process. The Itella case study indicates that changes in strategies are not yet fully reflected in the business models. For example, digital channels are not yet fully utilized. There seems to be several overlapping business models and processes supposedly leading to inefficiencies and inability to answer customer needs effectively.

The most important observation of paper 4 is that there should be a match between service strategies, business models and business processes. Strategic repositioning always creates needs to change the business models and their building blocks, including business processes. Standardization, modular services and service production structures are useful for efficient service production and output, but they also promote the flexible change of business models and processes when needed. The framework presented in the paper may help practitioners to find a match between the strategic service position of the company and its business model and the corresponding match with business processes.

3.6 Modularity and customization in LSPs' service strategies – paper 5

Rajahonka, M., Bask, A. and Lipponen, M. (201x), Modularity and customisation in LSPs' service strategies, Accepted in: International Journal of Services and Operations Management, Vol. X, No. Y, pp. xxx (forthcoming).

Paper 5 discusses and examines the approaches that LSPs use regarding modularity and customization. This is done by using the framework developed in paper 3. In this study, the underlying assumption is that LSPs that employ different service strategies use different approaches regarding modularity and customization.

Case studies of 23 LSPs are used to first classify service strategies that the LSPs apply. Four types of LSP strategies are identified based on differences

in specialization strategies (focused vs. wide service offering) and customer relationships (close vs. rather distant). These four types are subcontractors (general or special subcontractors), integrators, companies offering outsourced manufacturing, and companies that are affiliates of their customer companies. These LSP strategies are illustrated by using five cases from the Finnish logistics industry. The case companies are analyzed for the modularity and customization of their services, service offerings, processes and service production networks by using the framework of paper 3.

The findings suggest that different types of service strategies are reflected in the firms' approaches to combinations and degrees of modularity and customization in service offerings, processes and networks in the implementation of strategies. The findings show that firstly, only the case company that was "an integrator" (wide service offering and significant role in the logistics supply chain) used modularity and customization (i.e. mass-customization) at every level (service, process and network levels). Otherwise, the mass-customization of services in the case companies was not a rule, as might have been expected. The explanation could be that LSPs usually aim for rather standardized products and processes. Secondly, the case companies' processes seemed to be rather inflexible. Most of them were modular, but they were not or cannot be customized, or they were customized, but not modular. The third observation was that the network relations of almost all the case companies can be described as being rather modular and customized, thus representing "mass-customization".

There are presumably also differences related to modularity and customization between companies that employ the same strategy. Thus, we cannot make any strict conclusions about dependencies, causes or effects, etc. based on the limited material.

3.7 Modularity and service model evolution – paper 6

Rajahonka, M. and Bask, A. (201x) "Development of outbound logistics services in the automotive industry – case SE Mäkinen". Paper has been sent for review.

Paper 6 focuses on the outbound logistics of the automotive supply chain and on LSPs' role between manufacturers and dealers, and how their roles have developed over time. Modularity was discussed in the earlier literature on automotive manufacturing, but focused only on the supplier network. Postponement strategies and customization are still not commonly used in automotive manufacturing (Wadhwa et al., 2006), and even today, most vehicles are made to stock (Holweg and Miemczyk, 2002, 2003). The implications of modularity on outbound logistics have not been discussed in the literature.

The paper is based on a single case study. The case company, SE Mäkinen, was established in 1952 as a newspaper transportation company. In the 1960s it started transporting vehicles from Finnish ports to district dealers, and in the 1970s it decided to specialize in transporting vehicles, for which a holistic transport management system and the consolidation of the car flows of several customers were needed. In the recession of the early 1990s, vehicle importers started to play a bigger role in national transport operations and to emphasize efficiency. In this new situation, SE Mäkinen changed its contract model and decided to offer centralized logistics management services to vehicle importers. Nowadays the company offers a wide variety of services – transportation services, storage services and value added services, post-delivery inspections (PDIs) of vehicles and post-production operations (PPOs). In 2008 the company opened a new inland logistics hub at Luhtaanmäki Vantaa offering efficient value added services. The company has built its service model gradually, partly based on its old model, but also partly by adding new elements (modules) whenever it has seen new opportunities in the market. The evolutionary path shows that there are elements (modules) that are common to the old and new models, but that significant new elements have also been added.

Material flows are weak in the Finnish automotive markets, and economies of scale can be reached only if the vehicles of several customers are consolidated for transportation in the same delivery trucks. The operating model of SE Mäkinen is characterized by mass customization of services achieved by modularity of processes, because a platform process is combined with customer-specific features.

Based on the research in paper 6 it can be concluded that, if LSPs can understand the trends in the automotive supply chain in a broad industry context (Stank et al., 2011) and manage to offer innovative services for their customers' changing and divergent needs, this will lead to stronger roles for the LSPs in the automotive supply chain. Modularity may increase supply chain efficiency and flexibility, and it may enable changes in the roles of the actors in the supply chain. In service production, late customization often offers opportunities for more customized service offerings. The implementation of modularity principles creates opportunities to increase the division of labor in supply chains, and conduct tasks at optimal points of the supply chain. Saving costs through efficiency and increasing profits through effectiveness are both important. This observation is not limited to the automotive supply chain.

4. Conclusions, discussion and future research

This chapter presents the conclusions, theoretical contributions, and managerial implications of this dissertation, and discusses the findings and research limitations, and the implications for future research.

4.1 Main findings

Defining the concept of service modularity has proved to be demanding. In general, service modularity is a more complex concept than product modularity. Services have many characteristics of processes, and thus service modularity is close to process modularity. This is maybe one of the most essential differences between product and service modularity. Another important feature is that interfaces between service modules are often "soft", consisting of human relationships and knowledge. As a result of these two features, process-resemblance and softness of interfaces, service modules cannot typically be mixed and matched as easily as product modules (see paper 1). The empirical part of this research has shown that, although the concept of modularity is familiar to service providers, there are certain challenges in exploiting the concept in real business life (see paper 2).

One further challenge in defining the concept of modularity relates to the fact that the literature has not succeeded in separating modularity from adjacent concepts, in particular from customization. In this research a matrix framework is built for analyzing different combinations of modularity and customization (see paper 3). Paper 5 provides some empirical validation for the framework.

In an attempt to build a holistic framework for modularity-related issues, the concept of the business model has been used in this research. The developed framework encompasses important perspectives on modularity, namely modularity at the service product, process and organizational levels (see section 2.8). It may also be concluded that a combination of business

model and modularity thinking has the potential to add flexibility to business models and to help create competitive advantages (see section 4.3 and paper 6). Also the relationship between strategy, business models and processes, and the relevance of reaching a match between applications of modularity principles at these levels, were studied in this research (see papers 4, 5 and 6).

The main objectives, findings and conclusions of the papers of this dissertation are presented in Table 7.

The aims of this research have been theory building and increasing the practical knowledge related to the concept of modularity in the context of services. For this purpose, divergent frameworks have been developed and then illustrated with qualitative case studies. The research discusses the definitions and applicability of modularity in the service context. The developed frameworks clarify the relationship between modularity and related concepts, and help to analyze services, service processes and organization (i.e. service business models) related to modularity. Next, the theoretical and managerial contributions of the thesis will be discussed.

Table 7. Main objectives, findings and conclusions of the papers of this dissertation.

	Paper	Objectives	Findings and conclusions
1	The Concept of Modularity: Diffusion from Manufacturing to Service Production	To describe the current state of modularity research, and to clarify the concept; To discuss whether concept originally developed in the context of physical products could be applied in the context of product-related services	We have collected the main characteristics of the earlier definitions related to the four key themes in modularity i.e. products, production/processes, organizations/supply chains, and services. There seems to be diffusion from product and manufacturing modularity to service modularity. However, the extent to which the principles and concepts are useful in service-related research and practice is an unresolved issue. Service modularity is a more complex entity than product modularity. One essential difference between product and service modularity is that service modularity has many characteristics of process modularity.
2	Views of Logistics Service Providers on Modularity in Logistics Services	To increase understanding of the concept of service modularity and to present examples of applications of modularity approach in logistics services	The LSPs consider modularity as a useful approach, and examples of applications of modularity can be found in the logistics industry. However, the interviews reinforce the multidimensionality of the concept. The results show that the services and service processes of Finnish LSPs even today can be considered rather modular: the logistics services often are based on a basic service on which additional features can be added, or can be sold separately or combined into different service packages, and the service processes are mainly repetitive and routine standard processes that can be divided into separate sub-processes or process modules. The relationships between company partners are rather stable and dedicated, not as modular as described typical for modular networks in the literature. In the future, modularity thinking has potential to become a valuable tool for responding the challenges facing the logistics service industry, as customers' demands become increasingly diversified, and services, processes and organizational networks become more complex.
3	Framework for modularity and customization: service perspective	To introduce a framework with which different customer service offerings, service production processes, and service production networks can be analyzed in terms of both modularity and customization.	In the previous literature, the concepts of modularity and customization have been discussed in an intertwined manner. When modularity and customization are regarded as two separate dimensions, a useful framework for analysis is created. The four extreme categories are: non-modular regular, modular regular, modular customized and non-modular customized. The framework provides a basis for analyzing different combinations of modularity and customization from three perspectives - service offering, the service production process, and the service production network.
4	Matching Service Strategies, Business Models and Modular Business Processes	To analyze the relation and match of frameworks for analysis of service strategies, business models and business processes. To present a meta-framework describing the relations of the approaches to each other and how to coordinate these three levels	Strategy, business models and process models are closely linked, as they focus on the same challenges in organization, although on different levels. The findings show that in order to provide value to customers efficiently, there should be a match between service strategy, business models and operational level business processes. Standardization, service productization and modularization of services, and also service production structures are useful tools for efficient service production and output.
5	Modularity and customization in LSPs' service strategies	To classify service strategies that LSPs apply. To examine if and how modularity and customization is used by the LSPs in their implementation of strategies.	The findings show that different service strategies based on differences in specialization and customer relationship lead to differences also in relation to modularity and customization in service offerings, processes and networks. LSPs usually aim for rather standardized products and processes, but the network with which the services are executed rarely is standardized, but rather customized. Case studies show that network relations of all the case companies seem to be rather modular and customized, thus representing "mass-customization". The case company described as "an integrator" expresses mass-customization at all levels (service, process and network levels). In other cases, processes of the case companies seem to be rather inflexible, so that even though they are modular, they are or cannot be customized.
6	Development of outbound logistics services in the automotive industry – case SE Mäkinen	To increase understanding of automotive outbound logistics, and about the possible effects of increasing modularity for the LSPs offering services for the industry.	Modularity has been an important driver in the developments in automotive outbound logistics. The LSPs act as middlemen between different actors in the automotive supply chains. The manufacturers, importers and dealers all have different logistics needs and interests. Thus, the LSP can find many lucrative positions in this field, and it can rethink its role as the market positions and needs of other actors in the supply chain change. Our case study shows that in the industry wide perspective, the role of an LSP may change very much over time. The evolution path shows that there are elements (modules) that are common for the old and new models, but also significant new elements are added.

4.2 Theoretical contributions – Responses to the conceptual challenges

The concept of modularity has been popular and in use in divergent contexts, and has proved to be a useful approach when analyzing and building many kinds of complex systems. However, maybe just because of this versatility of the concept, there are still major conceptual challenges related to this approach.

Summarizing the literature review, paper 1 of this research presented a definition of a modular system:

"A modular system is a system built of components, where the structure ("architecture") of the system, the functions of the components ("elements", "modules"), and the relations ("interfaces") of the components can be described so that the system is replicable, the components are replaceable, and the system is manageable."

The interviews with LSPs showed that the observation presented in the earlier research literature about the multidimensionality of the concept is definitely true. Consequently, we conclude in paper 2 that any definition of modularity should be broad enough not to narrow down the discussion too much. Thus, a definition of a module presented in paper 2 is:

"A module can be defined as a relatively independent part of a system with a specific function and standardized interfaces, where the system can be, for example, a service, a service production process, or an organization or a network of organizations."

The literature on modularity has discussed the benefits of modularity intertwined with the concept itself, and this has led to conceptual challenges (Hölttä-Otto, 2005; Pekkarinen and Ulkuniemi, 2008). The interlinking of the concepts can be seen, for example, when definitions of modularity have been developed in the literature (see Table 3). One of the challenges has been caused by the obscure relationship between the concepts of modularity and customization. An important theoretical, but also practical, contribution of this research is the analysis of these intertwined but distinct concepts, and the presentation of a framework that separates these concepts (see papers 3 and 5).

Another of the theoretical contributions of this dissertation is the presentation of a holistic framework combining the most important fields of modularity research by means of the concept of the business model. The business model framework encompasses all the essential elements of a firm. Thus it also encompasses the issues connected to modularity in the literature and dealt with earlier, namely product, process and organizational modularity.

Modularity approach has been applied in multiple contexts and research

fields, bringing this research an interdisciplinary touch. This aspect is even strengthened by applying modularity in the service context and by linking the business model approach to modularity. By interconnecting two theoretical backgrounds – business models and modularity – it is possible to analyze complex service systems and to respond at least partially to the challenges of increasing our understanding about organizational flexibility and the business model change processes mentioned by Starr (1965) and business model researchers. The last-mentioned have noted that the change processes that arise when transforming business models into new models have rarely been discussed in the research on business models (Tikkanen et al., 2005; Osterwalder et al., 2005; Aspara et al., 2011). Combining the business model and modularity approaches brings forth useful insights into how flexible business models can be built. Due to the business model perspective of modularity it is also possible to find emerging fields of research (see section 4.5).

4.3 Managerial implications – Modularity as a framework for achieving business model flexibility

Our empirical research shows that, even today, some managers in the logistics industry recognize the benefits of flexible modular business models, and in these cases the service offerings are based on loosely coupled modular design (see paper 2). Paper 3 shows that a firm can have different strategies when it applies modularity and customization related to its products, processes and organization, and that mass customization is only one of the strategies available. However, our research on LSPs (see paper 5) shows that firms that have similar logistics strategies seem also to have at least some similarities in their attitudes towards modularity and customization principles when implementing these strategies.

To summarize the different levels of modularity, it may be concluded that service design modularity enables more effective customer relationships through greater service variety and opportunities for mass-customization, while process modularity enables these opportunities to be efficiently implemented and capitalized on, and organizational modularity enables the rational use of resources through specialization, the division of labor, outsourcing, etc. A business model platform view is useful in combining and integrating these views.

The shift to modular product or service designs also changes the processes and organizing logic of the firm. A new product or service platform should be able to address new markets and these markets may require new business models (Meyer and DeTore, 2001). The dominant organizing logic of an integral architecture is a vertically integrated hierarchy; a single firm

carrying out the majority of processes (Yoo et al., 2010). Conversely, a modular architecture typically enables or leads to vertical disintegration and horizontal structures in a firm's design and production functions, and the distribution of activities among a network of firms (Fine, 2000; Yoo et al., 2010). The division of labor enabled by modularity principles makes it possible to allocate tasks to the most suitable points of the supply chain. Thus a firm can find more lucrative roles in networks of actors by adopting a modular approach to business models (see paper 6). To manage this change, it is essential for companies to pay attention to defining the business model platform that forms the basis to which the interchangeable modules can be linked.

The idea and definition of business model modularity has been presented in paper 4:

"combining a more stable business model platform with customer- or situation-specific and interchangeable business model modules to accomplish flexibility".

An illustration of how business model platform thinking can be connected with scenarios is presented in Figure 5. Scenarios A and B require some different business model modules, but still have shared modules, and knowledge of this business model platform can be used as an important source of competitive advantage. For example, in relation to customers and channels, scenario A may emphasize consumers and web-based sales channels, but scenario B may emphasize business customers and sales via sales agents. When sketching strategies for the future, it is useful to identify which modules build the business model platform, i.e. which modules can be the same in these two scenarios and business models, and which modules must be easily substitutable. The stars in Figure 5 constitute the business model platform.

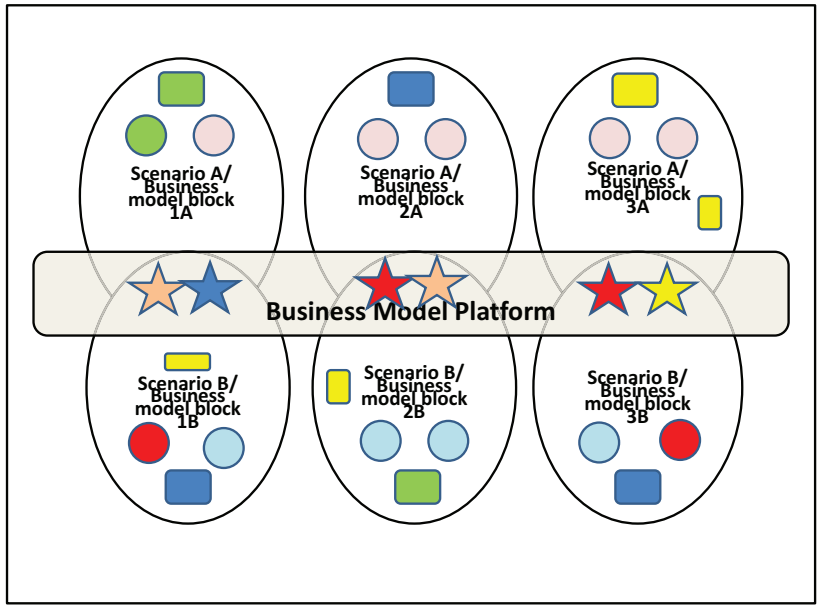

Figure 5. Business model platform thinking connected with scenarios. (adapted from Leminen et al., 2012).

4.4 Discussion, research limitations, validity and reliability

Referring to Sandberg and Alvesson (2011), this research has used both the gap-spotting and the problemization approaches. According to them, gap-spotting is more likely to reinforce or incrementally revise, rather than challenge, existing theories. Applying the concept of modularity in the context of services may be considered as problemization, because modularity theory has been developed in the physical product context. The problemization approach is also used when challenging the intertwined use of the concepts of modularity and customization in the research literature. The objectives of defining modularity in the service context, and building a holistic framework combining the perspectives of modularity, may be considered as closer to gap-spotting.

This research has excluded many of the traditional service research theories, approaches and concepts. Modularity gives one perspective to services that explains certain features, but also leaves other features unexplained. Both this research and the earlier research on service modularity have found strong interconnections between service modularity and product modularity research. However, this may be explained by "modularity" in the service context having been discussed in different terms than modularity in the product context. This might have overemphasized the influence that product modularity research has had on service

modularity research. However, this is not a significant drawback if we consider this research as only one contribution to the wider service research tradition.

This research has not overcome all the challenges of defining the concept of service modularity. Service modularity is a complex concept, and more research on it from both the theoretical and practical perspectives is needed. A theme that especially requires more research in the future is the measurement of modularity and customization, i.e. the further operationalization of the modularity and customization concepts.

The traditional criteria for evaluating methodological rigor are internal validity, external validity, construct validity, and reliability (Ellram, 1996; Halldórsson and Aastrup, 2003; Goffin et al., 2012). Internal validity has been defined as the extent to which causal relationships can be proven, external validity as the extent to which the findings are generalizable, construct validity as the extent to which correct operational measures are established, and reliability as the extent to which the research can be repeated with the same results (Mentzer and Kahn, 1995; Ellram, 1996; Voss et al., 2002).

It has been argued that good research design requires the same quality criteria, regardless of whether the research methods are quantitative or qualitative (Ellram, 1996). However, on the contrary, it has also been argued that the quality criteria of qualitative research must be – at least partly – different from that of quantitative research (Healy and Perry, 2000; Stenbacka, 2001; Halldórsson and Aastrup, 2003; Kovács, 2006). Halldórsson and Aastrup (2003) refer to Kvale (1996), and argue that the normal criteria of internal validity, reliability, external validity and objectivity are based on ontological realism, but also that realism in different forms dominates logistics thinking. Golafshani (2003) reminds us that the concepts of reliability and validity have been defined in quantitative terms, but are viewed differently by qualitative researchers. Based on the above discussion, the traditional criteria of research quality are employed in this research. Special attention is paid to the quality criteria presented in the literature related to case studies.

There are many ways to increase the validity and reliability of qualitative research. In this thesis the main research methods have been a systematic literature review, and single and multiple case studies that have been used for framework and theory building. The systematic literature review process has the characteristic of increasing the methodological rigor and practical relevance of research (Tranfield et al., 2003). Especially concerning their relation to case studies, validity and reliability issues have been discussed vigorously in the research literature. Although the criterion of internal

validity (causality) only concerns explanatory case studies, it can be increased by making proper interpretations from the data, considering alternative explanations, etc. (Ellram, 1996). Replicating case studies and verifying patterns is the best way to increase external validity, i.e. the generalizability of results, while construct validity can be addressed by using the triangulation of multiple data sources, forming a chain of events (so that the reader can follow the data and analysis from research questions to conclusion), and asking key informants to review the research (Ellram, 1996; Voss et al., 2002). The key issues to increase reliability (repeatability) are the development of a case study protocol and data base (Ellram, 1996).

A summary of the means used to ensure research quality, validity and reliability in the papers is presented in Table 8.

Table 8. Summary of the means used to ensure validity and reliability.

	Paper	Means for assuring validity and reliability
1	The Concept of Modularity: Diffusion from Manufacturing to Service Production	Integrative literature review: before-hand agreed research strategy including preliminary inclusion and exclusion criteria; decisions of inclusion and exclusion of articles made in the research team (after voting and discussions); adding "classics"; summarizing of the articles; discussions on the summaries and making conclusions and developing frameworks in the research team
2	Views of Logistics Service Providers on Modularity in Logistics Services	Multiple case study: Including different kinds of case companies in the sample (theoretical sampling); using interview protocol; sending outline of the protocol in advance for interviewees; two interviewers in different roles in some interviews; extensive field notes; recording and transcriptions of the interviews; accurate and iterative analysis of interviews; within and cross-case analysis; triangulation of the open-ended and structured questions (in-depth information with open-ended questions and cross-case generalization with structured questions) and other material; operationalization presented in the paper; generalizations basing on multiple cases
3	Framework for modularity and customization: service perspective	Several discussions in the research team during the framework and criteria building; using illustrative examples for concretizing; iterative process between theory matching and examples
4	Matching Service Strategies, Business Models and Modular Business Processes	Several discussions in the research team during the framework building; case study interviews; case study concretizing and illustrating the usage of the framework; iterative process between theory matching and the case; reviewing of the text by the key informant
5	Modularity and customization in LSPs' service strategies	Multiple case study: Including different kinds of case companies in the sample (theoretical sampling); using interview protocol; sending outline of the protocol in advance for interviewees; two interviewers in different roles in some interviews; extensive field notes; recording and transcriptions of the interviews; accurate and iterative analysis of interviews; within and cross-case analysis; triangulation of the open-ended and structured questions (in-depth information with open-ended questions and cross-case generalization with structured questions) and other material; judgments of cases presented in the paper; generalizations basing on multiple cases; iterative process between theory matching and cases
6	Development of outbound logistics services in the automotive industry – case SE Mäkinen	Single case study: selection of an exemplary case; in-depth interviews; two interviewers in all interviews; extensive field notes; recording and transcriptions of the interviews; accurate and iterative analysis of interviews; triangulation of the interviews and other material; reviewing of the text by the key informant

4.5 Conclusions and future research

Research work as such is a way of thinking through modularity and platforms; when you think inductively, you make conclusions about general ideas (a platform) starting from a particular case (a module), and when you think deductively, you make conclusions about particular cases (modules) starting from a general idea (a platform). Scientific analysis of phenomena usually proceeds through successive phases of disaggregation and aggregation. Aggregation means putting things together that are not necessarily connected and disaggregation is its opposite. Categorizing, sorting, picking and packing can even be seen in primitive hunter-gatherer societies; it can be argued that thinking with modules and platforms is not only an essential basis for all scientific thinking, but a profoundly human feature. However, the increasing complexity of systems makes this kind of approach more and more important.

Voss and Hsuan (2009) claim that service architecture is an important enabler of agility, and that the architecture must be designed with agility in mind. Normally, innovations have been classified as incremental or radical (e.g. Maidique and Zirger, 1984; Dewar and Dutton, 1986). Henderson and Clark (1990) build their theory of innovations on the classical division of radical and incremental innovation, but add two further types of innovations, namely architectural and modular innovations. Modular innovations change the component designs, and architectural innovations change the relationships between the components. Thus an architectural innovation reconfigures an established system so that, while the existing components are still useful, the way they are linked together changes. If a firm meets an architectural innovation, much of its old knowledge is still useful, but some of its knowledge is either inappropriate or disadvantageous in the new situation (Henderson and Clark, 1990). The typology of innovations presented by Henderson and Clark (1990) also illustrates the different routes of business model innovation and development that are available for a firm; business models can be changed in an incremental or radical manner, but also in a modular or architectural manner. Thus, more research on service architecture and its relation to innovations is needed.

There is another interesting question in the service context related to the concept of “innovations in between” presented by Yoo et al. (2010). “Innovations in between”, meaning interface innovations, are opposite to “module innovations”. The question is whether the interface innovations are, in fact, more important in the service context than in the product context. Service interfaces and the innovations related to them are

interesting topics for future research (de Blok et al., 2009), and more empirical research would be needed on these, as it is *"an area posited as important but where we have little detailed understanding"* (Voss and Hsuan, 2009). Logistics is an industry involving multiple network partners often operating around the globe. That is why the importance of interfaces cannot be emphasized too much in logistics. The modularity approach to the future research of logistics may bring new perspectives to the discussion on interfaces.

More research is needed related to process modularity, which is of utmost important in the service context, but maybe the least researched area of modularity so far. The challenge is that process modules have fewer degrees of freedom than modules of a typical modular product. Process modules often cannot be seen as totally independent parts of a system, because phases of work usually have a natural sequence related to each other. To give an example from logistics, delivery cannot occur before pick-up or haulage. As service products can typically be described as processes, research on service modularity has significant potential to reveal new features of the concept of modularity related to processes. It must also be mentioned that research topics on process modularity and interfaces are closely interconnected. Maybe one of the distinctions that must be taken into consideration in future research is an observation of Huemer (2006) that pooled interdependencies, i.e. cases where organizational activities share common resources, can typically be coordinated by standardization, but sequential interdependencies must be coordinated by planning, and reciprocal interdependencies by mutual adjustment involving information exchange during the action. This may lead to the conclusion that planning and mutual adjustments cannot be wholly replaced by standardization of modules and interfaces at the process and organizational levels.

The special features of customization in a service context would also require more research, as it is obvious that at least some services have a different logic related to customization than do products, as client involvement late in the service production cycle may allow more adaption to client needs (de Blok et al., 2010). Supposedly, this is due to the fact that services evolve as they are defined during the service process and as the understanding of specific customer requirements becomes clearer (see paper 6).

Combining business models and modularity perspectives extends modularity research to a new field of academic research, and helps to open up new research avenues. More extensive business model approaches (for example Osterwalder 2004; Osterwalder and Pigneur, 2009) suggest that there are still issues concerning business model modularity that have not

yet attracted the attention of academic researchers – for example, the modularity of customer relationships or the modularity of revenue or cost streams. More research would be needed in the future related to these topics.

References

Aastrup, J. Halldórsson, A. (2008),"Epistemological role of case studies in logistics: A critical realist perspective", *International Journal of Physical Distribution & Logistics Management,* Vol. 38 Iss: 10 pp. 746–763.

Afuah A. and Tucci C (2000), Internet business models and strategies: Text and case. McGraw-Hill Higher Education, New York.

Apte U.M. and Vepsäläinen A.P.J. (1993), "High Tech or High Touch? Efficient Channel Strategies for Delivering Financial Services", *Journal of Strategic Information Systems*, March, pp. 39-54.

Araujo, L and Spring, M. (2006), "Services, products, and the institutional structure of production", *Industrial Marketing Management*, Vol. 35, No. 7, pp. 797–805.

Arlbjørn, J.S. and Halldórsson, A. (2002),"Logistics knowledge creation: reflections on content, context and processes", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 Iss: 1, pp. 22–40.

Arlbjørn, J.S., Jonsson, P. and Johansen, J. (2008), "Nordic research in logistics and supply chain management: an empirical analysis", *International Journal of Physical Distribution & Logistics Management,* Vol. 38 No. 6, pp. 452-474.

Arnheiter, E.D. and Harren, H. (2005), "A typology to unleash the potential of modularity", *Journal of Manufacturing Technology Management*, Vol. 16, Iss. 7, pp. 699-711.

Arnheiter, E.D. and Harren, H. (2006), "Quality management in a modular world", The *TQM Magazine*, Vol. 18, Iss. 1, pp. 87-96.

Aspara, J., Lamberg, J.-A., Laukia, A. and Tikkanen, H. (2011), "Strategic Management of Business Model Transformation: Lessons from Nokia". *Management Decision*, Vol. 49, Iss. 4, pp. 622-647.

Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A. D., Greenough, R. M., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J. R., Angus, J., Basti, M., Cousens, A., Irving, P., Johnson, M., Kingston, J. C., Lockett, H. L., Martinez, V., Tranfield, D. R., Walton, I. M. and Wilson, H. (2007), "State-of-the-art in product service systems", *Journal of Engineering Manufacture*, Part B: 1543-51.

Baines, T.S., Lightfoot, H.W., 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 Iss: 5, pp.547 – 567.

Baldwin, C.Y. and Clark, K.B. (1997), "Managing in an age of modularity", *Harvard Business Review*, Vol. 75 No. 5, pp. 84-93.

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

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2010a), "The concept of modularity: diffusion from manufacturing to service production", *Journal of Manufacturing Technology Management*, Vol. 21 No. 3, 2010, pp. 355-375.

Bask, A., Tinnilä, M. and Rajahonka, M. (2010b), "Matching Service Strategies, Business Models and Modular Business Processes", *Business Process Management Journal*, Vol. 16, No. 1, pp. 153-180.

Berglund, M. van Laarhoven, P., Sharman, G. and Wandel, S. (1999), "Third-Party Logistics: Is There a Future?", *International Journal of Logistics Management*, The, Vol. 10 Iss: 1, pp.59 - 70

Brusoni, S. and Prencipe, A. (2001), "Unpacking the black box of modularity: Technologies, products and organizations", *Industrial and Corporate Change*, Vol. 10, Iss. 1, pp. 179-205.

Böttcher, M. and Klingner, S. (2011),"Providing a method for composing modular B2B services", *Journal of Business & Industrial Marketing*, Vol. 26 Iss. 5, pp.320-331.

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.

Casadesus-Masanell, R. and Ricart, J. (2007), "Competing Through Business Models", *IESE Business School Working Paper*, no. 713, November.

Casadesus-Masanell, R. and Ricart, J. E. (2010), "Competitiveness: business model reconfiguration for innovation and internationalization", *Management Research: The Journal of the Iberoamerican Academy of Management*, Vol. 8 No. 2, 2010, pp. 123-149.

Casadesus-Masanell, R. and Ricart, J. E. (2011), "How to design a winning business model", *Harvard Business Review*, Vol. 89, No. 1, pp. 100-107.

Chesbrough, H. (2003), "Open Innovation: The New Imperative for Creating and Profiting from Technology", Harvard Business School Press.

Chesbrough, H. and Prencipe, A. (2008), "Networks of innovation and modularity: a dynamic perspective", *International Journal of Technology Management,* Vol. 42, Iss. 4, 414 – 425.

Cooper, H.M. (1989), Integrating research: a guide for literature reviews. In: Applied Social Research Methods Series, vol. 2. SAGE Publications, Newbury Park/London/New Delhi.

Coyle J. J., Bardi E. J. and Langley C. J. (1992), The Management of Business Logistics, West Publishing, MN.

CSCMP Supply Chain Management, http://www.clm1.org/about-us/supply-chain-management-definitions, (last accessed 6 January 2013).

de Blok, C. (2010), "Modular Care Provision - A qualitative study to advance

theory and practice", Department of Tranzo, Faculty of Social and Behavioural Sciences, Tilburg University, the Netherlands. (Doctoral dissertation)

de Blok, C. , Meijboom, B., Luijkx, K. and Schols, J. (2009), "Adaptation of modular care and service packages for independently living elderly. Exploring service interfaces", In: Johansson, M. & Jonsson, P. (Eds.) 16th EurOMA conference: Implementation – realizing Operations Management. Gothenburg, Sweden.

de Blok, C., Luijkx, K., Meijboom, B. and Schols, J. (2010), "Modular care and service packages for independently living elderly", *International Journal of Operations & Production Management*, Vol. 30 No. 1, pp. 75-97.

Defee, C.C., Williams, B. Randall, W.S. and Thomas, R. (2010),"An inventory of theory in logistics and SCM research", *The International Journal of Logistics Management*, Vol. 21 Issue 3, pp. 404 – 489.

Dewar, R.D., and Dutton, J.E. (1986), "The Adoption of Radical and Incremental Innovations: An Empirical Analysis," *Management Science*, 32(11):1422-1433.

DiMaggio, P. J. (1995), Comments on "What Theory is Not", Administrative Science Quarterly, Vol. 40, Iss. 3, pp. 391-397.

Doran D. (2005), "Supplying on a modular basis: an examination of strategic issues", *International Journal of Physical Distribution & Logistics Management*, Vol. 35, Iss. 9, pp. 654-663.

Doran, D. (2004), "Rethinking the supply chain: an automotive perspective", Supply Chain *Management: An International Journal*, Vol. 9, Iss. 1, pp. 102-109.

Dubois, A. and Gadde, L-E. (2002), Systematic Combining - An abductive approach to case research, Journal of Business Research, Vol. 55, pp. 553-560.

Duray, R. (2002), "Mass customization origins: mass or custom manufacturing?" *International Journal of Operations & Production Management*, Vol. 22, No. 3, pp. 314-328.

Duray, R., Ward P.T., Milligan, G.W. and Berry, W.L. (2000), "Approaches to mass customization: configurations and empirical validation", *Journal of Operations Management*, Vol. 18, No. 6, pp. 605–625.

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*, 50 (1), 25-32.

Ellram, L.M. (1996), "The use of the case study method in logistics research", *Journal of Business Logistics*, Vol. 17, Issue 2, pp. 93–138.

Ernst D. (2005), "Limits to Modularity: Reflections on Recent Developments in Chip Design", *Industry and Innovation*, Vol. 12, Iss. 3, pp. 303-345.

Fine, C.H. (1998), "Clockspeed – Winning Industry Control in the Age of Temporary Advantage", Perseus Books, Reading, MA.

Fine, C.H. (2000), "Clockspeed-based strategies for supply chain design", *Production and Operations Management*, Vol. 9 No. 3, pp. 213-221.

Fixson, S.K. (2006), "Modularity and Commonality Research: Past Developments and Future Opportunities", MIT Sloan Working Paper 4629-06.

Frandsen, T. (2012), "Managing Modularity of Service Processes Architecture",

PhD Series 9.2012, Department of Operations Management, Copenhagen Business School.

Frankel, R., Näslund, D. and Bolumole, Y. (2005), “The White Space" of Logistics Research: A Look at the Role of Methods Usage”, *Journal of Business Logistics*, 2005, Vol. 26 Issue 2, p185-208.

Fredriksson P. (2006), “Operations and logistics issues in modular assembly processes: cases from the car sector”, *Journal of Manufacturing Technology Management*, Vol.17, No.2, pp.168-186.

Galvin, P. and Morkel, A. (2001), “The effect of product modularity on industry structure: The case of the world bicycle industry”, *Industry and Innovation*, Vol. 8, Iss. 1, pp. 31-48.

Gammelgaard, B. (2004),"Schools in logistics research?: A methodological framework for analysis of the discipline", *International Journal of Physical Distribution & Logistics Management*, Vol. 34 Iss: 6 pp. 479 – 491.

Goffin, K., Raja, J.Z., Claes, B., Szwejczewski, M. and Martinez, V. (2012),"Rigor in qualitative supply chain management research: Lessons from applying repertory grid technique", *International Journal of Physical Distribution & Logistics Management*, Vol. 42, Issue 8, pp. 804 – 827.

Golafshani, N. (2003), “Understanding Reliability and Validity in Qualitative Research”, The Qualitative Report, Vol. 8, Issue 4, pp. 597-607. http://www.nova.edu/ssss/QR/QR8-4/golafshani.pdf

Golicic, S.L. and Davis, D.F. (2012),"Implementing mixed methods research in supply chain management", *International Journal of Physical Distribution & Logistics Management*, Vol. 42, Iss. 8, pp. 726-741.

Grönroos, C. (2008), “Service logic revisited: who creates value? And who co-creates?”. *European Business Review*, Vol. 20, No. 4, pp.298 – 314.

Halldórsson, A. and Aastrup, J. (2003), “Quality criteria for qualitative inquiries in logistics”, *European Journal of Operational Research*, Vol. 144, Issue 2, pp. 321-332.

Halldórsson, A., Kotzab, H., Hsuan Mikkola, J. and Skjøtt-Larsen, T. (2007), "Complementary theories to supply chain management", *Supply Chain Management: An International Journal*, Vol. 12 Iss: 4, pp.284 – 296.

Healy, M. and Perry, C. (2000),"Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm", *Qualitative Market Research: An International Journal*, Vol. 3 Issue 3, pp. 118-126.

Henderson, R. M. and Clark, K. B. (1990), “Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms”, *Administrative Science Quarterly*, Vol. 35, Iss. 1, 9-30.

Hertz, S. and Alfredsson, M. (2003), “Strategic development of third party logistics providers”, *Industrial Marketing Management*, Vol. 32, Iss. 2, pp. 139-149.

Hoetker, G. (2006), “Do modular products lead to modular organizations?” *Strategic Management Journal*, Vol. 27, No. 6, pp. 501-518.

Hofer, A. and Knemeyer, A. (2009), “Controlling for Logistics Complexity: Scale Development and Validation”, *International Journal of Logistics Management*,

Vol. 20, No. 2, pp. 187-200.

Hölttä-Otto, K. (2005), "Modular product platform design", TKK Dissertations 10, Department of Mechanical Engineering, Machine Design, Helsinki University of Technology, Espoo.

Holweg, M. and Miemczyk, J. (2002), "Logistics in the "three-day car" age - Assessing the responsiveness of vehicle distribution logistics in the UK", *International Journal of Physical Distribution and Logistics Management*, Vol. 32, No. 10, pp. 829-850.

Holweg, M., Miemczyk, J. (2003), "Delivering the '3-day car'—the strategic implications for automotive logistics operations", *Journal of Purchasing and Supply Management*, Vol. 9, Iss.2, pp. 63–71.

Huemer L. (2006), "Supply Management: Value creation, coordination and positioning in supply relationships", *Long Range Planning*, Vol. 39, No. 2, pp. 133-153.

Hunt, S.D. (1991), Modern Marketing Theory: Critical Issues in Philosophy of Marketing Science, South-Western, Cincinnati, OH.

Hyötyläinen, M. and Möller, K. (2007), "Service packaging: key to successful provisioning of ICT business solutions", *Journal of Services Marketing*, Vol. 21, No. 5, pp. 304–312.

IBM (2005), "Component business models. Making specialization real", IBM Institute for Business Value, IBM Corporation, Available at: http://www-935.ibm.com/services/us/imc/pdf/g510-6163-component-business-models.pdf, last accessed 16 December, 2011.

Jacobides, M.G. (2005), "Industry change through vertical disintegration: How and why markets emerged in mortgage banking", *Academy of Management Journal*, Vol. 48, No. 3, pp. 465-498.

Jacobs, M., Vickery, S.K. and Droge, C. (2007), "The effects of product modularity on competitive performance. Do integration strategies mediate the relationship?", *International Journal of Operations & Production Management*, Vol. 27, No. 10, pp. 1046-1068.

Janssen, M. and Joha, A. (2008), "Emerging shared service organizations and the service-oriented enterprise. Critical management issues", *Strategic Outsourcing: An International Journal*, Vol. 1, Iss. 1, pp. 35-49.

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.

Kovács, G. and Spens, K.M. (2005), "Abductive reasoning in logistics research", *International Journal of Physical Distribution & Logistics Management*, Vol. 35 Iss: 2 pp. 132–144.

Kovács, G and Spens, K. (2007), "Logistics Theory Building", *The ICFAI Journal of Supply Chain Management*, Vol 4, No. 4, s. 7-27.

Kovács, G. (2006), "Corporate Environmental Responsibility in Demand Networks", *Publications of the Swedish School of Economics and Business Administration*, no. 166, Swedish School of Economics and Business Administration, Helsinki.

Kvale, S. (1996), “InterViews - an introduction to qualitative research interviewing”, Sage Publications, Thousand Oaks, CA.

Lampel, J. and Mintzberg, H. (1996), “Customizing Customization”, *Sloan Management Review*, Vol. 38, No. 1, pp. 21-30.

Lau, A.K.W., Yam, R.C.M. and Tang, E.P.Y. (2007), “Supply chain product co-development, product modularity and product performance. Empirical evidence from Hong Kong manufacturers”, *Industrial Management & Data Systems,* Vol. 107, Iss. 7, pp. 1036-1065.

Lau, A.K.W., Yam, R.C.M. and Tang, E.P.Y. (2010), "Supply chain integration and product modularity: An empirical study of product performance for selected Hong Kong manufacturing industries", *International Journal of Operations & Production Management*, Vol. 30 Iss. 1, pp.20-56.

Leminen, S., Rajahonka, M. and Siuruainen, R. (2012), “Modular Business Models for eReading Services”, Paper submitted to the Third International Service Modularity Seminar, Brunel University, London, UK, January 19-20, 2012 (unpublished).

Lin, Y. and Pekkarinen, S. (2011), “QFD-based modular logistics service design”, *Journal of Business & Industrial Marketing*, Vol. 26, Iss. 5, pp. 344-356.

Mahmoud-Jouini, S.B. and Lenfle, S. (2010), "Platform re-use lessons from the automotive industry", *International Journal of Operations & Production Management*, Vol. 30 Iss. 1, pp. 98 – 124.

Maidique M.A. and Zirger B.J. (1984), “A study of success, and failure in product innovation: the case of the US electronics industry”, *IEEE Transactions on Engineering Management*, Vol. 31, No. 4, pp. 192–203.

Maussang, N., Zwolinski, P. and Brissaud, D. (2009), “Product-service system design methodology: from the PSS architecture design to the products specifications”, *Journal of Engineering Design*, Vol. 20, No. 4, pp. 349-366.

McCutcheon D. M. and Meredith J. R. (1993), “Conducting Case Study Research in Operations Management,” Journal of Operations Management, Vol. 11, pp. 239-256.

Mentzer, J.T. and Kahn, K.B. (1995), “A Framework of Logistics Research”, *Journal of Business Logistics*, Vol. 16, Iss. 1, pp. 231-250.

Meredith, J.(1993),"Theory Building through Conceptual Methods", International Journal of Operations & Production Management, Vol. 13, Iss. 5, pp. 3-11.

Meyer, M.H. and DeTore, A. (1999), “Product Development for Services”, *The Academy of Management Executive,* Vol. 13, No. 3, pp. 64-76.

Meyer, C. and Schwager, A. (2007), "Understanding customer experience", Harvard business review, Vol. 85, No. 2, pp. 116-126.

Mikkola, J. H. (2006), “Capturing the degree of modularity embedded in product architectures”, *The Journal of Product Innovation Management*, Vol. 23, Iss. 2, pp. 128-146.

Mikkola, J.H. and Skjøtt-Larsen, T. (2004), “Supply-chain integration: implications for mass customization, modularization and postponement strategies”, *Production Planning & Control*, Vol. 15, No. 4, pp 352–361.

Millard, N. (2006), "Learning from the 'wow' factor -- how to engage customers

through the design of effective affective customer experiences", *BT Technology Journal*, Vol. 24, No. 1, pp. 11-16.

Miozzo, M. and Grimshaw, D. (2005), "Modularity and innovation in knowledge-intensive business services: IT outsourcing in Germany and the UK", Research Policy, Vol. 34, Iss. 9, pp. 1419-1439.

Momme, J., Moeller, M. M. and Hvolby, H.-H. (2000), "Linking Modular Product Architecture to the Strategic Sourcing Process: Case Studies of Two Danish Industrial Enterprises", *International Journal of Logistics: Research and Applications*, Vol. 3, No. 2, pp. 127-146.

Nesher Dan (2002), "Peircean Epistemology of Learning and the Function of Abduction as the Logic of Discovery", *Transactions of the Charles S Peirce Society*, Vol. 38, Nos. 1/2 (Winter), pp. 175-206.

Näslund, D. (2002),"Logistics needs qualitative research - especially action research", *International Journal of Physical Distribution & Logistics Management*, Vol. 32, Iss: 5 pp. 321-338.

Osterwalder A., Pigneur Y. and Tucci C. L. (2005), "Clarifying Business Models: Origins, Present, and Future of the Concept", *Communication of AIS*, Vol. 16, article 1.

Osterwalder, A. (2004), "The Business Model Ontology. A Proposition in a Design Science Approach". These Présentée à l'Ecole des Hautes Etudes Commerciales de l'Université de Lausanne, available at: http://www.hec.unil.ch/aosterwa/PhD/Osterwalder_PhD_BM_Ontology.pdf, (last accessed 6 May 2012).

Osterwalder, A. and Pigneur, Y. (2002), "An e-Business Model Ontology for Modeling e-Business", 15th Bled Electronic Commerce Conference, available at: http://129.3.20.41/eps/io/papers/0202/0202004.pdf, (last accessed 6 May 2012).

Osterwalder, A. and Pigneur, Y. (2009), "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers". Wiley.

Pateli, A. and Giaglis, G. (2003), "A Framework For Understanding and Analysing e-Business Models", *Bled Electronic Commerce Conference*, available at: https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/4C84233423603AD0C1256EA1002D1A29/$File/25Pateli.pdf, (last accessed 6 May 2012).

Pekkarinen S. and Ulkuniemi P. (2008), "Modularity in developing business services by platform approach", *The International Journal of Logistics Management*, Vol. 19 No. 1, pp. 84-103.

Persson G. and Virum H. (2001), "Growth Strategies for Logistics Service Providers: A Case Study", *The International Journal of Logistics Management*, Vol. 12, No. 1, pp. 53-64.

Peters M., Cooper J., Lieb R. B. and Randall Hugh L. (1998), "The Third Party Logistics Industry in Europe: Provider Perspectives on the Industry's Current Status and Future Prospects", *International Journal of Logistics: Research and Applications*, Vol. 1 No. 1, pp. 9-25.

Pine, B J. II. (1993), "Mass customizing products and services", *Planning Review*, Vol. 21, No 4, pp. 6-15.

Rahikka, E., Ulkuniemi, P. and Pekkarinen, S. (2011), "Developing the value perception of the business customer through service modularity", *Journal of Business & Industrial Marketing*, Vol. 26 Iss. 5, pp. 357-367.

Rajala, R. and Westerlund, M. (2007), "Business models - a new perspective on firms' assets and capabilities. Observations from the Finnish software industry". *International Journal of Entrepreneurship and Innovation*, Vol. 8, No. 2, pp. 115-125.

Rajala, R., Rossi, M., Tuunainen, V.K., and Korri, S. (2001), "Software Business Models: A Framework for Analyzing Software Industry", The National Technology Agency of Finland Tekes.

Sachan A. and Datta S. (2005), "Review of Supply Chain Management and Logistics Research," *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 9, pp. 664-705.

Salvador, F. (2007), "Towards a product modularity construct: literature review and reconceptualization", *IEEE Transactions on Engineering Management*, Vol. 54, No. 2, pp. 219–240.

Salvador, F., Rungtusanatham, M. and Forza, C. (2004), "Supply-chain configurations for mass customization", *Production Planning & Control*, Vol. 15, No. 4, pp. 381–397.

Sanchez R. and Mahoney, J.T. (1996), "Modularity, flexibility, and knowledge management in organization design", *Strategic Management Journal (1986-1998)*, Vol. 17, Winter Special Issue, pp. 63-76.

Sandberg, J. and Alvesson, M. (2011), "Ways of constructing research questions: gap-spotting or problematization?", *Organization*, Vol. 18, Iss. 1, pp. 23-44.

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.

Schilling, M. A. and Steensma, H.K. (2001), "The use of modular organizational forms: An industry-level analysis", *Academy of Management Journal*, Vol. 44, Iss. 6, pp. 1149-1168.

Selviaridis K. and Spring M. (2007), "Third party logistics: a literature review and research agenda", *The International Journal of Logistics Management*, Vol. 18, No. 1, pp. 125-150.

Spens, K.M. and Kovács, G. (2006), "A content analysis of research approaches in logistics research", *International Journal of Physical Distribution & Logistics Management,* Vol. 36 No. 5, pp. 374-390.

Spohrer, J. and Maglio, P.P. (2008), "The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value", *Production and Operations Management*, Vol. 17, No. 3, pp. 238-246.

Stank, T.P., Dittmann, J.P. and Autry, C.W. (2011), "The new supply chain agenda: a synopsis and directions for future research", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 Iss. 10, pp.940–955.

Starr, M.K. (1965), "Modular production – a new concept", *Harvard Business Review*, Vol. 3, No. 1, pp. 131-42.

Starr, M.K. (2010),"Modular production – a 45-year-old concept", *International*

Journal of Operations & Production Management, Vol. 30, No. 1, pp. 7-19.

Stenbacka, C. (2001),"Qualitative research requires quality concepts of its own", *Management Decision*, Vol. 39 Iss: 7 pp. 551-556.

Stock, J.R. (1997), "Applying theories from other disciplines to logistics", *International Journal of Physical Distribution & Logistics Management*, Vol. 27 Iss: 9 pp. 515 – 539.

Stoddard, D. B., Jarvenpaa, S. L. and Littlejohn, M. (1996), "The Reality of Business Process Reengineering. Pacific Bell's Centrex Provisioning Process", *California Management Review*, Vol. 38, No. 3, pp. 57–76.

Sundbo, J. (1994), "Modulization of service production and a thesis of convergence between service and manufacturing organizations", *Scandinavian Journal of Management*, Vol. 10, Iss. 3, pp. 245-266.

Tikkanen H., Lamberg J., Parvinen P. and Kallunki J. (2005), "Managerial cognition, action and the business model of the firm", *Management Decision*, Vol. 43, No. 6, pp. 789-809.

Tinnilä, M. and Vepsäläinen, A.P.J. (1995), "A Model for Strategic Repositioning of Service processes", *International Journal of Service Industry Management* , Vol. 6, No. 4, pp. 57-80.

Tranfield D., Denyer, D. and Smart, P. (2003), "Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review", *British Journal of Management,* Vol. 14, Iss. 3, pp. 207–222.

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, Iss. 2, pp.147-168.

Tuunanen, T., Bask, A., Merisalo-Rantanen, H. (2012), "Typology for Modular Service Design: Review of Literature", *International Journal of Service Science, Management, Engineering, and Technology*, Vol. 3, Iss. 3, pp. 99-112.

Tuunanen, T. and Cassab, H. (2011), "Service Process Modularization: Reuse Versus Variation in Service Extensions", *Journal of Service Research*, Vol. 14, Iss. 3, pp. 340-354

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

Uzkurt, C. (2010), "Customer participation in the service process: a model and research propositions", *International Journal of Services and Operations Management*, Vol. 6, No.1, pp. 17 – 37.

Vafidis, D. (2007), Approaches for Knowledge and Application Creation in Logistics: An Empirical Analysis Based on Finnish and Swedish Doctoral Dissertations Published Between 1994 and 2003. Turku School of Economics, 302 pages.

van Hoek, R.I. (2000a), "Role of third party logistic services in customization through postponement", *International Journal of Service Industry Management*, Vol. 11 No. 4, pp. 374-387.

van Hoek, R.I. (2000b), "The Role of Third-Party Logistics Providers in Mass Customization", *International Journal of Logistics Management*, The, Vol. 11 Iss.

1, pp.37 – 46.

van Laarhoven P., Berglund M. and Peters M. (2000), ”Third-Party Logistics in Europe – Five Years Later”, *International Journal of Physical Distribution & Logistics Management*, Vol. 30, No. 5, pp. 425-442.

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

Vargo, S.L. (2009), "Toward a transcending conceptualization of relationship: a service-dominant logic perspective", *Journal of Business & Industrial Marketing*, Vol. 24 Iss. 5/6, pp. 373-379.

Vargo, S.L. and Lusch, R.F. (2004), “Evolving to a new dominant logic for marketing”, *Journal of Marketing*, Vol. 68, Iss. 1, pp. 1-17.

Voordijk, H., Meijboom, B. and de Haan, J. (2006), “Modularity in supply chains: a multiple case study in the construction industry”, *International Journal of Operations & Production Management*, Vol. 26, No. 6, pp. 195-219.

Voss, C. A. and Hsuan, J. (2009), “Service Architecture and Modularity”, *Decision Sciences*, Vol. 40 No. 3, pp. 541-569.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), “Case research in operations management”, *International Journal of Operations & Production Management*, Vol. 22, Iss. 2, pp. 195–219.

Wadhwa, S., Bhoon, K.S. and Chan, F.T.S. (2006), “Postponement strategies through business process redesign in automotive manufacturing: Knowledge innovation”, *Industrial Management & Data Systems*, Vol. 106, Iss. 3, pp. 307–326.

Yoo, Y., Henfridsson, O. and Lyytinen, K. (2010), “The new organizing logic of digital innovation: An agenda for information systems research”, *Information Systems Research*, Vol. 21, Iss. 4, pp. 724-735.

Zeithaml, V., Parasuraman, A. and Berry, L. L. (1985), “Problems and strategies in services marketing”, *Journal of Marketing*, Vol. 49, Iss. 1, pp. 33–46.

Appendix. Some benefits of modularity mentioned in the literature.

Suggested benefit	Context	Authors
cost savings	cost structure	Jose and Tollenaere (2005); Pekkarinen and Ulkuniemi (2008); Mahmoud-Jouini and Lenfle (2010); Rahikka et al. (2011)
reduced costs of setting up production processes	cost structure	Lau et al. (2010)
reduced inventory costs	cost structure	Lau et al. (2010)
cost savings in product development	cost structure	Pekkarinen and Ulkuniemi (2008); Lau et al. (2010); Mahmoud-Jouini and Lenfle (2010)
accuracy of meeting customer needs due to shorter time to market	customer relationship	Hölttä-Otto (2005)
fast solving of technical problems, offering upgrades and improvements at marginal cost	customer relationship	Lau et al. (2010)
competitive performance (cost, quality, flexibility, cycle time)	customer relationship	Jacobs et al. (2007)
customization /mass-customization	customer relationship	Starr (1965 and 2010); Mikkola and Skjøtt-Larsen (2004); Jose and Tollenaere (2005); Voss and Hsuan (2009); Mahmoud-Jouini and Lenfle (2010)
customer value	customer relationship	Pekkarinen and Ulkuniemi (2008); Rahikka et al. (2011)
effectiveness	customer relationship	Rahikka et al. (2011)
fast reaction to market change	customer relationship	Jose and Tollenaere (2005); Lau et al. (2007)
responsive delivery times	customer relationship	Jacobs et al. (2007); Lau et al. (2007)
outsourcing	organization	Jose and Tollenaere (2005); Voss and Hsuan (2009)
coordination improvements and reduced coordination costs	organization	Galvin and Morkel (2001); Jacobs et al. (2007)
concurrent engineering	organization	Fine (2000); Jose and Tollenaere (2005)
division of labor and specialization	organization	Sanchez and Mahoney (1996); Fine (2000); Jose and Tollenaere (2005)
postponement	process / production	Voss and Hsuan (2009)
parallel processes	process / production	Baldwin and Clark (2000); van Liere et al. (2004)
efficient use of resources	process / production	Mahmoud-Jouini and Lenfle (2010)
standardized production process	process / production	Jacobs et al. (2007); Pekkarinen and Ulkuniemi (2008)
flexibility	process / production	Lau et al. (2007); Pekkarinen and Ulkuniemi (2008); Mahmoud-Jouini and Lenfle (2010)
scale production according to demand using subcontracting	process / production	Pekkarinen and Ulkuniemi (2008)
system reliability due to high production volume and experience curve	process/ production	Jose and Tollenaere (2005); Mahmoud-Jouini and Lenfle (2010)
economies of scale in component commonality	process/ production	Jose and Tollenaere (2005)
efficiency	process/ production	Jose and Tollenaere (2005); Jacobs et al. (2007); Pekkarinen and Ulkuniemi (2008)
scale and scope advantages (reduced capital requirements, economies in parts sourcing etc.)	process/ production	Baldwin and Clark (2000); Hölttä-Otto (2005)
fast product development	product and service development	Jose and Tollenaere (2005); Lau et al. (2007); Jacobs et al. (2007); Pekkarinen and Ulkuniemi (2008); Mahmoud-Jouini and Lenfle (2010)
autonomous innovation	product and service development	van Liere et al. (2004)
variety	products and services	Jose and Tollenaere (2005); Jacobs et al. (2007); Voss and Hsuan (2009)
profitability	revenue structure	Pekkarinen and Ulkuniemi (2008)
strategic flexibility	strategy	Sanchez and Mahoney (1996); van Liere et al. (2004)
ability to distinguish between strategic nonstrategic issues	strategy	Momme et al. (2000)
adaptivity to deal with uncertainty	strategy	Baldwin and Clark (2000)
increased supply chain efficiency and flexibility	supply chain	Doran (2004); Lau et al. (2007 and 2010)
managing complexity	system	Starr (1965 and 2010); Fine (2000); Baldwin and Clark (2000); Jose and Tollenaere (2005)

PART II: Original research papers

PAPER 1

Bask A., Lipponen M., Rajahonka M. and Tinnilä M. (2010), ”The Concept of Modularity: Diffusion from Manufacturing to Service Production”, *Journal of Manufacturing Technology Management*, Vol. 21, No. 3, pp. 355-375.

The concept of modularity: diffusion from manufacturing to service production

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Abstract

Purpose – Modules and modularity have been popular concepts in operations research and management rhetoric for decades. Nevertheless, it seems that there is no single universal definition of modularity for classical research themes such as modularity in physical products or modular manufacturing. The purpose of this paper is to describe the current state of modularity research and to clarify the concept and impacts of modularity by means of a literature review. The paper discusses whether the modularity concept originally developed in the context of physical products could be applied in the context of product-related services.

Design/methodology/approach – In this paper, the authors use a methodology called systematic integrative literature review to describe the current state of modularity research and to define – based on the findings of the review – the themes that are most commonly related to the modularity concept. As service modularity research is a relatively new topic, the authors look for definitions and themes related to modularity from other areas of modularity research.

Findings – The paper presents four key themes and definitions associated with modularity in different perspectives. To illustrate how modularity can be comprehended in the service context, the paper presents examples related to logistics services.

Research limitations/implications – The use of an integrative literature review has its limitations and a more thorough review of service literature is needed for more in-depth understanding of how modularity is actually manifested and conceptualized in the service context. In the future, in-depth interviews of service providers will be needed for a more thorough understanding of whether the modularity approach can be used in services today and in the future and if so, how it can be applied in practice.

Practical implications – The findings may be useful particularly for manufacturers and logistics service providers in improving their service offerings and processes.

Originality/value – There is growing interest in issues related to modularity. The paper discusses the key themes related to modularity in the contexts of product, production and processes, organization and supply chain, and service. In addition, the paper illustrates some practical implications for modularity, particularly in the logistics services context.

Keywords Modula, Distribution management, Operations and production management

Paper type Research paper

Introduction

Although modularity has been a popular concept especially in operations research and management rhetoric for decades, no universal definition of modularity seems to exist – not even for manufacturing of physical goods, let alone services. Also, although the relationship between product or service level modularity and the organization and process level has evoked discussion over the years, no consensus has been achieved (Campagnolo and Camuffo, 2009). Thus, although it has been argued that modularization brings many advantages, it seems that as a term modularity is still fairly vague when used in a business environment.

Hence, our objective in this paper is to identify the key themes of modularity discussed in the literature. There is growing interest in how issues related to modularity can benefit service research and service providers in their practical service development and implementation. However, there seems to be only limited literature available on modularity concerning services and service operations. Consequently, we also illustrate how the theoretical definitions emerge in practical business cases.

The contribution of this study to a definition of modularity in services is to categorize existing studies under key themes and reflect on what they might mean in service operations. This has been done with a systematic review of journal articles. We illustrate current applications of modularity in services by presenting some practical implications for modularity in the logistics services. We believe that formulation of definitions of modularity in service operations will contribute to an understanding of the concept and that illustrating them will provide insight into how service modularity can be implemented in practice.

The structure of the paper is as follows: first, we present the methodology of the systematic integrative literature review. Then, we define and describe the key themes that arise from earlier research on modularity in, e.g. physical products and services. We then turn to issues related to modularity in the logistics services and the implications for practice. Finally, we discuss conclusions and further research topics.

Methodology

A review of earlier literature is an important part of any research project. This paper is based on a systematic integrative literature review of the key modularity-related themes. We also discuss the implications of the modularity approach for service industries, particularly logistics.

For this paper, we selected the methodology of integrative research review presented by Cooper (1989) and systematic review presented by Tranfield et al. (2003). The systematic review approach has been previously used, e.g. by Bontekoning et al. (2004) and Pittaway et al. (2004). Based on Cooper (1989), an integrative research review summarizes past research by drawing overall conclusions from separate studies. In the integrative review, reviewer(s) aim to present the state of knowledge regarding the topic and to highlight important issues that research has left unresolved.

Based on Cooper (1989) and Tranfield et al. (2003), the stages of the systematic review are the following:

> (1) planning the review (identification of the need for a review, preparation of a proposal for a review, and development of the review protocol);
>
> (2) conducting the review (identification of research, selection of studies, evaluation of retrieved data, and data synthesis); and
>
> (3) reporting and dissemination.

We have performed integrative literature review for several reasons: first, to familiarize us with the methodology of the systematic literature review; second, to identify the relevant concepts related to the modularity theme and to gain a better understanding of these issues; and third, to form an up-to-date database from this relevant topic. Based on our data collection strategy, we conducted three searches and used two journal databases; we used the search term "Modularity" in Emerald, "Modularity" in ProQuest, and the search string "Modularization OR Modularisation" in Emerald. These particular journal databases and search terms were chosen to obtain a wide perspective on the themes. The searches resulted, respectively, in 546, 118, and 329 articles. We selected 12, 15, and 11 – i.e. the most relevant articles – for further inspection. Five of the last 11 articles were already included in the earlier selections. Altogether we read and summarized 33 articles. (The articles selected are presented in Table 1.)

Table 1. Selected articles and their key findings regarding modularity.

Writers	Year	Article Title	Key findings presented in the article
Anderson et al.	2006	Complexity: customization's evil twin	The company must obtain an in-depth understanding of the tradeoffs between customization and complexity. The focus should be on identifying the complexity drivers across the organization and determining where modularization can reduce unnecessary complexity.
Arnheiter and Harren	2005	A typology to unleash the potential of modularity	Most existing definitions of modularity are related to a common type called manufacturing modularity. Four types of modularity are defined: manufacturing, product-use, limited life and data access. New products often incorporate all four types in order to address both the needs of the customers as well as the manufacturer.
Arnheiter and Harren	2006	Quality management in a modular world	The purpose of this paper is to examine the impact of modular strategies on key quality dimensions. Six of the eight quality dimensions examined are potentially affected in a positive way by modularity, while five of the eight attributes are affected in a potentially negative manner by the use of modularity.
Asan et al.	2004	An integrated method for designing modular products	The paper suggests a methodology for a modular architecture design. The "modularization process" is designed so as to choose from three different perspectives – customer-based, function-based and structure-based design.
Braet and Ballon	2007	Business Model Scenarios for Remote Management	Remote management is believed to create new service opportunities and foster convergence between previously dissociated islands of end user devices. This paper introduces a business modeling methodology by combining four critical dimensions of design.
Braithwaite	1992	Integrating the global pipeline: Logistics systems architectures	The key principles of logistics systems architecture are standardizing the track, modularity - "plug and play," local functionality - global execution, and levels of integration.

Brusoni and Prencipe	2001	Unpacking the black box of modularity: Technologies, products and organizations	The paper argues that product modularity, organizational modularity and knowledge modularity follow different dynamics: knowledge and organizational coordination cannot be achieved by relying only on automatic mechanisms enabled by the modular product architectures. This coordination role is played by companies defined as "systems integrators."
Doran	2004	Rethinking the supply chain: an automotive perspective	This paper contends that the description of tiering within automotive supply chains is likely to require redefining in light of the development of modular supply. The skills required to become a modular supplier are likely to result in a number of first-tier suppliers either exiting the industry or becoming second or third-tier suppliers.
Doran	2003	Supply chain implications of modularization	The paper explores the development of modular supply within the automotive sector with particular emphasis on the impact that modularization is likely to have on the value-adding processes of key component suppliers. In addition, a reclassification of the term “first-tier” supplier.
Doran	2005	Supplying on a modular basis: an examination of strategic issues	The findings indicate that moving from the traditional approach to supplying parts to a modular approach requires suppliers to consider how they can develop their individual module offerings and to determine what operations do not add value to a modular offering and as a consequence can be transferred to downstream suppliers. Automotive industry, case study.
Ernst	2005	Limits to Modularity: Reflections on Recent Developments in Chip Design	There is a tendency in the "modularity" literature to generalize empirical observations that are context-specific. Evidence from chip design is used to analyze how competitive dynamics and cognitive complexity create modularity limits, and to examine management responses. Inter-firm collaboration requires more (not less) coordination through corporate management, if codification does not reduce complexity-which it fails to do when technologies keep changing fast and unpredictably.
Fredriksson	2006	Operations and logistics issues in modular assembly processes: cases from the automotive sector	The paper presents case studies of Volvo Cars, Toyota, and Saab, and identifies operations and logistics issues that are critical for the operational performance of modular assembly processes. A modular assembly process design brings structural disadvantages related to the dispersion of activities and resource needs. The issues also demonstrate the need for extensive coordination.
Galvin and Morkel	2001	The effect of product modularity on industry structure: The case of the world bicycle industry	The adoption of a modular product architecture for the bicycle allowed manufacturers to meet the simultaneous needs of product innovation and cost reduction. The fragmentation of the industry on the basis of specialized capabilities has led to economic efficiencies and low barriers to entry for most segments of the industry. However, the lack of coordination has limited the industry's capability to make changes in the product architecture beyond the component level.
Guo and Gershenson .	2007	Discovering relationships between modularity and cost	The goal of the research behind this paper was to clearly define the fundamental relationship between product modularity and product cost. There is not a significant relationship between any life-cycle modularity and any life-cycle cost unless there are significantly large modularity changes.
High et al.	2008	Creating and maintaining coherency in loosely coupled systems	The paper examines how coherency can be created and maintained in loosely coupled applications. Various techniques and design approaches are being examined, such as service management, the use of service buses, the role of industry models and semantic ontologies, and governance, to achieve and maintain coherency of composite applications using SOA.
Howard and Squire	2007	Modularization and the impact on supply relationships	The findings provide support for the notion that product modularization will lead to greater levels of buyer-supplier collaboration. The paper supports the argument that modularized components require collaborative sourcing practices in order to co-develop products and reduce interface constraints. This suggests that outsourcing requires a high level of integration, creating dependencies between firms representing considerable investment in equipment and sharing through proprietary information systems.
Hyötyläinen and Möller	2007	Service packaging: key to successful provisioning of ICT business solutions	Three service design and development methods – service industrialization, tangibilization, and service blueprinting – are introduced. The results include a service architecture framework, which can be used for creating a modularized offering and implementation system for complex business services.
Jacobs et al.	2007	The effects of product modularity on competitive performance. Do integration strategies mediate the relationship?	The paper examines empirically the effects of product modularity on four aspects of competitive performance: cost, quality, flexibility, and cycle time. A product modularity strategy enables simultaneous improvements on multiple dimensions of competitive performance.

Janssen and Joha	2008	Emerging shared service organizations and the service-oriented enterprise. Critical management issues	Technological developments enable a service-oriented approach, leading to new organizational forms and a shift towards a more market-oriented type of control. The service-oriented enterprise (SOE) is an enterprise that is modularized in business domains and organized around shared service centers (SSCs). New products can be created by orchestrating the services provided by the service centers, and this orchestration is expected to become a core capability.
Jiao and Tseng	2000	Fundamentals of product family architecture	The paper studies product family architecture (PFA) with respect to design for mass customization (DFMC). To organize product varieties in DFMC, a PFA should be described from three different perspectives: functional, behavioral and structural perspectives. Meeting diverse customer requirements and achieving volume economy simultaneously can be best achieved by synchronizing these three perspectives.
Jose and Tollenaere	2005	Modular and platform methods for product family design: literature analysis	The paper is a literature review of the platform concept with a special interest on the efficient product family development
Kumar	2004	Mass Customization: Metrics and Modularity.	The paper describes modularity in product design and the role it plays in bringing about high levels of customization on one hand and economies of scale at component level, on the other.
Lau et al.	2007	Supply chain product co-development, product modularity and product performance. Empirical evidence from Hong Kong manufacturers	The paper aims to examine how an organization can achieve higher performance through integrating supply chain product co-development (SCPC) and modular product design. SCPC is found to have a direct and positive relationship with product modularity (PM), and product performance (PP). PM improves flexibility and customer service and PP. Managers should involve their suppliers, internal functional units and customers early in their design stages, especially in the decisions relating to PM
Liere et al.	2004	Embedded coordination in a business network	This case study describes how three unconnected business networks were integrated using modularity at the business process, or activity component, level and the role standardization played to implement embedded coordination. The case study was conducted at ABZ, a trusted Business Service Provisioner in the Dutch insurance industry
Moore	2006	Business ecosystems and the view from the firm.	Markets facilitate transactions for goods. Hierarchies facilitate control over activities that produce goods. The business ecosystem organizational form solves the problem of how to open up and extend a framework of modularity and participation. Modularity determines industrial structure, as once a module and interface is defined and established, the work "behind the interface" can be accomplished by a discrete firm. Thus, increases in modularity—or perhaps better said, increased technical granularity—tends to lead to an increase in the number and types of firms engaged in the ecosystem.
Muffatto	1999	Platform strategies in international new product development	The impact of a platform strategy on international product development is then analyzed. The paper draws on examples from the experience of major Japanese automobile companies.
Pekkarinen and Ulkuniemi	2008	Modularity in developing business services by platform approach	The authors explore the literature related to modularity in developing and manufacturing physical products in order to employ the idea of modularity into the business services context. They develop modular service platform including four modularity dimensions: service, process, organizational and customer interface dimensions.
Rantala and Hilmola	2005	From manual to automated purchasing Case: middle-sized telecom electronics manufacturing unit	Business conditions of electronics manufacturers are demanding due to ever shortening product life-cycles, higher variety and increased outsourcing activity. Research results provide needed practical evidence for the middle-sized electronics manufacturers that automated purchasing implementations are valuable for them.
Sanchez and Mahoney	1996	Modularity, flexibility, and knowledge management in product and organization design.	Modular product architectures create information structures that provide the 'glue' that holds together the loosely coupled parts of a modular organization design. Modular product designs is being accompanied by new knowledge management strategies that allow product creation to be carried out more effectively through flexible, 'modular' organization structures. It can also be argued that products design organizations, because the coordination tasks implicit in specific product designs largely determine the feasible organization designs for developing and producing those products
Schilling and Steensma	2001	The use of modular organizational forms: An industry-level analysis	The paper explains why in some industries there is a greater use of modular organizational forms, including contract manufacturing, alternative work arrangements, and alliances, than in other industries.
Smith	2006	Modularity in contracts: boilerplate and information flow	Modularity and other formal devices are more important in some areas, like contracts, than in others, like property, because these purposes differ from one area to the next.

Tu et al.	2004	Measuring Modularity-Based Manufacturing Practices and Their Impact on Mass Customization Capability: A Customer-Driven Perspective.	The study defines modularity-based manufacturing practices (MBMP), develops a valid and reliable instrument to measure MBMP, builds a framework that relates customer closeness, MBMP, and mass customization capability, and tests structural relationships within this framework. Statistically significant and positive relationships were found among customer closeness, modularity-based manufacturing practices, and mass customization capability.
Voordijk et al.	2006	Modularity in supply chains: a multiple case study in the construction industry	The objective is to assess the applicability of Fine's three-dimensional modularity concept as a tool to describe and to analyze the alignment of product, process, and supply chain architectures. Empirical research shows that Fine's three-dimensional modularity concept works well for descriptive purposes, but the concept needs refinement when it is used for analytical purposes

Five of the 33 articles selected were published in the *International Journal of Operations & Production Management*, three in the *Journal of Manufacturing Technology Management*, and two each in the *Industrial Management & Data Systems, Industry and Innovation*, and the *Journal of Intelligent Manufacturing*. The other articles selected were published in various journals. The issues dealt with in the articles were more varied in the first years of our sample – they dealt with product and product development, manufacturing, and organizational and supply chain issues. Since 2005, the most popular themes have been the supply chain and since 2007 service-related modularity.

To improve the quality of the research, we extended the literature base with a few first-class articles about service modularity that were for some reason not included in our searches and/or selections. We included a few "classics" of the field and also a few more recent, but highly relevant articles.

Four key research themes in modularity

To systematize our examination of literature, we collected the article summaries. The most relevant issues in these articles can be included under four key themes, namely:

(1) modularity of product, including modularity of product development;

(2) modularity of production/manufacturing and processes;

(3) modularity of organization and supply chain; and

(4) modularity of services, including modularity of service product; modularity of service development; modularity of service production/process and service organization/supply chain.

Next, we analyze these themes more closely.

To obtain an extensive perspective on the concept of modularity, we have collected different types of definitions related to modularity from the articles selected, including the definitions from other articles and sources used in them.

Definitions and concepts of modularity generally include many aspects. Among the most commonly referenced definitions of a module in the selected articles is Baldwin and Clark's (2000) definition "A module is a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units" (Arnheiter and Harren, 2005, 2006; Lau et al., 2007; Ernst, 2005; Schilling and Steensma, 2001; Fredriksson, 2006). Baldwin and Clark's (1997) definition of modularity is also used frequently: "Building a complex product or process from smaller subsystems that can be designed independently yet function together as a whole" (Asan et al., 2004; Jose and Tollenaere, 2005; Doran, 2003, 2004, 2005; Fredriksson, 2006). Other often referenced definitions are Ulrich and Tung's (1991) and Ulrich's (1995) definitions of modularity:

> Modularity is the relationship between a product's functional and physical structures such that there is a one-to-one or many-to-one correspondence between the functional and physical structures and unintended interactions between modules are minimized (Lau et al., 2007; Jiao and Tseng, 2000; Jose and Tollenaere, 2005; Brusoni and Prencipe, 2001; Fredriksson, 2006).

Several concepts have been associated with modularity. They include architectures and platforms, interchangeability or loose coupling of components, standardization of interfaces, and one-to-one matching of module and function (Jacobs et al., 2007; Arnheiter and Harren, 2005; Asan et al., 2004; Jose and Tollenaere, 2005). Commonly mentioned benefits of modularization include larger product variety, improved flexibility, simplification of complex systems, cost savings, etc. (Jose and Tollenaere, 2005; Liere et al., 2004; Pekkarinen and Ulkuniemi, 2008).

In the following sections, we proceed to analyze the selected articles more closely under the four themes mentioned earlier in order to identify the central issues and definitions in them.

Product modularity

Product modularity (PM) is the most concrete type of modularity. The meaning of modules in products is easy to understand intuitively on a general level, since products are composed of separate components and subassemblies. Nevertheless, little consensus on a definition of PM has emerged (Jacobs et al., 2007).

However, the literature suggests that modularity is a design strategy that avoids creating strong interdependencies among specific components (modules) within the product. A module can be seen as a group of components that can be removed from the product non-destructively as a unit. PM is the use of standardized and interchangeable components or units that enable the configuration of a wide variety of end products (Jacobs et al., 2007). The critical element in unit standardization is the interface (Sanchez and Mahoney, 1996).

Lau et al. (2007) present PM as a continuum, describing separateness, specificity, and transferability of product components in a product system. Separateness refers to the degree to which a product can be disassembled and recombined into new product configurations without loss of functionality. Specificity refers to the degree to which a product component has a clear,

unique and definite product function with its interfaces in the product system. Transferability refers to the degree to which product components in a product system can be handed over and reused by another system.

Another issue related to PM is flexibility. Modular architecture is flexible because different product variations can be achieved by substituting different modular components into the product architecture without having to redesign other components. Such "loose coupling" also allows "mixing and matching" of modular components within modular product architecture and provides the potential for a large number of product variations with distinctive functionalities, features or performance levels (Sanchez and Mahoney, 1996). A modular architecture also enables companies to upgrade their products throughout their life cycle (Brusoni and Prencipe, 2001).

In summary, the key issue mentioned in relation to PM is loose coupling of standardized and interchangeable components having the same functional purpose in different systems. This issue can be seen to define PM. Modularity facilitates a wide number of product configurations and rapid product development. It helps to increase flexibility, for example mass customization.

Modularity in production and processes

In modularity-based manufacturing units, standardization and substitution principles are applied to create modular components and processes that can be configured into a wide range of end products to meet specific customer needs. The computer industry has been the leader in successful application of modular production principles (Tu et al., 2004). In fact, according to Campagnolo and Camuffo (2009), it seems that the computer industry has been the preferred area to study modularity, and this may have led to the belief that all industries are heading towards more modular structures, while the generalization may in fact be too straightforward.

Process modularity makes it possible to break down the process into standard sub-processes and customization sub-processes, and to place the standard sub-processes before the customization sub-processes to achieve maximum flexibility. Postponed manufacturing extends the final modular assembly to distribution centers and even customer sites. This makes it possible to response quickly to changing customer requirements. In modular assembly lines workstations and units can be flexibly added, removed, or rearranged to create different process capabilities (Tu et al., 2004).

Modularity in production and processes has sometimes been seen as an almost inevitable result of increased PM (Brusoni and Prencipe, 2001). What seems to define production modularity is partly analogical to PM: key issues seem to include the extent to which production steps are loosely coupled, standard interfaces between sub-processes or elements and the opportunity to mix and match the elements in the production system. However, as manufacturing processes involve humans and independent companies, standardizing the interfaces between them may require additional coordination mechanisms and platforms as compared with products. Examples can include information systems and contracts.

Modularity of organization and supply chain

Regarding organizations, Schilling and Steensma (2001) argue that organizational systems are becoming increasingly modular. As firms in a given industry begin to "outsource" functions and to use organizational components that lie outside the firm, the entire production system becomes increasingly modular. According to Schilling and Steensma (2001), firms use three primary ways of loose coupling, i.e. contract manufacturing, alternative work arrangements, and alliances. This type of organizational modularity is referred to as production systems modularity by Campagnolo and Camuffo (2009). According to them, it has to do with modularity and task management, which refers to the relationship between PM and outsourcing strategies, and with modularity and networks, which refers to the relationship between firm boundaries, inter-firm coordination, and PM.

Arnheiter and Harren (2005) maintain that it is possible to greatly simplify the supply network by reducing a product containing thousands of individual parts to a handful of subassemblies. They also state that there has been a trend among Western manufacturers to reduce the number of Tier 1 suppliers and establish longer-term contracts with a select group of supplier partners. Also, Tu et al. (2004) argue that modularity has significant impacts on a firm's supply chain and the industry structure. The result is a more responsive supply chain that can satisfy individual customer needs without higher production and inventory costs.

Voordijk et al. (2006) refer to Fine (1998) and argue that one way of measuring the modularity of a supply chain is to use the dimensions of geographic proximity, organizational proximity, cultural proximity, and electronic proximity. A modular supply chain consists of "geographically dispersed actors that have autonomous managerial and ownership structures, diverse cultures and low electronic connectivity". Modular supply chains permit substitution for the purpose of creating supply chain variations (Voordijk et al., 2006).

There are descriptions in the academic literature on how supply chains or whole industries have been restructured after adoption of modular product and production structures. Sanchez and Mahoney (1996) state that as modularity leads to a high degree of independence or "loose coupling" between components, this kind of product architecture requires little coordination between the manufacturers of different components. Through loosely coupled product architecture modularity leads to "embedded coordination" that reduces the extent to which management coordination or intervention is required (Galvin and Morkel, 2001).

One of the topical issues discussed in the literature related to the possible consequences of modularity at the inter-organizational level has been the effects of modularity on the innovation capabilities of firms. In the manufacturing industries, modularity is often presented as a design strategy that stimulates innovation through accelerating division of labor, specialization, and concurrent engineering (Jose and Tollenaere, 2005). On the contrary, Galvin and Morkel (2001) suggest that when modularity is adopted in the extreme form of internationally accepted standards, the industry will fragment and firms can and will operate entirely independently. They use the bicycle industry as an example. The fragmentation of the bicycle industry has led to a situation where innovations that change architectures and component interfaces are unlikely to

be successful. Ernst (2005) refers to the risk of being caught in a "modularity trap." If a firm focuses too much on developing products within given interface standards, this may erode the firm's system integration capabilities.

On the contrary, Brusoni and Prencipe (2001) argue that in fact, the increased division of labor resulting from modularity requires close cross-company interaction and conscious efforts at coordination on the levels of both knowledge and organization. Standards, protocols, agreements, and rules are part of the coordination activities in supply chains (Liere et al., 2004).

The direction taken by the relationship between product and organizational modularity has also been discussed; it is not clear whether, for example, PM determines outsourcing or if the outsourcing of tasks by companies affects the modularity of the products (Campagnolo and Camuffo, 2009).

In the literature, the modularity of supply chains has been related to "loosely coupled" modular product architecture that allows a division of labor and outsourcing of tasks across firms and supply chain variations, even leading to modular structures at the industry level. However, there is no consensus about whether the modular structures themselves encompass the means of "embedded" coordination and facilitate management of complex supply chains and if so, how this takes place.

Modularity in services

Service modularity is a rather new theme in the literature – only one of the articles in our selection dealing with service modularity was published before 2008. One of the reasons maybe that modularity in the services context has been discussed with different terms. Next, we present the key issues concerning modularity in services in the light of the articles selected.

Hyötyläinen and Möller (2007) argue that modularization aims at packaging individual functionalities so that the functionalities in one module have as much in common as possible and that the modules themselves are as reusable as possible. They argue that in the case of human-intensive activities, hard, soft, and hybrid technologies should be used to systematically industrialize services. Hard technology means replacing human activities with technology-based processes (as in ATM and internet banking services); soft technology refers to rationalizing and specialization of the human activities involved in services, as well as repacking or modularizing them. Hybrid is a combination of hard and soft technologies. Janssen and Joha (2008) maintain that service-orientation emerges from service-oriented architectures (SOAs). In a SOA, what is inside the modules is hidden, which means that the environment is only exposed to the service interface, the idea being that the elements within the module can be altered without affecting the interface. In this way, it should be easy to replace the modules, using a variety of sourcing options. New partners, business services, and software modules can be plugged in or removed.

Voss and Hsuan (2009) point out that there has been little application of the concepts of "modularity" or "architecture" in the design of services. According to them, reasons for this could be the heterogeneity of services, the role of people in service personalization and customization,

and the nature of the services as both products and processes. They conclude that one of the dilemmas of service design is the question of whether a service product or a process is being designed. In examining architecture in services, it is important to consider the similarities and differences between services and products. One of the characteristics of services is that they are produced and consumed at the same time: the service product can often be the service process as well. Interfaces in services can include people, information, and rules governing the flow of information. Voss and Hsuan (2009) propose a service modularity function (SMF), a mathematical model that measures the degree of modularity derived from unique services and the degree to which the modules can be replicated across a variety of services. The SMF allows for the comparison and simulation of different service systems (Voss and Hsuan, 2009).

Modularity and its effects related to services – like modularity and its effects related to physical products – can be discussed at different levels, for example modularity at the service product level, modularity at the service production or process level, and modularity at the organizational, supply chain or service industry and network level. In the framework presented by Pekkarinen and Ulkuniemi (2008), a modular service is combined from one or more service modules. Based on their literature review, they identify the 3Ds of modularity in:

(1) services;

(2) processes; and

(3) organization.

A service module can be seen as one or more service elements offering one service characteristic. As an example from logistics services, warehousing could be regarded as the service module and the needed space in the warehouse could be regarded as the service element. Process modules are standardized, indivisible process steps. For example, an ordering process includes two process modules: sending and receiving of orders. In logistics services, modularity can be defined as the integration of various functions within a company in order to decrease service complexity and achieve better responsiveness to service variety (Pekkarinen and Ulkuniemi, 2008).

Themes most commonly related to service modularity are for example packaging of functionalities, standardization of interfaces, and reusability and substitution of modules. Research on modularity in service-related issues is rather new, and its origin is powerfully connected to increased automation of service processes and the use of IT in business. That is why one of the most popular concepts mentioned in the selected articles is SOA.

Summarizing product and service modularity

Based on our literature review, the key issues in modularity are related to product, manufacturing and industrial organization, including supply chains, and lately increasingly to service design. The focus of this paper has been on exploring and categorizing modularity issues and particularly on what – if any – are the issues we can learn from modularity related to

products and manufacturing as we shift to analysis of services.

Voss and Hsuan (2009) maintain that it is important to consider the similarities and differences between services and products. Differences are for example heterogeneity of services, the role of people in service personalization and customization, and the nature of services as both products and processes. One of the characteristics of services is that they are produced and consumed at the same time and the service product can often be the service process as well. Interfaces in services can include people, information, and rules governing the flow of information.

Based on the literature review, we maintain that there seems to be diffusion from product and manufacturing modularity to service modularity. It can be argued that modularity from the service perspective has been closely connected to productization of services and the discussion of modularity related to services has been greatly influenced by the earlier discussion on PM. However, the extent to which the principles and concepts developed for the analysis of PM are useful in service-related research and practice is an unresolved issue.

As our own summary of the literature review of modularity:

> [.. .] we define a modular system as a system built of components, where the structure ["architecture"] of the system, functions of components ["elements", "modules"], and relations ["interfaces"] of the components can be described so that the system is replicable, the components are replaceable, and the system is manageable.

In Table II, we have collected some of the main characteristics of earlier definitions related to the four key themes in modularity, i.e. products, production/processes, organizations/supply chains, and services.

One essential difference between product and service modularity is that service modularity has many characteristics of process modularity. The "human touch" related to many services is the reason why interfaces between service modules are more often "soft"/human interfaces than in the case of products. We may say that service modularity is a more complex entity than PM and that as a concept it is closer to process modularity than to PM.

Table 2. Characteristics of product- and service-related modularity.

	Module	Interface	Architecture
Product	component, part, subassembly, function, product characteristics	Interface between components/parts/subassemblies, interface between customer and product, standard "plug-and-play" "hard"/ physical/ technological interfaces, loose coupling	product blueprint
Process / production	sub-process, process step	specification of division of labor, "soft" / human and "hard"/technological process interfaces, loose coupling	process map
Organization / Supply chain	member of supply chain, organizational unit, strategic business unit (SBU), business model module	interface between organizations/ organizational units, mainly "soft" / human interfaces, standards, contracts, quality levels, loose coupling	organization chart, supply chain structure
Service	service characteristics, service type, function	specification of division of labor, interface between service modules, interface between customer and service, "soft" / human and "hard"/technological interface, "plug-and-play" interface, loose coupling	service blueprint
Service process/ Service production	sub-process, process step, service business model module	specification of division of labor, interface between processes, "soft" / human and "hard"/technological process interfaces, loose coupling	process map
Service organization/ Service supply chain	member of service supply chain, organizational unit, SBU, service business model module	interface between organizations/ organizational units, mainly "soft" / human interfaces, standard, contract, service/quality level, loose coupling	organization chart, supply chain structure

How to apply modularity principles to services – some examples from logistic services

Modularity, particularly modular product structures, facilitate different strategies in manufacturing and supply chain management for offering the large variety of products needed to fulfill the needs of different customer segments. The strategies in manufacturing and supply chain management have been analyzed, e.g. by Pagh and Cooper (1998), Johnson and Anderson (2000), Bask (2001) and Bask and Juga (2001). Similar strategies should also exist in services. However, there are few frameworks for analyzing the impact of modularization on service

strategies, business models, and processes (Bask et al., 2009). In service literature many matrix type analysis tools for strategic positioning have been presented (for a review, see Tinnilä, 2009), but service modularization is not specifically recognized as a tool for repositioning services.

We define service process modularity as the usage of reusable process steps that can be combined ("mixed and matched") to accomplish flexibility and customization for different customers or situations in service implementation. For example, the delivery process, being one of the core competences of logistics service companies, encompasses activities ranging from placing orders to receiving products and services. An organization's delivery process might include activities such as order handling, procurement and production planning, production, testing, warehousing, and transporting to the customer. Business model modularity can be defined as combining a more stable business model platform with customer- or situation-specific and interchangeable business model modules to accomplish flexibility to serve different customers and offer different services in the most efficient and profitable ways (Bask et al., 2009).

Service industries are currently looking for tools for greater efficiency, and modularity has been recognized as a way to meet differing service requirements efficiently. Logistic services are often related to manufacturing operations, providing warehousing services for raw materials and components, transportation between manufacturing operations, providing final assembly services for products or final delivery operations, and even after sales services for products. Consequently, they can be used to illustrate the impacts of modularity in services.

As modularity facilitates variety in manufacturing structures, similar effects can be recognized in logistics services. Networked operations underline the importance of modularizing services; they facilitate the division of tasks within the network, rather than each player doing the operations by themselves. This is connected to the trend of outsourcing, as service modules can be outsourced to network partners. This requires greater attention to service interfaces than in integrated services. New logistic services have been introduced based on modular structures such as express carriers, value-added logistics (VAL) centers, and third and fourth party logistics services. Next, we analyze some of the impacts of modularity on logistic services. We illustrate the changes in two types of logistic operations: effects of modularity on warehousing and modularity in value added services. We use electronic business (e-business) as a context where new services have emerged and which provides opportunities for different types of both business-to-business and business-to-consumer services.

Warehousing

Warehousing operations can be greatly influenced by modularity. As Arnheiter and Harren (2005) point out, supply networks can be simplified by reducing the number of parts in a product by replacing them with modules that can be kept in stock. As the number of components declines, the modular product structure reduces the number of individual components to be held in inventory. Such reduction of stock keeping units cuts inventory values and also facilitates outsourcing to specialized warehousing operators for greater efficiency and scale economies. Most logistic operators today provide a large range of services in warehousing. Also, the trend for

scale economies is seen in the extension of the role of regional service centers. Instead of several regional warehouses, there may be a joint Scandinavian service center or even a European level service center. This changes the scope of operations, but also the requirements for outsourced logistic services. Eliminating local service centers requires better inventory control, as replacements cannot be found close by, and also fast transports such as courier services and express carriers. Logistics service providers (LSPs) are able to offer scale economies for warehousing and transportation services as they specialize in these operations and offer these services to several companies in supply chains.

E-business-related warehousing operations are a particularly good target for outsourcing, as many of the online stores have no existing warehousing network and are thus able to start from scratch. Consequently, logistic operators such as the Finland-based Itella Group offer full-scale solutions including warehousing, order picking, packaging and delivery, or any combination of these service modules (Bask et al., 2009). Furthermore, as e-business is global in scale, there is greater freedom in locating the inventories, as the physical delivery channel is separated from the ordering channel. Therefore, the warehouses can be centralized and located anywhere in the world. This type of decoupling of service modules has been found to improve efficiency in service operations (Metters and Vargas, 2000). The decoupling of ordering and delivery channel has also enabled selling of less popular niche products that traditional retailers cannot afford to keep in their assortment as their shelf space is limited. Being able to earn from these “long tail” sale, can be a competitive advantage for e-business (Anderson, 2008; Elberse, 2008).

As warehousing operations are being transformed as part of the reorganization of e-business distribution chains, roles in logistic service network are also changing. LSPs that are able to handle the entire distribution chain have extended their role from providing basic warehousing services towards being logistics network partners and third or fourth party logistics operators with overall responsibility of distribution operations. With the emergence of global e-business there is a vast demand for worldwide logistics services.

Value added services

Manufacturing modularity allows a firm to differentiate its product to a high degree by combining a limited number of standard parts (Muffatto, 1999), which provides scale economies. Similar scale economies based on a smaller number of components are seen in the logistics services supporting manufacturing operations. These operations can be internal or externalized. Process modularity makes it possible to break down the process into standard sub-processes and customization sub-processes (Tu et al., 2004). This greatly simplifies outsourcing of the manufacturing tasks. Consequently, manufacturing operations are now typically conducted in a large network of different types of service providers, including contract manufacturers, fabricators, stockists, and transport companies.

Examples from manufacturing services. Recently, manufacturing service companies and component producers have adopted wider roles than they have had traditionally. One example of this type of development is Elcoteq, which started as a component subcontractor of Nokia and has now become one of the leading electronics manufacturing service companies. It now offers

services ranging from product development, supply chain management, and manufacturing, to after-market services. Recently, Elcoteq develops its own designs, as well as designs owned by its customers, having thus become a full-scale manufacturing service company. The operation of these manufacturing networks requires management of complex logistic flows consisting of modules, parts, subassemblies, and finished products to and from different players in the network. The emergence of these new roles may become an added driver for outsourcing of logistics services and reconsideration of the division of service tasks. On the other hand, these changing roles in supply chains may create further needs for innovative value-added services from LSPs.

Value-added logistics. Postponed manufacturing extends the final modular assembly into distribution centers and even customer sites (Tu et al., 2004). Modular product structures are one of the drivers behind the rise of VAL centers, which provide postponed manufacturing operations as services. The benefits of postponement are often connected to greater flexibility in meeting customer demands with lower inventories, as the final products are assembled and packaged only after receiving the customer order. This was formerly done in the manufacturing plant, but has now been moved to VAL centers, where it is closer to customers. For example, the language of instructions for mobile phones can be matched with customer orders with postponed inclusion of instructions in the product package, and the color with postponed assembly of the phones' cover-module. This type of postponed services is moved down-stream in supply and delivery chains. Moreover, LSPs increasingly offer different types of value-added services in customization sub-processes, e.g. final assembly and ticketing of products.

Modular services in e-commerce. Modularity can also be used in the e-commerce setting, as there are new opportunities for LSPs to bundle services. It seems that at least two types of value-added service modules can be provided in connection with last-mile logistics: First, the service traditionally offered by a brick-and-mortar retail store during the shopping event should be compensated. Such service may be, for example, gift wrapping. For example, from Amazon.com you can get the items gift-wrapped with an extra cost of a few dollars. Another example of service offered by physical retail stores is related to shopping for cars: Zhang (2008) argues that as the local car dealer provides financing and after sales service, consumers may prefer buying offline, although pre-sales information gathering may be done through the internet. Thus, compensating for the services traditionally provided by retail stores is also a challenge for e-commerce. Second, there are new opportunities to bundle value-added services to the delivery event – installation and recycling services of household appliances are one example. Both of these service types are often not traditionally in the core of the LSPs service offering and are easily separated from the transportation service. They can be offered as additional service modules to the customers, and, on the other hand, outsourced to a service provider specializing in such services.

Logistic services in electronic channels provide consumers with both responsiveness and convenience, as research has revealed that lower prices are not the only motives for consumers to use an electronic purchasing channel. Although the electronic grocery business has not been the great success expected, there are some successful online stores. Among them are Peapod

and Tesco, and their success lies at least partly in consumer responsiveness and convenience for consumers, rather than in low costs (Lunce et al., 2006; Boyer and Hult, 2005). Usually, internet stores have several different types of logistics services ranging from overnight couriers to slower postal services. Thus, the modules of the services differ in, e.g. delivery time, costs, and convenience, e.g. home delivery or pick-up services. Further convenience is provided by mobile and wireless services, including track-and-trace services, and SMS notifications of arrivals.

As a summary, it seems that in e-commerce the roles in the retail chain can be redistributed. With the opportunities for centralized warehousing, value-added services and the possible need for international express deliveries, more efficient specialization and economies of scale are feasible as the volumes of e-commerce increase. As the consumer can choose different service modules, the future will show which of the services and activities in the delivery chain increase in volume to allow economies of scale to service providers and which services and rearrangements fade away.

Conclusions and further research topics

In this paper, we discuss definitions and concepts related to service modularity as well as the impacts of the modularity approach for service industries, particularly for logistics services. We also illustrate current applications of modularity in services by presenting some practical implications of modularity for example in e-commerce logistics. Modularity is discussed in the earlier literature mostly from the product perspective. PM is closely connected with production, organizational, and supply chain modularity. However, there are relatively few analyses of modularity focusing on services. It can be maintained that the impact and possibilities of service modularity are not fully understood or used. There is growing interest in what the issues related to modularity can offer service research and service providers. Useful definitions of modularity are needed both in research and for service providers. In this paper, we have explored concepts that help us to find definitions for modules and modularity that are useful in service-related research and in practical service and service operations development. We have reviewed and analyzed the literature related to modularity, keeping in mind logistic service viewpoints in particular. We contribute to bridging the gap between theory and practice by discussion of modularity concepts found in the literature and providing illustrations of modularity in logistics services.

It can be maintained that product and production modularity have greatly influenced today's types of manufacturing industry structures and networks. Similar impacts can be seen in supply chains and delivery structures where regional service centers, VAL, and postponed manufacturing are used regularly. The trend of outsourcing is also to some extent facilitated by modularity, and has given rise to new types of logistics services. In the future, we aim to carry out in-depth case studies of service providers that will further illuminate the significance, benefits and disadvantages of the modularity approach for managerial practice in logistics services.

References

Anderson, B., Hagen, C., Reifel, J. and Stettler, E. (2006), "Complexity: customization's evil twin", Strategy & Leadership, Vol. 34 No. 5, pp. 19-22.

Anderson, C. (2008), The Long Tail: Why the Future of Business is Selling Less for More, Hyperion, New York, NY, p. 267s.

Arnheiter, E.D. and Harren, H. (2005), "A typology to unleash the potential of modularity", Journal of Manufacturing Technology Management, Vol. 16 No. 7, pp. 699-711.

Arnheiter, E.D. and Harren, H. (2006), "Quality management in a modular world", The TQM Magazine, Vol. 18 No. 1, pp. 87-96.

Asan, U., Polat, S. and Serdar, S. (2004), "An integrated method for designing modular products", Journal of Manufacturing Technology Management, Vol. 15 No. 1, pp. 29-49.

Baldwin, C.Y. and Clark, K.B. (1997), "Managing in an age of modularity", Harvard Business Review, Vol. 75 No. 5, pp. 84-93.

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

Bask, A. (2001), "Relationships among TPL providers and members of supply chains – a strategic perspective", Journal of Business & Industrial Marketing, Vol. 16 No. 6, pp. 470-86.

Bask, A. and Juga, J. (2001), "Semi-integrated supply chains: towards the new era of supply chain management", International Journal of Logistics: Research and Applications, Vol. 4 No. 2, pp. 137-52.

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2009), "Modularity in service business models and processes", Proceedings of the 14th Annual Logistics Research Network Conference (LRN)-Cardiff Business School, Cardiff University, Cardiff, pp. 786-95.

Bontekoning, Y.M., Macharis, C. and Trip, J.J. (2004), "Is a new applied transportation research field emerging? – A review of intermodal rail-truck freight transport literature", Transportation Research Part A, Vol. 38 No. 1, pp. 1-34.

Boyer, K.K. and Hult, G.T.M. (2005), "Extending the supply chain: integrating operations and marketing in the online grocery industry", Journal of Operations Management, Vol. 23 No. 6, pp. 642-61.

Braet, O. and Ballon, P. (2007), "Business model scenarios for remote management", Journal of Theoretical and Applied Electronic Commerce Research, Vol. 2 No. 3, pp. 62-80.

Braithwaite, A. (1992), "Integrating the global pipeline: logistics systems architectures", Logistics Information Management, Vol. 5 No. 3, pp. 8-18.

Brusoni, S. and Prencipe, A. (2001), "Unpacking the black box of modularity: technologies, products and organizations", Industrial and Corporate Change, Vol. 10 No. 1, pp. 179-205.

Campagnolo, D. and Camuffo, A. (2009), "The concept of modularity in management studies: a literature review", International Journal of Management Reviews, retrieved online in advance of print (published online: March 26, 2009 6:59AM, available at: www.3.interscience. wiley.com/journal/120125469/issue).

Cooper, H.M. (1989), "Integrating research: a guide for literature reviews", Applied Social Research Methods Series, Vol. 2, Sage, Newbury Park, CA.

Doran, D. (2003), "Supply chain implications of modularization", International Journal of Operations & Production Management, Vol. 23 No. 3, pp. 316-26.

Doran, D. (2004), "Rethinking the supply chain: an automotive perspective", Supply Chain Management: An International Journal, Vol. 9 No. 1, pp. 102-9.

Doran, D. (2005), "Supplying on a modular basis: an examination of strategic issues", International Journal of Physical Distribution & Logistics Management, Vol. 35 No. 9, pp. 654-63.

Elberse, A. (2008), "Should you invest in the long tail?", Harvard Business Review, Vol. 86 Nos 7/8, pp. 88-96.

Ernst, D. (2005), "Limits to modularity: reflections on recent developments in chip design", Industry and Innovation, Vol. 12 No. 3, pp. 303-45.

Fine, C.H. (1998), Clockspeed – Winning Industry Control in the Age of Temporary Advantage, Perseus Books, Reading, MA.

Fredriksson, P. (2006), "Operations and logistics issues in modular assembly processes: cases from the automotive sector", Journal of Manufacturing Technology Management, Vol. 17 No. 2, pp. 168-86.

Galvin, P. and Morkel, A. (2001), "The effect of product modularity on industry structure: the case of the world bicycle industry", Industry and Innovation, Vol. 8 No. 1, pp. 31-48.

Guo, F. and Gershenson, J.K. (2007), "Discovering relationships between modularity and cost", Journal of Intelligent Manufacturing, Vol. 18 No. 1, pp. 143-57.

High, R. Jr, Krishnan, G. and Sanchez, M. (2008), "Creating and maintaining coherency in loosely coupled systems", IBM Systems Journal, Vol. 47 No. 3, pp. 357-76.

Howard, M. and Squire, B. (2007), "Modularization and the impact on supply relationships", International Journal of Operations & Production Management, Vol. 27 No. 11, pp. 1192-212.

Hyötyläinen, M. and Möller, K. (2007), "Service packaging: key to successful provisioning of ICT business solutions", Journal of Services Marketing, Vol. 21 No. 5, pp. 304-12.

Jacobs, M., Vickery, S.K. and Droge, C. (2007), "The effects of product modularity on competitive performance: Do integration strategies mediate the relationship?", International Journal of Operations & Production Management, Vol. 27 No. 10, pp. 1046-68.

Janssen, M. and Joha, A. (2008), "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", Strategic Outsourcing: An International Journal, Vol. 1

No. 1, pp. 35-49.

Jiao, J. and Tseng, M.M. (2000), "Fundamentals of product family architecture", Integrated Manufacturing Systems, Vol. 11 No. 7, pp. 469-83.

Johnson, M.E. and Anderson, E. (2000), "Postponement strategies for channel derivatives", International Journal of Logistics Management, Vol. 11 No. 1, pp. 19-35.

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. 371-90.

Kumar, A. (2004), "Mass customization: metrics and modularity", International Journal of Flexible Manufacturing Systems, Vol. 16 No. 4, pp. 287-311.

Lau, A.K.W., Yam, R.C.M. and Tang, E.P.Y. (2007), "Supply chain product co-development, product modularity and product performance: empirical evidence from Hong Kong manufacturers", Industrial Management & Data Systems, Vol. 107 No. 7, pp. 1036-65.

Lunce, S.E., Lunce, L.M., Kawai, Y. and Maniam, B. (2006), "Success and failure of pure-play organizations: Webvan versus Peapod, a comparative analysis", Industrial Management & Data Systems, Vol. 106 No. 9, pp. 1344-58.

Metters, R. and Vargas, V. (2000), "A typology of de-coupling strategies in mixed services", Journal of Operations Management, Vol. 18 No. 6, pp. 663-82.

Moore, J.F. (2006), "Business ecosystems and the view from the firm", Antitrust Bulletin, Vol. 51 No. 1, pp. 31-75.

Muffatto, M. (1999), "Platform strategies in international new product development", International Journal of Operations & Production Management, Vol. 19 Nos 5/6, pp. 449-59.

Pagh, J.D. and Cooper, M.C. (1998), "Supply chain postponement and speculation strategies: how to choose the right strategy", Journal of Business Logistics, Vol. 19 No. 2, pp. 13-33.

Pekkarinen, S. and Ulkuniemi, P. (2008), "Modularity in developing business services by platform approach", The International Journal of Logistics Management, Vol. 19 No. 1, pp. 84-103.

Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A. (2004), "Networking and innovation: a systematic review of the evidence", International Journal of Management Reviews, Vols 5/6 Nos 3/4, pp. 137-68.

Rantala, L. and Hilmola, O.-P. (2005), "From manual to automated purchasing. Case: middle-sized telecom electronics manufacturing unit", Industrial Management & Data Systems, Vol. 105 No. 8, pp. 1053-69.

Sanchez, R. and Mahoney, J.T. (1996), "Modularity, flexibility, and knowledge management in organization design", Strategic Management Journal, Vol. 17, pp. 63-76 (winter special issue).

Schilling, M.A. and Steensma, H.K. (2001), "The use of modular organizational forms: an industry-level analysis", Academy of Management Journal, Vol. 44 No. 6, pp. 1149-68.

Smith, H.E. (2006), “Modularity in contracts: boilerplate and information flow”, Michigan Law Review, Vol. 104 No. 5, pp. 1175-223.

Tinnilä , M. (2009), “A review of service frameworks analyzing strategic repositioning: the case of bank services”, accepted to the International Journal of Information Systems in the Service Sector (in press).

Tranfield, D., Denyer, D. and Smart, P. (2003), “Towards a methodology for developing evidence-informed management knowledge by means of systematic review”, British Journal of Management, Vol. 14, pp. 207-22.

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. 147-68.

Ulrich, K.T. (1995), “The role of product architecture in the manufacturing firm”, Research Policy, Vol. 24, pp. 419-40.

Ulrich, K.T. and Tung, K. (1991), “Fundamentals of product modularity”, Proceedings of the 1991ASME Winter Annual Meeting Symposium on Issues in Design/Manufacturing Integration, Atlanta, GA, pp. 1-14.

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. 261-9.

Voordijk, H., Meijboom, B. and de Haan, J. (2006), “Modularity in supply chains: a multiple case study in the construction industry”, International Journal of Operations & Production Management, Vol. 26 No. 6, pp. 195-219.

Voss, C.A. and Hsuan, J. (2009), “Service architecture and modularity”, Decision Sciences, Vol. 40 No. 3, pp. 541-69.

Zhang, A. (2008), “Examining product and process effects on consumer preferences for online and offline channels”, Business Process Management Journal, Vol. 14 No. 1, pp. 85-95.

Further reading

Bask, A., Tinnilä, M. and Rajahonka, M. (2010), “Matching service strategies, business models and modular business processes”, Business Process Management Journal, Vol. 16 No. 1.

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II

PAPER 2

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Views of logistics service providers on modularity in logistics services

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The objective of this paper is to increase understanding of the concept of service modularity and to present examples of applications of modularity approach in logistics services. This aim is pursued with an empirical case study, consisting of interviews of 25 logistics service providers (LSPs). Themes found in the literature are used in the interviews and in the analysis of the interviews. The findings show that the LSPs consider modularity as a useful approach, and examples of applications of modularity can be found in the logistics industry. In the future, modularity thinking has potential to become a valuable tool for responding to the challenges facing the logistics service industry, as customers' demands become increasingly diversified, and services, processes and organisational networks become more complex.

Keywords: logistics services; modularity; services; processes; networks

1. Introduction

The concept of modularity is over 40 years old, and in recent decades it has been one of the popular themes in the research and managerial literature related to many fields, including new product development, manufacturing and IT (Starr 1965, 2010). With modularity it has proved possible to achieve many benefits. These benefits include combining economies of scale with flexibility in cost-efficient customisation – 'mass customisation' (Momme, Moeller, and Hvolby 2000; Tu et al. 2004; Jose and Tollenaere 2005; Lau, Yam, and Tang 2007). Service industries have increased their share in the economy, and are currently looking for practical and useful tools and methods of analysis. Modularity has also been recognised as one of the possible means to meet customers' divergent requirements efficiently in the service sector (Voss and Hsuan 2009; Bask et al. 2010; de Blok et al. 2010; Starr 2010).

Despite the popularity of the concept of modularity, discussion about how the concept should be conceptualised or defined has not yet reached a consensus. Service modularity is a rather new research area, and it has inherited the vagueness of the concept (Voss and Hsuan 2009). The definition of service modularity is still far from clear or unambiguous, and even though service modularity may offer a richer research field than manufacturing modularity, examples of good practical applications are still hard to find (Starr 2010). However, it may be assumed that modularity principles have been in use also in service context, but without relying on academic rigor for planning and modelling, because this has happened also in manufacturing (Starr 2010). This

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paper tries to fill this research gap by increasing the understanding of the concept of modularity and its applicability in the service setting.

The research approach of this paper is empirical and it focuses on how the concept of modularity is understood and used in practice among logistics service providers (LSPs). A case study approach is used in the analysis of interviews of 25 Finnish LSPs about modularity and how modularity shows in logistics. Semi-structured interviews were conducted during spring and summer of 2009. The focus of this paper is on analysis of the questions related to modularity – how the LSPs understand the concept of modularity, if they perceive modules in logistics – for example, in service offerings, processes or organisations – or use modularity thinking in their own work and if and how modularity thinking could be used in logistics in the future, and whether it would be beneficial or not.

The research questions in this paper are as follows:

(1) What are the relevant themes discussed in the earlier literature of modularity, and how they are applicable to services and to this research setting?
(2) According to the views of logistics industry, how can the modularity approach be used in logistics and what does the industry think are the benefits and disadvantages of modularity in logistics?
(3) How does modularity feature in the current services, processes and company networks of the LSPs? Is the modularity approach used currently by the LSPs and what are its current applications?
(4) How is the concept of modularity understood or defined by the LSPs? How can the concept of modularity be defined in the logistics service setting, or more broadly, in the service setting?
(5) What are the future developments considering modularity in logistics? Do the LSPs consider the concept useful and worth using in the future?

In this paper, first in Section 2, the concepts and definitions related to modularity are briefly discussed based on the earlier research literature. After that, research methodology is discussed in Section 3. In Section 4, a summarising framework based on the earlier literature is presented, and is used in the analysis of the empirical material. After that follows discussion in Section 5. Finally, conclusions and implications for future research are presented in Section 6.

2. Literature review on the concepts and definitions related to modularity

In the literature, there is a quite widespread agreement on that modularity is a systems concept describing the relationships between components in the system. Another issue that is widely accepted is that modularity is a matter of degree, that is, modularity of a system may range from non-existent – when the system is highly integral – to highly modular (Brusoni and Prencipe 2001; Mikkola and Skjøtt-Larsen 2004; Salvador, Rungtusanatham, and Forza 2004; Ernst 2005). Often mentioned benefits of modularisation include larger product variety, improved flexibility, simplification of complex systems, cost savings, combining economies of scale and scope in cost-efficient customisation, i.e. 'mass customisation' (Liere van et al. 2004; Jose and Tollenaere 2005; Voss and Hsuan 2009).

In other respects, the concept has been defined and conceptualised in various ways. Attempts to define the concept of modularity unambiguously have faced difficulties (Salvador 2007; Campagnolo and Camuffo 2010). The difficulties at least partly result from the use of the concept in many different contexts (Campagnolo and Camuffo 2010; Starr 2010), as well as different levels of abstraction, and different disciplinary areas (Salvador 2007). Several research fields have defined and applied the concept to their own interest. Based on his thorough analysis, Salvador (2007)

even questions the existence of a single concept of modularity and concludes that the concept may encompass a number of different, but interrelated, concepts. Another observation mentioned in the literature is that the definition of a module has often been linked and confused with the benefits sought from modularity (Hölttä-Otto 2005).

Hölttä-Otto (2005) defines a module as 'an independent building block of a larger system with a specific function and well-defined interfaces'. Baldwin and Clark (2000) define a module as 'a unit whose structural elements are powerfully connected among themselves and relatively weakly connected to elements in other units'. This definition has been referenced frequently in the literature. Baldwin and Clark (1997, 2000) claim that modularisation requires making a distinction between visible design rules and hidden design parameters; the hidden parameters are encapsulated in the modules, but the visible rules are shared between companies.

The modularity concept has been analysed in three contexts in the earlier literature, namely the contexts of product; production or process; and organisation or supply chain (Salvador 2007). Finally, service modularity has been added to this list (Voss and Hsuan 2009; Bask et al. 2010). At least for the present, service modularity discussion is strongly connected to the discussion on product-related modularity. Like product modularity, service modularity can be discussed at different levels, that is, the service product level, service process level, and at the organisational and network level (Bask et al. 2010).

Modular products are often described consisting of loosely coupled components, so that products can easily be decomposed into modules and reconfigured – by mixing and matching the modules – to a wide variety of end products (Jacobs, Vickery, and Droge 2007). The interfaces between modules are highly standardised in modular products, and the interface constitutes the critical element (Voss and Hsuan 2009). The basic idea in modularisation is that a module can be detached and substituted in the product without affecting the thoroughly defined and standardised interfaces (Sanchez and Mahoney 1996; Mikkola 2006; Jacobs, Vickery, and Droge 2007; Salvador 2007; Campagnolo and Camuffo 2010). Standardisation of interfaces makes customisation possible, if the interfaces still allow for enough variations (Momme, Moeller, and Hvolby 2000). A service product module has been described as one or more service elements offering one service characteristic (Pekkarinen and Ulkuniemi 2008). In practice, if the services of a company can be sold separately or can easily be combined into different service packages, or are based on a basic service on which additional features can be added, this may indicate high degree of modularity of service products (Tu et al. 2004).

Production or process modularity refers to breaking down the production processes into sub-processes. Modular processes enable postponed manufacturing, shifting the final assembly into distribution centres or to the customer. Standard sub-processes can be placed before the customisation sub-processes to achieve flexibility (Mikkola and Skjøtt-Larsen 2004). Production and process modularity are made possible by standard interfaces between sub-processes, and this allows mixing and matching the elements in the production system (Tu et al. 2004). Process interfaces typically are not physical, but may include human interactions, information systems or contracts, etc. (Voss and Hsuan 2009). Service process modules have been defined as standardised, indivisible process steps (Pekkarinen and Ulkuniemi 2008). A modular service production process can be split into process modules that can be combined in different ways. In practice, processes can be seen as modular, if they can easily be broken down into sub-processes, or if the company has a core process, to which it combines process modules that are specific for different channels or customer groups.

In the recent decades, firms have increasingly outsourced functions and have begin to use organisational components that lie outside the firm. That is why it has been argued that modularity of the organisation and supply chain is increasing, and organisational systems are becoming increasingly modular (Schilling and Steensma 2001). Modular organisational forms may include contract manufacturing, alternative work arrangements and alliances (Schilling and Steensma

2001). There has been a vivid discussion in the research literature about the relation between product and organisational modularity, and this discussion is connected to the definitions of the concept of organisational modularity. One extreme is the research by Sanchez and Mahoney (1996), because they argue that 'products design organisations' and that modular products are produced through modular organisation structures. They and a few other researchers (Brusoni and Prencipe 2001; Liere van et al. 2004; Chesbrough and Prencipe 2008) also claim that a modular product architecture contains embedded coordination that defines the division of work between units. At the same time, it is rather common to describe the modular organisational structures as 'arm's length', or 'market-based' as opposite to integral structures (Ernst 2005; Jacobides 2005). To combine these lines of discussion it can be concluded that a successful division of labour both in a partner network and inside a company is based on accurate definitions about who does what for what cost and price, and how the work is performed and aggregated to accomplish a streamlined offering to the customer. In practice, companies can express different degrees of organisational modularity, for example, in their practices in the use of temporary workforce or outsourcing or in their relationships with partners.

It can be argued, that organisational modularity, in particular, should be analogical regardless whether the focal firm is in manufacturing or in service industry. Instead differences can be seen when comparing product modularity to service product modularity: an essential difference between product and service modularity is that service product modularity may have many of the characteristics of process modularity, and the interfaces between service modules are more often 'soft' or human interfaces than is the case with products (Voss and Hsuan 2009; Bask et al. 2010). This difference relates to the outcome-process duality of services discussed in the earlier literature (Grönroos 1998).

The themes discussed in the earlier literature that are relevant for the empirical part of this research can be summarised and categorised as: (1) definitions of modularity, (2) applicability of modularity in services, and its benefits and disadvantages, (3) applications of modularity in service products, processes, organisations and organisational networks and (4) future developments of modularity. In this paper, all these themes are discussed in the practical context of the logistics service industry. In the next section, the methodology and research sample are introduced.

3. Methodology

In this research, a case study approach (Yin 1984) is used to understand if and how modularity as presented in the literature transpires in practice in logistics services and logistics industry. Qualitative research methods are used because they have been proven to be useful when the goal, as in this research, is to develop understanding of real-world events and to generate and test a theory (Eisenhardt 1989; Voss, Tsikriktsis, and Frohlich 2002; Eisenhardt and Graebner 2007).

The empirical part of the paper is based on a sample of 25 Finnish LSP companies. The interviews were semi-structured and they were conducted during spring and summer of 2009. To get a general view of the industry, the selection of companies was made so that the sample would include different kinds of companies related to, for example, size, geographical range, services and operations of LSPs – road, rail and sea transport, forwarding, warehousing, value added logistics (VAL) services, etc. In the sample, there were both globally operating large multinational companies and locally operating small- and medium-sized enterprises (SMEs). The services of the interviewed companies were correspondingly emphasised on wide offerings, including integration of supply chains, or on rather narrow offerings, for example, concentrating on sub-contracting for larger LSPs. An overview of the sample is presented in Table 1.

Themes on modularity found in the literature and described in the previous section were used in the formulation of the interview questions and in the analysis of the interviews. In the interviews,

Table 1. Overview of the sample.

Interviewees	14 managing directors, 5 marketing/sales/development managers and 6 other
Company size	13 large, 5 medium and 7 small
Geographical range of the company	13 domestic and 12 international
Main services of the company	11 general transports, 8 multiple (transports, warehousing, VAL, etc.) and 6 other
Field of transportation-related services (if any)	19 road, 1 rail, 1 sea and 1 air

there were both open-ended questions and structured statements that required answering with a number (with a scale of 1 = totally disagree–7 = totally agree). The themes included definitions of modularity in logistics, applicability of modularity in logistics and benefits and disadvantages of modularity in logistics, modularity of service products, modularity of service processes, modularity of organisation and organisational networks, and future developments of modularity in logistics.

4. Views of LSPs on modularity

The relevant themes for this research related to service modularity discussed in the earlier literature are operationalised as presented in Table 2. These themes constitute the foundation of this paper, as they were discussed with the companies in the interviews and used in the analysis of the interview material.

Next, the interviews are analysed concentrating on modularity issues. In this section, the views of the LSPs about characteristics of modularity and interviewees' own definitions of modularity are discussed. This is followed by a discussion about the applicability of modularity approach in the service context and in particular in logistics, as well as benefits and disadvantages of modularity. After that service products and processes, and organisational and network structures of the LSPs are discussed regarding whether they express modularity and how. Finally, future expectations of LSPs about use of modularity in their own service products and logistics industry are presented.

4.1. *Defining modularity*

The interviewees were asked to formulate their own definitions of modules and modularity in the context of logistics services and their own work. Many of them did not want to define the concept before getting some focus, specification or clarification about the concept or the purpose of the research. In these situations, the interviewer pointed out that in manufacturing modularity principles have been used for a long time in creating products of modules, and that this has enabled cost-efficient customisation of products, wider division of labour in companies as well as outsourcing in company networks, and that the purpose of this research was to study if and how modularity principles can be used also in the service context.

As the company representatives formulated their own definitions of modularity, they brought up various themes and levels of abstraction, among them physical modularity, modularity in service products and processes, modularity of resources and in supply chain relationships, different hierarchy levels of modularity, etc. Most of these themes have been discussed in the earlier research literature. Some of the definitions and characteristics mentioned by the interviewees are gathered in Table 3.

Many interviewees wanted to make comparisons between the concepts of modularity and standardisation or even though that these concepts were synonyms: 'Modularity means that we

Table 2. Themes in the literature of modularity and operationalisation of them into questions presented in the interviews to the LSPs.

Theme in the literature of modularity	Open questions	Statements (scale 1 = totally disagree–7 = totally agree)
Definitions of modularity in logistics	What do you think modularity means in the logistics industry (where does it show; what are the dimensions of modularity?)	
Applicability of modularity in logistics and benefits and disadvantages of modularity in logistics	Which benefits does the modularity thinking bring or could bring? Does it enable quicker compilations of service solutions or duplication/scaling of services, etc.? Are there any disadvantages of modularity?	Modularity in logistics • It is possible to improve competitiveness by standardising parts of services • It is possible to separate elements from logistics services without losing functionality • Modular solutions are not suitable for the logistics industry
Modularity of service products	Does modularity show in your current services and service production?	Evaluate your services today • Our services are mainly standardised • Our services are mainly customised • Most of our services can be sold separately • Most of our services are based on a certain basic service on which additional services or additional features can be added • Our basic services can be combined into different service packages
Modularity of service processes	Does your company have divergent processes in the production of the services, for example, horizontally (customer groups) or vertically (for example, back office/front office)? Do you have descriptions of your service processes? Are the interfaces of the processes defined? Do you standardise your service processes?	Describe the service processes of your company • Our service processes are mainly repetitive and routine standard processes • Our service processes are tightly integrated with the processes of our most important customers • Our service processes are diverged according to the needs of different customer groups • Our service processes can be divided into separate sub-processes or process modules • There are comprehensive process descriptions of our service processes • Our different service processes can be easily coupled to each other
Modularity of organisation and organisational networks	Describe your company's position in the business network.	Describe your company's functions and role in the network of logistics service companies • We use temporary workforce to balance the fluctuations in demand • Our collaboration with other logistics service companies is mainly based on stable networks • We use subcontracting (services bought from other actors) in the production of our services • In the production of the services, we use only a couple of partners that in their part may use their own subcontractors • By networking we try to find ways to produce services more efficiently

(*Continued*)

Table 2. Continued.

Theme in the literature of modularity	Open questions	Statements (scale 1 = totally disagree–7 = totally agree)
Future developments of modularity	What kinds of services will you offer in the future? What kinds of challenges will be confronted in the industry in the future? What will be the most important sources of competitive advantage in the industry in the future?	How will your services develop in the next 3–5 years? • Our services are mainly standardised • Our services are mainly customised • Most of our services can be sold separately • Most of our services are based on a certain basic service on which additional services or additional features can be added • Our basic services can be combined into different service packages Describe the general development of the logistics industry in the future • Customers buying logistics services will buy larger entities than before • Customer needs will become more heterogeneous • The logistics companies will be expected to have deeper understanding of their customers' supply chains • The services offered will become more complex (they are produced by combining different kinds of resources and production inputs) • The challenges in the management of service chains will increase in the future, because the service chains will get more complex Modularity in logistics • Modular solutions will increase in the production of logistics services

act on the standard mode – there is a standard service and a standard process'. This way of thinking applied especially to standardisation of processes and interfaces. Others saw strong linkage between the concepts of modularity and mass customisation, and wanted to emphasise the opportunities for customisation emerging through the use of modularity principles. It can be argued that customisation in the customers' point of view is seen as important: one of the interviewed companies even stated 'The customer needs to feel that it is customised, even though when you think about production, it consists of modules'. One interviewee expressed this by saying that 'The point of view is crucial: our services are either totally standardised or totally customised, and also the totally customised services can be assembled from standard modules if you think about our internal operations'. These statements indicate that the service product or customer perspective has different logic concerning customisation than the service process perspective.

Also, productisation and a distinction between a basic service or process and modules as add-ons ('Modules are something extra you add onto a fixed basic process') were commonly mentioned characteristics of modularity in services or processes. This implies that the LSPs quite commonly use platform thinking related to their service products and processes. Only a few defined modularity principally through organisational modularity or division of labour in the organisation or organisational networks. An explanation for this may be that organisational relationships have traditionally been described with concepts relying on other theories, for example, network theories (Håkansson and Persson 2004; Ford and Håkansson 2006) or theories related to supply chains and their coordination (see review by Bahinipati, Kanda, and Deshmukh 2009), instead of modularity concepts. Aspects mentioned in connection to modularity by the interviewees that have not gained much attention in the research literature include physical resource perspective (i.e. resources

Table 3. Different views towards modularity presented in the interviews by the LSP companies.

View	Examples how the view is presented by interviewees
Service product view	'Modules are service packages of which different service solutions can be built' 'Modularity means that services are productised, and these modules can be combined. A basic module has a basic process. Value added services can be added to it' 'Modularized services are same as productised services' 'Modular services are built of building blocks, red blocks and then you put green blocks between them' 'Modules are service entities, components of logistics chain, which services are built of. A service is completed when every activity in the row has been completed. This is like connecting pieces of a puzzle together' 'Modularity means service entities or process components which can be picked from the toolbox and used to build a package according to the customer need'
Service process view	'Modules are standardised service entities, mode of transport, etc., that can be decoupled and coupled with each other' 'The processes can be broken up into parts: they consist of import and export processes, HR processes, IT processes, etc' 'There are modules like trunk haulage, pick-up and delivery transport, warehousing, etc. And these can be divided even into smaller components' 'Modularity means that you have uniform processes which have descriptions and which can be produced similarly regardless who produces them. A synonym is standardised. Processes can be linked with each other' 'Modularity is as a concept near standardisation: services are produced in a certain manner and the customer buys tickets' 'Modules are something extra you add on a fixed basic process' 'A route can be considered as a module and it can be cut out'
Organisation and organisational networks	'A module is a clearly staged work entity that can be linked to other entities' 'Modularity means division and connection of entities – it is something we have to consider as we grow: what to do self and what to outsource. If a work phase can be done in a separate business unit, it can be said to be a module. Thus, a module is an entity, the outcome of which we can measure and improve' 'Modularity means easy connectivity. Delivery clauses define interfaces between supply chain actors – when ownership shifts, who is in charge, etc.'
Other aspects	*Supply chain* 'We are a subcontractor, one module in our customers' supply chain' 'A customer's goods flow is a module' *Resources* 'As modules we have trucks and drivers and working hours which are stipulated by legislation' 'There are many modules in logistics: companies and harbours and other physical modules' 'The structure consists of modules: site, office, terminal hall, vehicles, containers, etc. There are internal modules and interfaces between them inside the corporation, and external modules outside the corporation' 'There are issues that have to be agreed on internationally, for example, sea containers'

seen as modules) and customers' supply chain perspective – that is, a few of the LSPs describe themselves as modules in their customers' supply chains.

4.2. *Applicability of modularity in the logistics industry and its benefits and disadvantages*

In this section, the applicability of modularity in the logistics service industry in general is discussed. Almost all of the interviewees expressed the feeling that modularity is a suitable approach for the logistics industry and also for services in general. Standardisation of parts of services was considered as an important method for reaching competitive advantage – only a couple of interviewees did not believe in this statement. The majority also considered that it is possible to separate elements from logistics services without losing functionality.

Benefits of modularity for the customer relationships mentioned by the interviewees include more options for the customer to choose from, and more rapid development of customer solutions. Also, efficiency and cost savings were mentioned as possible consequences of application of modularity. Some of the interviewees had a clear view of that, when solutions are built of modules, it is easier to respond to divergent needs of different customers or customer groups. The interviewees generally believe that modularity makes complex things easier to manage. One of the interviewees visualised this by saying that as the building blocks are defined, they can be attached to each other such as LEGO blocks, and the customer only decides the height of the tower to be built. Another interviewee claimed that even duplicating the whole of its service production system in another country would be easy, because all operations of the company in Finland are defined and standardised. According to the interviews, benefits of modularity in partner relationships come from the opportunity to outsource other than core business areas, and this leads to flexibility and efficiency. Also, better quality and better cost-efficiency were mentioned as benefits. Above-mentioned themes, including use of modularity to develop variety for customers, that is, for 'mass customisation', and management of complex systems with modularity by decomposing the systems into smaller parts, have been important themes discussed as benefits of modularity also in the literature (Starr 1965; Jose and Tollenaere 2005; Starr 2010).

Disadvantages are usually seen only if modularity thinking is excessive – according to the interviewees in these cases modularity could lead to inflexibility or disregard of the customer needs. One of the interviewees argued that it should always be possible to customise parts of the service process if the customer is willing to pay for it, for example, it should be possible to open up a container in a stop-over terminal and pick a parcel for express delivery if the customer has an urgent need of delivery. Another interviewee emphasised that if there are too many modules and too many options for the customer to choose from, it may lead to a complex system that is difficult to manage. Also, some of the interviewees saw dangers in excess division of labour combined with too little coordination as it can lead to sub-optimisations, 'grey areas' that are not cared for, or weak understanding of 'the big picture'. Answers of the LSPs to the statements about applicability of modularity in logistics and its benefits and disadvantages are presented in Table 4.

4.3. *Modularity of service products, processes, organisations and organisational networks of the LSPs*

Based on the interviews, the services of Finnish LSPs even today can be considered rather modular. Loose coupling of service modules seem to be a rather common and natural way of thinking. LSPs consider that their services can often be sold separately or combined into different service

Table 4. Answers of the LSPs to the statements about applicability of modularity in logistics and its benefits and disadvantages.

Applicability of modularity in logistics and benefits and disadvantages of modularity in logistics						
Modularity in logistics						
Scale 1 = totally disagree–7 = totally agree)	Average	Max	Min	Mode	*n*	Variance
It is possible to improve competitiveness by standardising parts of services	5.38	7	3	5	24	1.11
It is possible to separate elements from logistics services without losing functionality	4.96	7	3	5	24	1.09
Modular solutions are not suitable for the logistics industry	2.50	5	1	2	24	0.96

packages. Platform thinking is also commonly used, that is, the use of shared basic services to which additional services can be added (Pekkarinen and Ulkuniemi 2008).

LSPs have also informed us that widespread customisation seems to be somewhat unusual in logistics services. However, the LSPs do not think that their services are standardised, either. Interviews showed that wider service packages, for example, 3PL services, are more often customised for a particular customer than simpler services, for example, transportation services. There were many examples of modular customised value adding services offered by LSPs in the interview sample: there were, for example, companies offering re-fillings of sales displays, pre-delivery inspections or final assembly of vehicles, ticketing and labelling of products, and country-specific packing (adding manuals, etc.). On the contrary, in some cases in practice, the customer has very limited choice of services. For example, large amounts of heavy and bulk products are best suited for rail transportation. One interviewed company compared its trunk haulage service to commuter traffic, as the customer 'buys a ticket' to get goods on the long-distance truck which has regular routes every night. In these cases, the customer has no mixing-and-matching opportunities of service modules (as there are no modules to choose from), and the customer does not get – or even want – a profound customisation experience. Answers of the LSPs to the statements about modularity in their current service products are presented in Table 5.

It seems that the interviewed LSPs use mainly repetitive and routine standard processes that can be divided into separate sub-processes or process modules. One interviewed company maintained that, for example, a particular route can be seen as a module that can be added or removed. Using process modularity and repetitive standard process modules companies aim to achieve cost-efficiency and economies of scale. Based on the interviews, in the logistics sector one of the drivers towards standard processes is regulation, as authorities, especially in international trade but increasingly also in domestic trade, demand specified and formal processes. One of the interviewed companies even remarked that logistics companies too often track their own resources (trucks, etc.) instead of customers' goods, and wanted to describe the flow of goods of one particular customer as a process module.

Light customisation with customised process modules for a particular customer or customer group seems to be rather common. Divergence of service processes according to the needs of different customer groups is rather commonly used to achieve at least some level of customisation. One of the interviewed companies described customisation as 'seasoning': goods can be taken away from the standard process for 'seasoning', and after that they come back to the standard track. Another maintained that customisation usually is situated in the last mile, or in the beginning of the process, and the trunk haulage in the middle is always the same for every customer. However, some interviewees emphasised that customisation is done in customer-specific development projects ('Tailoring is done in the fitting') – if the customer, for example, outsources warehousing,

Table 5. Answers of the LSPs to the statements about modularity in their service products today.

Modularity in service products						
Evaluate your services today						
(Scale 1 = totally disagree–7 = totally agree)	Average	Max	Min	Mode	*n*	Variance
Our services are mainly standardised	4.25	7	2	5	24	2.54
Our services are mainly customised	4.16	7	2	3	25	2.56
Most of our services can be sold separately	4.88	7	1	6	24	3.33
Most of our services are based on a certain basic service on which additional services or additional features can be added	5.13	7	1	5	24	2.38
Our basic services can be combined into different service packages	5.08	7	2	5	24	1.99

the service has to be customised, and the customer's needs are translated into the language of implementation in a separate development project. These projects are always conducted case by case. In these cases, after the development project, the actual implementation of the customer-specific service can be based on standardised processes. LSPs consider that their processes are tightly 'integrated' with the processes of their most important customers, and this also implies a high level of customisation in production processes in relation to important customers. There are also other examples of situations where deeper customising reaches the processes: one interviewee from a 3PL company mentioned that, as they perform operations for firms that are each other's competitors, they use customers' own IT systems and have to have non disclosure agreement-bounded personnel dedicated for these customers. In these cases, one customer's goods flow is a separate module, but it cannot be combined freely with other modules to gain economies of scale.

Among the LSPs, there are clearly some development needs related to coupling of service processes, as many interviewees consider that coupling of their different service processes is not easy. Also, descriptions of service processes seem not to follow any industry standard, and there are many companies that do not have comprehensive descriptions of their processes. However, companies offering 3PL services mentioned that their customers ask for process descriptions and these are formulated later when contracts are negotiated. In the future, if 3PL services increase, process descriptions supposedly will become more common. Answers of the LSPs to the statements about modularity in their processes are presented in Table 6.

Organisational modularity – alternative work arrangements or subcontracting and partner networks (alliances) – is rather popular among Finnish LSPs. When analysing the responses company-by-company, it can be observed that use of temporary workforce is divergent: it is customary in warehousing and particularly related to goods that have clear high and low seasons, for example, groceries and other consumer goods. In contrast, for example, in harbours use of temporary workforce is very limited due to strong trade unions.

In most cases, partner networks of Finnish LSPs are rather stable, usually consisting of a larger focal company and many SMEs conducting rather simple and limited tasks, for example, basic transportation services. Even tiering – use of subcontractors that have their own subcontractors – is used, but it is not too common. Some of the interviewees reported that to some extent, even competitors are used as subcontractors in routine tasks. These cases include smoothing the impact of fluctuations in demand on capacity, or win–win situations, for example, exploiting the opportunity

Table 6. Answers of the LSPs to the statements about modularity in their processes.

Modularity in processes						
Describe the service processes of your company (By service processes we mean service production in your company and in your partner network)						
(Scale 1 = totally disagree–7 = totally agree)	Average	Max	Min	Mode	*n*	Variance
Our service processes are mainly repetitive and routine standard processes	5.04	7	2	5	25	1.62
Our service processes are tightly integrated with the processes of our most important customers	5.56	7	2	6	25	1.51
Our service processes are diverged according to the needs of different customer groups	4.76	7	2	5	25	1.86
Our service processes can be divided into separate sub-processes or process modules	5.16	7	2	6	25	2.06
There are comprehensive process descriptions of our service processes	4.84	7	1	6	25	2.89
Our different service processes can be easily coupled to each other	4.88	7	2	5	25	1.44

to achieve full truckloads when competitors' flows of goods are regularly directed towards opposite directions. Outsourcing and flexibility of contracts make it possible to add or remove even significant process modules or scale them up or down according to fluctuations in demand. However, usually the relationships between company partners are rather stable and dedicated, not as modular as described typical for modular networks in the literature, that is, temporary, 'market-based' or 'arm's length' (Ernst 2005; Jacobides 2005). Thus, using the classification presented by Momme, Moeller, and Hvolby (2000), in practice, the relationships between the LSPs and their partners are closer to strategic system sourcing than to mere make-or-buy decisions of components or use of capacity suppliers in outsourcing. These kinds of stable relationships between companies are strategic partnerships or can even resemble relationships between an employer and an employee. According to the interviews, an important driver for using partner networks in service production is more efficient service production, but new ways to produce services are also sought. Answers provided by the LSPs to the statements about organisational modularity are presented in Table 7.

4.4. *Future developments*

In the future, the LSPs aim to pursue increased standardisation of services but also aim towards wider customisation of services. A possible explanation for this apparent contradiction is that on the one hand the companies seek economies of scale and standardisation of processes, but on the other hand they also need to fulfil the divergent needs of customers, because customisation will be important from the customers' perspective. One of the interviewed companies expressed this view by saying that 'the customer always has to feel pure joy and pleasure, because the service seems to be just fit for him or her, even though the service actually is produced from rather standard modules'. The LSPs also consider that in the future their own services will express additional modularity as their services can be more often than today based on basic services to which additional services can be added, sold separately or combined into different service packages.

There are a few drivers in the logistics industry that affect the significance of modularity in the future. First, competition and technological change are issues that in the literature have been proved to be drivers towards increasing organisational modularity (Schilling 2000), and the interviewees expect these to increase. Second, the LSPs are rather unanimous that in the future customers will be willing to buy larger service entities, leading to increased demand for 'turn-key logistics solutions' and 3PL services. According to the expectations of the companies, this will lead to

Table 7. Answers of the LSPs to the statements about modularity in their organisational networks.

Modularity in organisational networks						
Describe your company's functions and role in the network of logistics service companies						
(Scale 1 = totally disagree–7 = totally agree)	Average	Max	Min	Mode	*n*	Variance
We use temporary workforce to balance the fluctuations in demand	4.42	7.0	1	6	24	3.56
Our collaboration with other logistics service companies is mainly based on stable networks	4.96	7.0	1	6	25	2.04
We use subcontracting (services bought from other actors) in the production of our services	5.76	7.0	1	6	25	1.77
In the production of the services, we use only a couple of partners that in their part may use their own subcontractors	4.28	7.0	1	5	25	2.63
By networking we try to find ways to produce services more efficiently	5.60	7.0	2	6	25	1.25

more complex services and service production networks, as more network partners are needed for the implementation of wider service entities. At the same time, customer needs will become more heterogeneous, and logistics companies will be expected to have deeper understanding of their customers' businesses and supply chains. This inevitably will lead to increased demand for customisation of services. Relying on literature, it can be claimed that both the increasing complexity and the demands for deeper customisation can be managed cost-efficiently with modularity principles (Jose and Tollenaere 2005). In fact, the Finnish LSPs seem to think that modular solutions will increase in production of logistics services in the future – only six respondents did not believe in this. However, rather high variance concerning this question shows that there are divergent opinions. One possible explanation for this is – if and as it may supposed based on the interviews, many of the respondents consider modularity as a synonym to standardisation – that the respondents are actually evaluating here whether standardised solutions will increase in the future or not. As the logic for customisation differs between the service production point of view and the customer point of view, this is a difficult question to answer.

The interviews confirm that modularity thinking is a useful approach in logistics and by using it competitive advantages may be reached, and the use of modularity will increase in the future. One interviewee from a 3PL company even claimed that the modularity approach until now has not been commonly used in the logistics industry, but it will become more popular after a generation shift in the industry. Answers of the LSPs to the statements about future developments of their own service products and modularity in the logistics industry are presented in Table 8.

Table 8. Answers of the LSPs to the statements about future developments of their own service products and modularity in the logistics industry.

Modularity in service products						
How will your service products develop in the next 3–5 years?						
(Scale 1 = totally disagree–7 = totally agree)	Average	Max	Min	Mode	*n*	Variance
Our services are mainly standardised	4.57	7	2	6	23	0.32
Our services are mainly customised	4.84	7	3	5	25	0.68
Most of our services can be sold separately	5.17	7	2	6	24	0.29
Most of our services are based on a certain basic service on which additional services or additional features can be added	5.29	7	1	6	24	0.17
Our basic services can be combined into different service packages	5.54	7	3	6	24	0.46
Future developments of modularity in logistics						
Describe the general development of the logistics industry in the future						
Customers buying logistics services will buy larger entities than before	5.54	7	4	6	24	0.78
Customer needs will become more heterogeneous	5.00	7	2	5	24	1.39
The logistics companies will be expected to have deeper understanding of their customers' supply chains	6.21	7	4	7	24	0.69
The services offered will become more complex (they are produced by combining different kinds of resources and production inputs)	5.17	7	3	6	24	1.36
The challenges in the management of service chains will increase in the future, because the service chains will get more complex	5.46	7	3	5	24	1.13
Modularity in logistics						
Modular solutions will increase in the production of logistics services	4.92	7	1	5	24	1.47

5. Discussion

As mentioned also in the literature, the concept of modularity seems to be intuitively familiar to people, and at first sight simple and straightforward (Starr 2010). Some of the interviewed representatives of LSPs used examples from other fields of life to describe modularity; some mentioned LEGO blocks as examples of modules. In other words, the concept as such was generally understandable for most of the interviewees, and they seemed to think that it could also be used in logistics. However, modularity is a multidimensional concept, or as Starr (2010) describes it, 'a splintered concept with a variety of inchoate offshoots', and examples of good applications are somewhat surprisingly hard to find (Starr 2010). This ambivalence could also be seen in our sample, and the multidimensionality of the concept makes discussions with the practitioners challenging.

The empirical approach used in this research of searching for practical definitions of modularity combined with the current state analysis of its applications in the logistic service industry proved to be rather fruitful, but also confusing. As the research is of an explorative nature, the interviewers did not want to give any predetermined definitions of modularity to the interviewees. Thus, the interviewers and interviewees had no clear and mutually agreed framework of concepts, and due to this the discussions leant, on the one hand, on the language used by the interviewees and on the other hand, the concepts presented in the earlier research literature on modularity. These concepts include among others modules and modularity, but also standardisation, customisation and interfaces between modules, processes and organisations. The reason for the fruitful confusion was the diversified and even opposite perceptions of the concept of modularity and its applications among the practitioners. One example of this is that some observers tend to perceive modularity strictly as standardisation ('Benefits of modularity are increased efficiency and profitability; you don't need to think all over again about what you need to do each and every time'), and others as customisation ('I see modularity as flexibility and possibility to offer unique service solutions and that we do not do standard tasks'). Afterwards, when conducting more thorough literature reviews on modularity, a comparable ambivalence was found also in the research literature.

Another similarity found both in the research literature and practical views of the interviews is that when speaking about modularity, multiple perspectives or levels of abstraction are used, and that the perspective or level used is not always explicitly expressed. Thus, the interviewees talk about customer perspective, about company's own processes, and even about the network through which the services are produced. However, service modularity has one more characteristic that increases challenges in discussions; many interviewees used 'a service (product)' as a synonym of 'a service process'. One of the interviewees even used the expression 'productised service processes'. This indicates the product-process duality that is characteristic for services and has been discussed in the earlier service and modularity literature (Grönroos 1998; Bask et al. 2010). It can be maintained that in practice service products and processes cannot be strictly separated.

The interviews with the LSPs reinforce the perceptions presented in the literature about the multidimensionality of the concept of modularity. As a consequence, any definition of modularity should be loose enough not to narrow down the discussion too much. To summarise, based on the literature review and the interviews of the LSPs *a module can be defined as a relatively independent part of a system with a specific function and standardised interfaces, where the system can be, for example, a service, a service production process or an organisation or a network of organisations.*

As mentioned earlier, the interviewed LSPs consider modularity to be a useful approach. Moreover, the LSPs seem to believe that the use of modularity approach will become more common in the future, as services will become more diverse and demands of customisation increase, and also service production networks will become more complex. Many interviewees expect that through modularity thinking, competitive advantages may be reached. However, for several reasons application of the modularity approach is challenging in the service setting. One reason is the vagueness

of the modularity concept, as the concept can be understood in different ways. Another reason is that as services and service processes are in practice difficult to separate, service modularity resembles process modularity and is a more complicated issue than product modularity. Furthermore, because all of the process steps have to be completed – and usually in a certain order – before the goods are delivered to the customer, the entity of processes in logistics resembles a jigsaw puzzle rather than a building built of LEGO blocks. It can also be claimed that from the LSPs perspective logistics processes typically are more customised at the beginning and at the end of the process, and standardised in the middle of the process, and that is why easy and light mass customisation usually cannot be reached in logistics simply by using postponement principles as in manufacturing, i.e. placing standard sub-processes before the customisation sub-processes. Comparable observation about differences in service and manufacturing modularity in relation to customisation has been made by de Blok et al. (2010) who claim that in case of elderly care early client involvement tends to lead to lower levels of customisation, but late client involvement offers opportunities for higher level of customisation.

Only a few of the interviewees thought that the concept of modularity was too theoretical to be of any use in logistics or related to their own services. However, only three of the interviewees reported that they had actually used modularity as a tool in their own work to date. Many interviewees expressed that they had never thought about their services or operations through the concept of modularity before, but at the same time, that their own services, processes and networks actually could be analysed using modularity thinking. As mentioned by Momme, Moeller, and Hvolby (2000), an important benefit of modularisation is that it increases the ability to distinguish between strategic issues – built on core competencies and critical capabilities – and nonstrategic issues. This is one reason why it can be concluded that modularity thinking has a lot of unused potential in the context of services.

6. Conclusions and future research

The aim of this research has been to increase understanding of the concept of service modularity and to present examples of applications of modularity approach in logistics services. The current state of the logistics industry related to modularity has been examined, that is, whether the companies use a modularity approach in their work and if and how modularity thinking could be applied in logistics. The empirical case study approach was based on interviews of 25 LSPs operating in Finland.

In the interviews, in general, it became apparent that most of the LSPs think that modularity is a useful mindset. The interviewees' own definitions of the concept of modularity included multiple perspectives or levels of abstraction reflecting the multidimensionality of the concept. The results show that the services and service processes of Finnish LSPs even today can be considered rather modular: the logistics services often are based on a basic service on which additional features can be added, or can be sold separately or combined into different service packages, and the service processes are mainly repetitive and routine standard processes that can be divided into separate sub-processes or process modules. Organisational modularity is also common, and alternative work arrangements or subcontracting and partner networks (alliances) are used among Finnish LSPs. However, in particular the potential in modularity in the partner networks of the LSPs is not employed in its extreme, because the networks are in most cases rather stable.

The companies agree on that customers will have increasingly diversified needs in the future, and at the same time, the service production and production networks will become more complex. These challenges also apply to service industries in general. When navigating in a business environment, including increasingly complicated service product, service production and network entities and requirements for deeper customisation of services, a modularity approach may become

extremely beneficial. Modularity perspectives are also useful for analysing, planning, developing and testing services, production processes and organisational networks. In other words, modularity thinking can be seen as a useful tool for responding to the future challenges facing the logistics service industry.

As this research has been of an exploratory nature and can be seen as one of the first steps towards understanding modularity in the service setting, interesting themes for future research have emerged. These themes include whether there is a particular type of modularity that is applicable only for logistics or services, and whether the use of a modularity approach enhances profitability and company success. The findings of our research do imply that there are aspects related to modularity that typically relate to logistics services and to services in general. One of the issues, as discussed earlier, is that in the service sector context, service product modularity is closer to process modularity than in the physical product context, and these modules cannot be mixed and matched as freely as can be done for modules in physical products. Another issue is the importance of the interfaces, as brought up by many of the interviewees. The importance of interfaces is understandable because logistics is an industry involving multiple network partners often operating around the globe. One of the interviewees even compared logistics to a relay race, where the baton should be handed over smoothly to the next runner. Interfaces are not a new theme in logistics but as complexity and networking increases and well-defined interfaces become more and more important, the modularity approach may bring new perspectives to the discussion on interfaces. Unfortunately, this research, due to its exploratory nature and methods, cannot give answers to the question on the relationship between modularity and profitability. Effects of modularity on profitability, the characteristics of process modularity and interfaces between modules are certainly themes that should be studied more thoroughly in the future in the service context.

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References

Baldwin, C. Y., and K. B. Clark. 1997. “Managing in an Age of Modularity.” *Harvard Business Review* 75 (5): 84–93.
Baldwin, C. Y., and K. B. Clark. 2000. *Design Rules: The Power of Modularity*. Vol. 1. Cambridge, MA: MIT Press.
Bahinipati, B. K., A. Kanda, and S. G. Deshmukh. 2009. “Coordinated Supply Management: Review, Insights, and Limitations.” *International Journal of Logistics: Research & Applications* 12 (6): 407–422.
Bask, A., M. Lipponen, M. Rajahonka, and M. Tinnilä. 2010. “The Concept of Modularity: Diffusion from Manufacturing to Service Production.” *Journal of Manufacturing Technology Management* 21 (3): 355–375.
de Blok, C., K. Luijkx, B. Meijboom, and J. Schols. 2010. “Modular Care and Service Packages for Independently Living Elderly.” *International Journal of Operations & Production Management* 30 (1): 75–97.
Brusoni, S., and A. Prencipe. 2001. “Unpacking the Black Box of Modularity: Technologies, Products and Organisations.” *Industrial and Corporate Change* 10 (1): 179–205.
Campagnolo, D., and A. Camuffo. 2010. “The Concept of Modularity in Management Studies: A Literature Review.” *International Journal of Management Reviews* 12 (3): 259–283.
Chesbrough, H., and A. Prencipe. 2008. “Networks of Innovation and Modularity: A Dynamic Perspective.” *International Journal of Technology Management* 42 (4): 414–425.
Eisenhardt, K. M. 1989. “Building Theories from Case Study Research.” *Academy of Management Review* 14 (4): 532–550.
Eisenhardt, K. M., and M. E. Graebner. 2007. “Theory Building from Cases: Opportunities and Challenges.” *Academy of Management Journal* 50 (1): 25–32.
Ernst, D. 2005. “Limits to Modularity: Reflections on Recent Developments in Chip Design.” *Industry and Innovation* 12 (3): 303–345.
Ford, D., and H. Håkansson. 2006. “IMP – Some Things Achieved: Much More to Do.” *European Journal of Marketing* 40 (3/4): 248–258.
Grönroos, C. 1998. “Marketing Services: The Case of a Missing Product.” *Journal of Business & Industrial Marketing* 13 (4/5): 322–338.

Håkansson, H., and G. Persson. 2004. Supply Chain Management: The Logic of Supply Chains and Networks." *International Journal of Logistics Management* 15 (1): 11–26.

Hölttä-Otto, K. 2005. "Modular Product Platform Design." TKK Dissertations 10, Department of Mechanical Engineering, Machine Design, Helsinki University of Technology, Espoo.

Jacobides, M. G. 2005. "Industry Change Through Vertical Disintegration: How and Why Markets Emerged in Mortgage Banking." *Academy of Management Journal* 48 (3): 465–498.

Jacobs, M., S. K. Vickery, and C. Droge. 2007. "The Effects of Product Modularity on Competitive Performance. Do Integration Strategies Mediate The Relationship?" *International Journal of Operations & Production Management* 27 (10): 1046–1068.

Jose, A., and M. Tollenaere. 2005. "Modular and Platform Methods for Product Family Design: Literature Analysis." *Journal of Intelligent Manufacturing* 16 (3): 371–390.

Lau, A. K. W., R. C. M. Yam, and E. P. Y. Tang. 2007. "Supply Chain Product Co-Development, Product Modularity and Product Performance: Empirical Evidence from Hong Kong Manufacturers." *Industrial Management & Data Systems* 107 (7): 1036–1065.

Liere van, D. W., L. Hagdorn, M. R. Hoogeweegen, and Vervest, P. H. M. 2004. "Embedded Coordination in a Business Network." *Journal of Information Technology* 19 (4): 261–269.

Mikkola, J. H. 2006. "Capturing the Degree of Modularity Embedded in Product Architectures." *Journal of Product Innovation Management* 23 (2): 128–146.

Mikkola, J. H., and T. Skjøtt-Larsen. 2004. "Supply-Chain Integration: Implications for Mass Customisation, Modularisation and Postponement Strategies." *Production Planning & Control* 15 (4): 352–361.

Momme, J., M. M. Moeller, and H.-H. Hvolby. 2000. "Linking Modular Product Architecture to the Strategic Sourcing Process: Case Studies of Two Danish Industrial Enterprises." *International Journal of Logistics: Research and Applications* 3 (2): 127–146.

Pekkarinen, S., and P. Ulkuniemi. 2008. "Modularity in Developing Business Services by Platform Approach." *The International Journal of Logistics Management* 19 (1): 84–103.

Salvador, F. 2007. "Towards a Product Modularity Construct: Literature Review and Reconceptualization." *IEEE Transactions on Engineering Management* 54 (2): 219–240.

Salvador, F., M. Rungtusanatham, and C. Forza. 2004. "Supply-Chain Configurations for Mass Customisation." *Production Planning & Control* 15 (4): 381–397.

Sanchez, R., and J. T. Mahoney. 1996. "Modularity, Flexibility, and Knowledge Management in Organisation Design." *Strategic Management Journal* 17 (Winter): 63–76.

Schilling, M. A. 2000. "Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity." *Academy of Management Review* 25 (2): 312–334.

Schilling, M. A., and H. K. Steensma. 2001. "The Use of Modular Organisational Forms: An Industry-Level Analysis." *Academy of Management Journal* 44 (6): 1149–1168.

Starr, M. K. 1965. "Modular Production – A New Concept." *Harvard Business Review* 3 (1): 131–142.

Starr, M. K. 2010. "Modular Production – A 45-Year-Old Concept." *International Journal of Operations & Production Management* 30 (1): 7–19.

Tu, Q., M. A. Vonderembse, T. S. Ragu-Nathan, and B. Ragu-Nathan. 2004. "Measuring Modularity-Based Manufacturing Practices and Their Impact on Mass Customisation Capability: A Customer-Driven Perspective." *Decision Sciences* 35 (2): 147–168.

Voss, C. A., and J. Hsuan. 2009. "Service Architecture and Modularity." *Decision Sciences* 40 (3): 541–569.

Voss, C., N. Tsikriktsis, and M. Frohlich. 2002. "Case Research in Operations Management." *International Journal of Operations & Production Management* 22 (2): 195–219.

Yin, R. 1984. *Case Study Research: Design and Methods*. Newbury Park, CA: Sage.

PAPER 3

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Framework for modularity and customization: service perspective

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Abstract

Purpose – Modularity has been identified as one of the most important methods for achieving mass customization. However, service models that apply varying levels of modularity and customization also exist and are appropriate for various business situations. The objective of this paper is to introduce a framework with which different customer service offerings, service production processes, and service production networks can be analyzed in terms of both modularity and customization.

Design/methodology/approach – The paper builds theory and offers a systematic approach for analyzing service modularity and customization. To illustrate the dimensions of the framework, the authors also provide service examples of the various aspects.

Findings – In the previous literature, the concepts of modularity and customization have often been discussed in an intertwined manner. The authors find that when modularity and customization are regarded as two separate dimensions, and different perspectives – such as the service offering, the service production process, and the service production network – are combined we can create a useful framework for analysis.

Research limitations/implications – Rigorous testing is a subject for future research.

Practical implications – The framework helps companies to analyze their service offerings and to compare themselves with other companies. It seems that in practice many combinations of modularity and customization levels are used in the three perspectives.

Originality/value – This paper develops a framework for analyzing service offerings in terms of modularity and customization. The framework provides a basis for analyzing different combinations of these two aspects from the three perspectives, and herein lies its value.

Keywords Customer service management, Service systems, Networks, Supplier relations, Mass customization

Paper type Research paper

An executive summary for managers and executive readers can be found at the end of this article.

Introduction

The growing significance of services in the global economy, combined with the growing divergence of customer needs, have led to demands for services that are more efficient and based on customer needs. Mass customization has been one production strategy for achieving cost-efficient customization, and modularity has been recognized as an important means for enabling it. Today, the business excellence of a firm is often defined by its flexibility and responsiveness to customer needs. However, it is not always in the business interests of a firm to have customized offerings, as demand for them has to exist for a mass customization strategy to be successful (Da Silveira et al., 2001; Womack, 1993). It is important to recognize when mass customization is a feasible objective and to understand that despite its popularity it is not a panacea (Womack, 1993). What means could then be applied to analyze service models more comprehensively, taking into account other alternatives than mass customization? On the other hand, in the literature of modularity, there has recently been a call for frameworks examining the perspectives of modularity in a more comprehensive way than just in one perspective, for example product or organization (Campagnolo and Camuffo, 2010).

To address this research gap, we develop a framework discussing the degrees of customization and modularity separately, leading to combinations also other than mass customization. Examination of service models of companies in a framework that separates the degree of modularity and customization seems also theoretically worthwhile: in the previous literature, the objectives of customization and exploitation of modularity strategies often seem to go hand in hand (Jacobs et al., 2007; Fixson, 2006). As for considering different perspectives of modularity in a holistic way, the framework includes three perspectives in which these dimensions are discussed: 1 service offering; 2 service production; and 3 production network.

Using the automotive industry as an example, we illustrate how the same service offerings can vary with respect to the degree of modularity and customization in the three perspectives. The automotive industry is an illustrative example: there is a lot of material available describing the industry and it also offers a good example of how physical goods become more and more service-oriented by involving different ways to include the customer perspective in the offering.

Accordingly, the service component is considered in this paper to consist of customer involvement and the way that the services and products are offered to customers through the production process and network. We acknowledge three key perspectives at the customer interface creating the service

component: service offering indicating how the products and services are offered to the customer and service production processes as well as service production networks (outsourcing, in-house operations) for achieving the customer offerings.

Methodology

There is growing interest in issues related to modularity, and especially how modularity can benefit research and practical service implementation. There currently seems to be only limited literature available on modularity concerning services and service operations (Bask et al., 2010).

The key objective of this paper is in theory building, i.e. in creating a framework for systematic analysis of modularity and customization from the service perspective. The framework has been constructed on the basis of literature on modularity and customization. Additionally, we offer examples from automotive industry to illustrate four key combinations of service modularity and customization from the three points of view. The automotive industry has been widely studied (e.g. Collins et al., 1997; van Hoek and Weken, 1998; von Corswant and Fredriksson, 2009; Fredriksson and Gadde, 2005; Doran et al., 2007; Ro et al., 2007; Lim et al. 2009), including different points of view, and it thus offers a rich base of secondary material for use. To provide examples, we have used academic articles (see references), material that is publicly available (web pages, articles, etc.), and our own knowledge. Our objective is to illustrate the different positions with descriptive, well-known and easy-to-understand examples, rather than to conduct full-scale case studies.

The examples were chosen so that distinctive service models regarding the issues of the framework would be represented. The information was gathered from the internet and academic articles. The purpose was to find information on the specific issues that would illustrate the logic, i.e. how different service models can be distinguished with the framework.

Literature on modularity and customization

Traditionally, modularity research literature has focused on products and product design (Fixson, 2006; Campagnolo and Camuffo, 2010) and the concept has diffused to process and organizational issues related to manufacturing and delivery of products, and finally to supply chains and related service production networks. The service branch of modularity research has its roots in the software industry. These approaches have gradually converged and become overlapping. Customization has become more important in recent years as customer needs have become more divergent. In the manufacturing context, customization is often discussed as "mass customization", in which modularity is one of the basic means enabling cost-efficient customization. In the service context, it can be argued that customization has been more of a typical modus operandi over the years, whereas mass production of services is still rather unusual.

The concept of modularity

Benefits of modularity have been extensively discussed in the literature. They include cost savings, ability to offer product variety, enhanced flexibility and simplification of complex systems (Jose and Tollenaere, 2005; van Liere et al., 2004; Pekkarinen and Ulkuniemi, 2008, Bask et al., 2010). However, because of its use in different contexts, the meaning of modularity has not been altogether clear (Campagnolo and Camuffo, 2010), which may be due to the different levels of abstraction or to the different disciplinary areas in which modular systems are discussed (Salvador, 2007). Of the many definitions of modularity, Baldwin and Clark's (1997) is used frequently: "Building a complex product or process from smaller subsystems that can be designed independently yet function together as a whole". According to Ulrich and Tung (1991) and Ulrich (1995), if a product is modular there is a one-to-one or many-to-one equivalency between its functional and physical structures.

Simon (1962) argued that complex systems often have a hierarchical structure with subsystems whose internal links are stronger than the linkages between the subsystems. Characteristics related to the concept of modularity include for example avoidance of creating strong interdependencies between specific components within the product. Such "loose coupling" allows "mixing and matching" of modular components within modular product architecture and enables a large number of product variations with distinctive functionalities, features or performance levels. They can be achieved by substituting modular components into the product architecture without having to redesign other components (Sanchez and Mahoney, 1996). A modular architecture also enables companies to upgrade their products throughout their life cycle (Brusoni and Prencipe, 2001).

There is a great variety of approaches for measuring, creating, using, and testing of modularity related concepts. Closely related concepts of modularity are for example commonality, product platform, product family, or standardization (Fixson, 2006). Interconnection between the concepts of modularity

and standardization has been strong (Fixson, 2006; Jacobs et al., 2007). Fixson (2006) maintains that the discussion of modularity and communality in the literature overlaps, as for example component similarity across products is mentioned in references describing modularity. Moreover, commonality, and modularity descriptions often refer to a combinatorial element where modules can be mixed and matched to create new variants of a product. Also, it has been stated that "there is a consensus among several researchers that standardization and product modularity are conceptually inseparable" (Jacobs et al., 2007). The interconnection of standardization – or its near opposite, customization – and modularity is an expression of the fact that modularity has been closely related to mass- customization strategies. However, we maintain that it is fruitful to study these concepts separately to identify their self- contained domain.

Process modularity enables breaking down the process into standard sub-processes and customization sub-processes, and to place the standard sub-processes before the customization sub-processes to achieve maximum flexibility. Postponed manufacturing shifts the final assembly to distribution centers and even customer sites. This makes a quick response to changing customer requirements possible. Workstations and units can be flexibly added, removed, or rearranged to create different process capabilities if the assembly lines are modular (Tu et al., 2004).

In addition to service production and product modularity, this paper deals with service production network modularity. Network and supply chain modularity are related to the discussion of vertical disintegration. Some authors, for example Schilling and Steensma (2001), argue that organizational structures are becoming increasingly modular: as firms in a given industry begin to outsource functions the entire production system becomes increasingly modular. According to them firms use three primary ways of loose coupling: 1 contract manufacturing; 2 alternative work arrangements; and 3 alliances.

Modular supply chains make substitution and creation of supply chain variations possible (Voordijk et al., 2006).

Modular organizational structure can be understood in two ways: network modularity is related to the position of the boundaries of a firm and the production outsourcing network, while organizational modularity has to do with, for example, virtual learning organizations (Campagnolo and Camuffo, 2010). Supply chain modularity has been associated with "loosely coupled" modular product architectures that allow a division of labor and outsourcing of tasks across firms and supply chain variations, even leading to modular structures at the industry level. However, there is no consensus on whether the modular structures themselves encompass the means of "embedded" coordination and facilitate management of complex supply chains and if so, how this takes place. For example, Brusoni and Prencipe (2001) argue that systems integrators are needed to manage actors and activities and to coordinate the required knowledge.

Although there seems to be a unique connection between the modularity of products and production systems (Campagnolo and Camuffo, 2010), some authors have been skeptical of whether modular products actually lead to modular organizations: in a study of notebook computer manufacturers, Hoetker (2006) finds that while product modularity leads to more reconfigurable organizations, it contributes less or not at all to the development of outsourcing activities. It seems that modularity at different levels – product or service, process and organizational or production network level – should be discussed separately as high degree of modularity at product or process level does not lead straightforwardly to a high degree of modularity at the organizational or network level, and the measures related to modularity at different levels are different.

As for services, themes that have commonly been related to service modularity are for example packaging of functionalities, standardization of interfaces, and reusability and substitution of modules. The origin of modularity has been seen as strongly connected to increased automation of service processes and the use of IT in business (Bask et al., 2010). Pekkarinen and Ulkuniemi (2008) identify the 3Ds of modularity, which are modularity in services, processes, and organization.

The concept of customization

Lampel and Mintzberg (1996) argue that in the continuum between customization and standardization, customization logically begins from a value chain's downstream activities, while standardization starts from its upstream activities. The authors identify five distinct categories on the standardization- customization continuum. In the first type, pure standardization, there is no customization. In the other types, customization reaches distribution, assembly, fabrication, and finally design. According to the authors, the alternative in which the product is assembled to order (customization reaching assembly stage) could also be called modularization.

Bask (2001) investigates the interrelations between customization and supply chain strategies. She presents three supply chain strategies – i.e. direct, stop-over and assembled-stop-over – and maintains that the assembled- stop-over supply chain strategy contains the manufacturing postponement strategy, matching with customized logistics services where light manufacturing, assembly, ticketing, and labeling can be carried out in a decentralized or centralized logistics service provider's warehouse.

Fredriksson and Gadde (2005) maintain that modularity and build-to-order production are key features of customizing. Mass customization is applied in order to achieve both economies of scope and scale while offering customized products (Mikkola and Skjøtt-Larsen, 2004; Pine, 1993). Pine (1993) defines mass customization as a strategy enabling the low-cost production of high-variety, even individually customized goods and services. Modularity is an important aspect for realizing mass customization (Pine, 1993; Duray et al. 2000).

While considering customization and modularity essential features in mass customization, Kumar (2004) also includes manufacturers that deliver an entirely customized product at affordable cost through customer co-design in the group of mass customizers (e.g. with the help of scanning machines). Gilmore and Pine (1997) identify four distinct approaches to customization that refer to the degree of product change and representation to the customer: 1 collaborative; 2 adaptive; 3 cosmetic; and 4 transparent. In service production, customization has been studied since the work of Maister and Lovelock (1982).

Duray et al. (2000) and Duray (2002) also identify types of mass customizers: fabricators; involvers; modularizers; and assemblers. They argue that identifying the point of customer involvement is essential for determining the degree of customization: the deeper customer involvement goes in the production cycle, the higher the degree of customization is. They also point out that offering great variety is not the same as customization. Fixson (2006) explains the difference between variety and customization: the idea of product variety is to offer the customer multiple options, but product customization aims to offer each customer exactly the wanted product. He also states that the insight behind mass customization is that a customer does not want product variety per se but rather his own version of a product. Modularity bounds the degree of customization of the product and so distinguishes mass customization from pure customized products, as modularity restricts the range of possible customer choices (Duray et al., 2000; Duray, 2002).

The discussion on customization is also related to the so-called order penetration point (OPP) or customer order decoupling point, i.e. the point in the manufacturing value chain where a product is linked to a specific customer order. Different manufacturing logics such as make-to-stock (MTS), assembly-to-order (ATO), make-to-order (MTO) or engineer-to-order (ETO) relate to different positions of the OPP (Olhager, 2003). Olhager (2003) reflects on factors affecting the position of OPP and maintains that if the customization offered is extensive and at early production stages, a make-to-order policy is necessary, whereas if customization enters at a very late production stage, assembly-to-order may be more appropriate.

This study uses customer involvement as a primary criterion to measure the degree of customization in relation to the service production perspective. To capture the different strategies available for customization, the concept of customization should be discussed from the customer, service production and production network perspectives. Also, the measures related to customization may be different for these perspectives.

Developing the framework

There is quite an extensive literature related to the special characteristics of services. The recent literature more often emphasizes the similarities between product and service characteristics than the differences, for example that services can be mass produced and that the heterogeneity of services can be controlled through standardization of service modules, quality measures, and automation of service functions (Araujo and Spring, 2006). Increased overlapping of concepts and frameworks related to services and physical products can also be seen in concepts such as productization of services and servitization of products (Vandermerwe and Rada, 1988). In addition, customer involvement and the way products are offered to customers can be considered as the service component differentiating the offering (Grönroos, 1998).

Next, we will present a framework combining modularity and customization. Duray et al. (2000) and Duray (2002) developed a framework separating modularity and customization in order to distinguish different mass customizer types. They differentiate between modularity types varying across the production cycle, and customization level depends on customer involvement in production. In contrast, our framework combines the degrees of modularity and customization. We use similar evaluation criteria for the degree of customization related to service production but for modularity, the focus is on the level of modularity and not on the type. Only one quadrant in our matrix represents mass customization, while they focus on mass customizer types. We also apply our framework in three different perspectives: service offering, service production, and service production network. These perspectives explain how the service is offered to the customer and how the offering is implemented.

In our framework, the measure of the customization level for the service offering is the profundity of the customization experience for the customer. In service production, the measure is the deepness of customer involvement. The measure for modularity in the customer perspective is the product variants offered with different modules and service levels, and in the production perspective, the use of modularity principles in production. In the service production network perspective, the measure of network modularity comprises the responsibilities of the suppliers and the measure of customization the degree of dedication in supplier relations.

Four extreme categories emerge when the degree of modularity and customization are combined. We call them "non-modular regular", "modular regular", "modular customized" and "non-modular customized", as presented in the basic service modularity framework (Figure 1). "Regular" illustrates a pre-determined and standardized element in the service and "customized" a more customer- specific element. We will analyze these four categories to illustrate how different kinds of products, services and their combinations differ in relation to service offerings, service production processes, and networks producing and delivering the service to customers.

As argued by several authors (Salvador et al., 2004; Brusoni and Prencipe, 2001; Ernst, 2005; Mikkola and Skjøtt-Larsen, 2004), neither of the dimensions of the framework is dichotomous – there are different degrees of both modularity and mass customization. However, describing the extreme cases facilitates visualization of different strategies in services regarding service production and their service production networks.

We will next present the categories from the service offering, service production process, and service production network perspectives in connection with a discussion of how different kinds of services differ in relation to the customer interface. After introducing the framework, we use it to describe service models of the automotive industry.

Service offering

The service offering of the non-modular regular service in the framework (Figure 2) is standard and monolithic. When a service offering is non-modular and regular, there are only a few pre-determined alternative products, services or a combination thereof offered, and the customer does not influence their specifications. The customer can only choose from alternatives, for example products in stock in a retail store or from completely pre-determined travel packages. We call this type of customer service philosophy buy-from-store, to illustrate the predetermined alternatives for customers.

If a service offering is modular and regular, the pre-determined bundles of products, services or their combinations consist of standard modules for the customer to choose from. The level of customization is lower than in the category of modular customized product, as the level of customer involvement in the production process is more restricted. In the case of modular regular service offerings, customers can choose a suitable combination of different alternatives. In this type of service the customer service lead time is short; assembly can be postponed close to the customer interface. A typical example is postponed production. In this type, final assemblies can be carried out close to the customer or even postponed to the customer's premises. An example is a menu in a restaurant that offers a reasonable variety of choices for the customer to choose from and combine into a meal (for example McDonald's). Offering this kind of variety – as stated earlier in the literature review – does not as such constitute customization. To illustrate this category from the customer perspective, we call this type of customer service philosophy "buy-to-configure".

In the case of the modular customized category, there are a large number of options available for the customer. The alternative outcomes are realized with both standard and customized modules that may be mixed, matched, and bundled together to meet more individual customer needs. In this category, the customization level is relatively high. The statement of customer preferences, for example the choice of modules, needs to be made in a specific stage of the production process. Standard modules are at least partly customized and integrated in the relatively early stages of the production process, and thus, while able to get a more deeply customized offering, customers may have to wait a long time for the delivery. One example is constructing a house, in which the plans are made in co-operation with the customer and the finalized building consists of both standard and customized modules. Another example comes from the automotive industry: Volvo can offer more than one million car variants, but the lead time is fairly long. However, it is not necessary for the customer to know whether the service alternatives are actually produced from modules. We call this type of service philosophy buy-from-order. In this case it takes longer, possibly weeks or months, to provide the services than in the modular regular case.

Finally, in the non-modular customized class, the product, service or their combination is fully customized according to customer needs and production is carried out accordingly, with the best methods for the product in question. The production process can be fully integrated for the specific requirements of the customer, and customer involvement extends even to the design stages of the process. The services are "tailor-made solutions". The skyscraper elevators of Kone Elevators illustrate the case in point, as customers are involved in determining the technical and design features

(Kallio et al., 2002). An everyday example is tailoring the interfaces of an information system to match the customers' specific systems. As we move towards more customized solutions, we also tend to have to make changes in the underlying processes, interfaces, and even into the organizational networks with which the service is produced. We call this type of service offering buy-from-tailor.

Figure 1 A general framework combining service modularity and customization

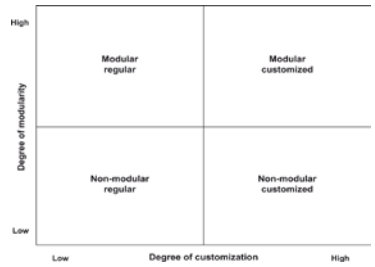
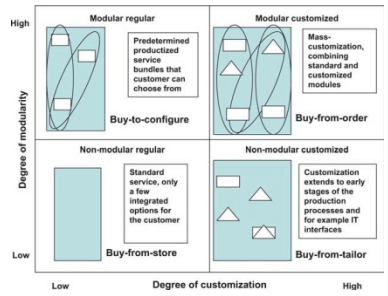


Figure 2 Combining modularity and customization in service offerings



Service production

In this section, we focus on the service production side. We regard production as a service element for solving customer problems (Grö nroos, 1998). Modularity in production also reflects modularity at the customer interface, and while there are inter-connections between these two, differences also exist. For example, it may be possible that different service bundles are produced in the same or in an only slightly modified production process. Thus, the differences in the service types may have only minor impacts at the production process level. However, as we move towards more customized solutions, customer-specific adjustments or redesign of products and processes become more common. Based on Duray et al. (2000) and Duray (2002), the point of customer involvement in the production is a key indicator of the degree, or type of customization. For example, the degree of customization cannot be very high if the customer preferences are only taken into account at the assembly stage in contrast to involvement in earlier production stages.

Non-modular regular service production process with low modularity in production and low customization typically produces standard products, services or their combinations according to the make-to-stock principle. There are typically only few variants that are pre-determined and manufactured on the basis of forecasts. In this category, there is no customer involvement in production process and the order penetration point (OPP) is at the stock or place of sale (Figure 3).

On the other hand, modular regular service production is executed on the assemble-to-order principle and customer preferences are integrated with the product or service in the assembly stage by assembling the right configuration from predetermined modules. Although there is medium variety of products available, the customization level is low or medium.

With modular customized service production, products or services can be executed from customized and pre-determined modules. Here the lead time for the customer is longer than in the modular regular alternative, as customization starts from earlier stages of production. The production principle in this case is make-to-order. OPP takes place in earlier stages of production.

In the non-modular customized category the service production principle is engineer-to-order. The products or

services are often one-of-a-kind. The customers are already involved in production at the design phase of the product. The production process is largely customized, while some modularity can be used to achieve commonality of components. OPP occurs in the first stage of the service production process. For a service producer low modularity and high customization of production means that the processes are customer-specific and monolithic in such a way that there are almost no process modules that could be replaced with process modules from another customer's process.

Service production network

Several authors have brought up that there seems to be a connection between modular production and production networks. Modular production logic calls for new types of first-tier suppliers able to manage the complexity of the product, and on the other hand the ability to manage upstream suppliers contributing to the various elements of constituting a module (Doran et al., 2007). The modular model postulates tight linkages between a final assembler and its suppliers (Salvador et al., 2004). Suppliers are often located within the same physical infrastructure hosting the final assembly line, are responsible for module fabrication and installation, and are bound by long-term contractual relationships to the final assembler. As production becomes modular, it allows manufacturers to involve suppliers and distributors in different roles in supply, assembly and distribution. This extension in involvement is possible if the product is modular (van Hoek and Weken, 1998). Fredriksson and Gadde (2005) maintain that customization with respect to offering a huge range of product variants at reasonable cost and lead-time is dependent on a complex interplay between flexibility and rigidity and that the outcomes of the individual firm's efforts in this interplay are strongly contingent on its cooperation with actors on its demand and supply sides.

Regarding the modularity axis, the evaluation criterion is the degree of suppliers' responsibility in the manufacture of their own components, parts or modules as part of the final product, which can var y from low to high. In the customization axis, the measurement criterion is how dedicated the supplier is to the end product or service manufacturer, i.e. how generic or customized the networks are.

In a non-modular regular network the supplier's responsibility for the component as a part of the final product, service or their combination, is limited and the network (if used) is generic. In this case, suppliers provide generic components, not modules, to the manufacturer. As regards to customization, as the network is generic (several manufacturers use the same components), manufacturer can buy same components from several suppliers. Consequently, the suppliers' responsibility for the final product is low, and the relations between the manufacturer and its suppliers are not outsourcing-based but purchasing-based where the manufacturer uses the components in its own production process as "raw materials" (Figure 4).

In the case of a modular regular network, the supplier's responsibility is high and modules are produced in generic networks. In the extreme case modules can be bought from market-based suppliers. The partner network is flexible and adapts according to the production of different service and product bundles. One example of this type is the computer industry, where customers can freely configure their final product from the products of several producers.

In the modular customized case, the supplier's responsibility is also high, while customized networks are used. The manufacturer-specific and well-defined service or product modules are outsourced to partners.

In the non-modular customized networks the supplier's responsibility is limited and customized networks are used. The component is customized and the manufacturer gives exact specifications to the supplier. Often only a single supplier produces the manufacturer-specific component.

Figure 3 Combining modularity and customization from the service production perspective

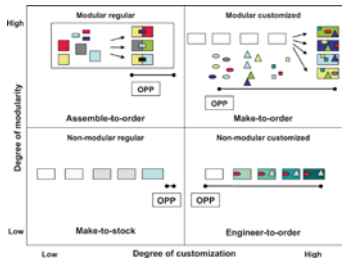
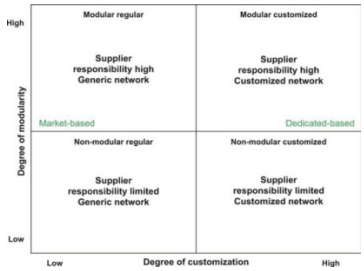


Figure 4 Combining modularity and customization from the service production network perspective



Modularity and customization in the car industry

Next we will present examples from car manufacturing industry that explain different service offering variations, service production alternatives and service production networks with combining these two dimensions, modularity and customization. Describing the extreme cases concerning the degree of low versus high modularity, and low versus high degree of customization facilitates depicting different strategies.

In recent decades modularity combined with customization has had a profound impact on the car manufacturing industry. From the beginning of the twentieth century until the 1980s the automotive industry was regarded as the archetypal example of a mass production industry. The modularity phenomenon is relatively new to the automotive industry, having been first introduced in the latter part of the 1990s (Ro et al., 2007). Since then, the practices of car manufacturing, production networks, and customer interfaces have been completely reshaped. The major changes have included a shift towards teamwork in manufacturing processes, a move toward partner networks and tiering in production and supply networks, and a shift toward customization at the customer interface.

Service offering

An example of a non-modular regular service offering is "traditional" car production, in which cars were made according to the make-to-stock principle. The best-known example of a mass produced cars was Ford's Model T, which was offered in "any color as long as it was black" (Figure 5). Later, more – but still relatively few – models and color options were available for customers, and with mostly in- house production. Make-to-stock has long traditions in the USA. As recently as 2001 about 95 percent of cars were built on the make-to-stock principle (Holweg and Pil, 2001). Although the customer is able to choose from a list of limited and/or standardized options, customer preferences are not used to guide design and production (Ro et al., 2007). This principle is still used in cases such as budget-priced cars. An example is the new exceptionally cheap Tata Nano. It has been regarded as a low-cost disruptive innovation (Lim et al., 2009). Nano has only a few options available (see http://tatanano.inservices.tatamotors.com), and has accordingly been compared to the Model T. The car is very low in customization, and because of its few models, it is low in modularity from the customer perspective. In customer service, this corresponds to the buy-from-store logic.

The Smart car is a typical example of a modular regular service offering. The offering is built from larger standard, pre-determined modules chosen by the customer, including a colored plastic body. Customization is at the level of assembly, and the lead time in the factory's assembly line is short, only 4.5 hours (see www.ifm.eng.cam.ac.uk/ctm/idm/cases/smart. html). The corresponding customer service logic is buy-to- configure. In this case, the level of customization is medium.

An example of a modular customized offering is a Volvo car. Volvo offers more than one million car variants. The five models produced on the basis of one production platform are available in 14 colors, with nine engine and five transmission alternatives, as well as 22 types of interior trim and nine wheel variants (Fredriksson and Gadde, 2005). The customer can choose from many pre-determined options, is involved in the early stages of production. Compared with Smart, for example, delivery time is much longer, taking weeks or even months. The corresponding logic is buy-from-order.

An example of a non-modular customized offering can be a Formula One car. It is tailored from the beginning, and the car can be described as an integrated product, as opposed to a modular product (Mikkola and Gassmann, 2003). The logic for the customer offer is buy-from-tailor.

Service production

The non-modular regular service production process with low levels of modularity and customization typically produces standard products according to the make-to-stock principle. The few variants of Model T and Nano

produced are pre- determined in their features and manufactured according to forecasted demand. In this category the customer has no direct influence on production and accordingly, the order penetration point (OPP) is at the stock or place of sale (Figure 6).

Modular regular service production is executed according to the assemble-to-order principle, and customer preferences are integrated with the product or service at the assembly stage close to customer by assembling the right configuration from predetermined modules. There is a pretty large variety of products and the customization level is medium. The Smart car's production flow is designed on the basis of this principle.

With modular customized service production the main production principle is based on customization of pre-determined modules. For Volvo, lead times for customers are longer than in the modular regular alternative, as customization also affects the early stages of production in make-to-order. OPP takes place at the early stages of production.

Finally, non-modular customized production is executed according to the engineer-to-order principle. Formula One cars are truly one-of-a-kind, as the customers are involved in the design and testing of the product and its components. While the production process is highly customized, some modularity can be used to achieve component commonality. OPP takes place at the first stage of the production process. In the categorization of Duray et al. (2000) and Duray (2002), fabricators belong to this category of producer, as modularity is used only for gaining commonality of components. The point of customer involvement is in the early stages.

Figure 5 Examples of modularity and customization in the automotive industry from the service offerings perspective

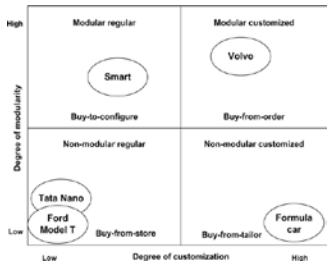
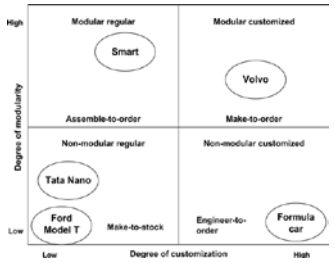


Figure 6 Examples of modularization and customization in automotive industry from the service production perspective



Service production network

The supplier network is an essential part of any modern industrial manufacturing operation. One of the best examples is the automotive industry, where the component supplier network answers for up to 75 percent of the value created. For example, BMW does only 25 percent of its manufacturing internally (Wagner et al., 2009). In the automotive industry this share is typically around 65 percent, and is expected to rise to 77 percent by 2015 (von Corswant and Fredriksson, 2009). Modularity has accompanied a major reorganization of the automotive supplier industry (Ro et al., 2007).

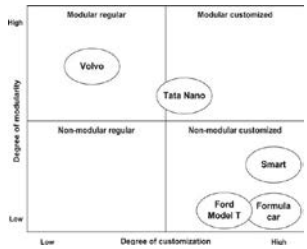
There are different types of supplier networks with varying degrees of modularity and customization. The trend in car manufacturing has been on increasing the role and responsibility of first-tier suppliers and reducing the total number of suppliers (Collins et al., 1997).

In a non-modular regular network the suppliers have only a limited responsibility for the final product or service, and the network (if used) is generic (Figure 7). This would mean the use of generic components by several manufacturers to produce highly standardized cars. This would facilitate easy change of component suppliers for the manufacturers and the creation of a market for generic components.

In the case of modular regular networks, the supplier's responsibility is high and modules are produced in generic networks. The role of modules in the final product is much greater compared with the non-modular regular case. In the extreme case modules can be bought from market-based suppliers. The partner network is flexible and transforms according to the production of different service and product bundles. This mode of operation has been typical of the automotive industry for decades. The network typically consists of 100-300 main suppliers, with usually two to three suppliers for each main component. Volvo belongs to this class, along with most other main car manufacturers. A main component, such as an engine, is used within the corporation in several product families, in each case with minor modifications. In some cases the car manufacturers themselves are also component producers, and members of supplier network, specializing for example in some engine- types.

In the modular customized case the supplier's responsibility is also high, while customized networks are used. The manufacturer-specific well-defined service or product modules are outsourced to rather independent partners. Tata Nano has some 100 direct suppliers. Approximately 85 percent of components measured with costs were thus outsourced (Lim et al., 2009). The network is rather dedicated in respect of designs and partners. Local suppliers are often situated close to the car factory. There are also many well-known global component suppliers supplying for Tata.

Figure 7 Examples of modularization and customization in the automotive industry from the service production network perspective



For example, Bosch and Lumax were involved in the early design stages of Nano (Lim et al., 2009). These global suppliers are rather independent, and bear responsibility, for their part, for the final product. However, the Tata Nano is constructed of components that can be built and shipped separately for assembly at a variety of locations. In fact, the Nano is being sold in kits that are distributed, assembled, and serviced by local entrepreneurs (Nextbillion.net, 2008).

In the production of non-modular customized services supplier's responsibility is limited and customized networks are used. Components are customized according to exact specifications of manufacturers. In some cases only a single supplier is responsible for any single component. In the most extreme case of Formula One cars, few standard components come from suppliers. In addition to in-house component manufacturing, the only manufacturer specification-based components are outsourced.

Smart car has seven first-tier suppliers on site who are responsible for modules such as space frame, doors, paint shop, cockpit, and plastic body panels; they provide their modules directly to the assembly line. Of the 2,200 workers of the factory, some 1,300 are employed by the supplier network (see www.autofieldguide.com/columns/will/0404euro.html). About 85 percent of the costs of the cars are accounted for by the supplier network and the three main logistics partners work on site (see www.ifm.eng.cam.ac.uk/ctm/idm/cases/smart.html). Smart's suppliers are more involved in activities that are typically undertaken by the OEM. However, the suppliers' responsibility for the final product can be considered to be rather limited, as the focal company is responsible for the design of the modules and also for the production principles and guidelines. The production of Smart car deals with considerably fewer suppliers than typical car manufacturers (Doran et al., 2007). As typical car manufacturers have 200-300 suppliers (Doran et al. 2007), this development is a good illustration of the trend toward more integral supply chains of highly modular products, with the supplier network taking a more strategic role in production process. With Smart the network is tightly coupled, as there is only one supplier for each of seven main modules of the final manufacturing process. Typically the suppliers do not supply to other clients, and thus the network is dedicated to the production of the Smart car.

Conclusions and further research

In this paper, we have offered a general framework for analyzing service offerings, production and networks with dimensions of modularity and customization. This facilitates analysis of the service models used by companies. The framework enables examining different combinations of modularity and customization degrees – also other than mass customization. Also, service models can contain different combinations of modularity and customization levels with

respect to the three perspectives (service offering, production, network). To demonstrate this point, we have provided examples that illustrate differences in the service offerings of the car industry. Table I summarizes the comparison.

Table I Summary of the examples in car industry from the three perspective.

	F1 car	**Volvo**	**Smart**	**Tata Nano**	**Model T**
Service offering (customer perspective)	Tailored for the customer, no predetermined alternatives but built to customer requirements	Customer involved in early stages of the production process (even possible to reserve a car from the manufacturing process and follow the production), many predetermined elements to choose from	Customer can choose from a few predetermined alternatives at the assembly stage, possibility to configure from predetermined elements	Customer can choose from three predetermined variants, color alternatives offered (http://tatanano.inservices.tatamotors.com)	Low opportunity to choose (principle: offered in "any color as long as it is black")
Service production	Engineer-to-order, long lead times, low modularity (integrated product)	Make-to-order, long lead times, customization of predetermined modules	Assemble-to-order, short lead times, configuration from predetermined modules	Make-to-stock, manufactured according to forecasts, process produces only few variants	Make-to-stock, manufactured according to forecasts, mass-production of one model
Production network	For example, Ferrari, Renault and Toyota manufacture their F1 cars completely. Others have close relationships with manufacturers. (http://www.autoracing.com/formula-1/manufacturers/)	Large supplier base, flexible network	Relatively small, integrated network of dedicated first tier suppliers (operating even in Smart's factory)	Medium modularity (100 direct suppliers), medium customization (some dedicated partners, situated close to the factory)	In-house manufacturing
Summary	Integrated and customized offering, production and network	Modular offering and production with relatively high customization, relatively modular network with low customization	Modular offering and production with medium customization, integrated and customized network	Low modularity and customization in offering and production, medium modularity and customization (dedication) in the network	Low modularity and customization in offering and production, integrated and customized network

With the framework, by combining modularity and customization, we have presented four extreme categories:

1 non-modular regular;

2 modular regular;

3 modular customized; and

4 non-modular customized.

The measure of the degree of customization used is the penetration of customer involvement in the production process or, from the service offerings perspective, the profundity of the customization experience for the customer. The measure for modularity is the use of modularity principles in production, or, from the customer perspective, the product variants offered with different modules and service levels that can be mixed and matched and perceived by the customer. In the network perspective, the measure of network modularity comprises the responsibilities of the suppliers and the measure of customization the degree of dedication in the partnership relations.

Campagnolo and Camuffo (2010) concluded that the current literature does not provide a framework combining different perspectives in modularity analysis, and that a comprehensive approach is needed for further analysis of relationships between different modularity aspects. We attempt to contribute to the service modularity literature by offering one way to look at modularity and customization in a more comprehensive way, using three perspectives. We also build on the framework by Duray et al. (2000) and Duray (2002) by discussing combinations of the degree of modularity and customization, also other than mass customization, in service offerings.

The managerial implications include opportunities for a systematic examination of modularity and customization in service offerings, production and supplier networks and opportunities for benchmarking with respect to competitors. This type of systematic examination of modularity and customization also aims at a better understanding of the concepts of modularity and customization, concepts which – despite their popularity in management literature – are apparently the source of some confusion. With our framework we emphasize that different strategies related to the degrees of modularity and customization can be right for different types of business environments.

Our future research aims for operationalization of modularity and customization, which is a challenging and promising research area (Fixson, 2006), in the context of the framework. We also plan to conduct case studies of the dynamics and underlying causes of the various service models.

References

Araujo, L. and Spring, M. (2006), "Services, products, and the institutional structure of production", Industrial Marketing Management, Vol. 35 No. 7, pp. 797-805.

Baldwin, C.Y. and Clark, K.B. (1997), "Managing in an age of modularity", Harvard Business Review, Vol. 75 No. 5, pp. 84-93.

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2010), "The concept of modularity: diffusion from manufacturing to service production", Journal of Manufacturing Technology Management, Vol. 21 No. 3, pp. 355-75.

Bask, A.H. (2001), "Relationships among TPL providers and members of supply chains – a strategic perspective", Journal of Business & Industrial Marketing, Vol. 16 Nos 6/7, pp. 470-87.

Brusoni, S. and Prencipe, A. (2001), "Unpacking the black box of modularity: technologies, products and organizations", Industrial and Corporate Change, Vol. 10 No. 1, pp. 179-205.

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. 259-83.

Collins, R., Bechler, K. and Pires, S. (1997), "Outsourcing in the automotive industry: from JIT to modular consortia", European Management Journal, Vol. 15 No. 5, pp. 498-508.

Da Silveira, G., Borenstein, D. and Fogliatto, F.S. (2001), "Mass customization: literature review and research directions", International Journal of Production Economics, Vol. 72 No. 1, pp. 1-13.

Doran, D., Hill, A., Hwang, K.-S. and Jacob, G. (2007), "Supply chain modularization: cases from the French automobile industry", International Journal of Production Economics, Vol. 106, pp. 2-11.

Duray, R. (2002), "Mass customization origins: mass or custom manufacturing?", International Journal of Operations & Production Management, Vol. 22 No. 3, pp. 314-28.

Duray, R., Ward, P.T., Milligan, G.W. and Berry, W.L. (2000), "Approaches to mass customization: configurations and empirical validation", Jour nal of Operations Management, Vol. 18 No. 6, pp. 605-25.

Ernst, D. (2005), "Limits to modularity: reflections on recent developments in chip design", Industry and Innovation, Vol. 12 No. 3, pp. 303-45.

Fixson, S.K. (2006), "Modularity and commonality research: past developments and future opportunities", MIT Sloan Working Paper 4629-06, Sloan School of Management, Cambridge, MA.

Fredriksson, P. and Gadde, L.-E. (2005), "Flexibility and rigidity in customization and build-to-order production", Industr ial Marketing Management, Vol. 34 No. 7, pp. 695-705.

Gilmore, J.H. and Pine, B.J. II (1997), "The four faces of mass customization", Har vard Business Review, Vol. 75 No. 1, pp. 91-101.

Grönroos, C. (1998), "Marketing services: the case of a missing product", Jour nal of Business & Industr ial Marketing, Vol. 13 Nos 4/5, pp. 322-38.

Hoetker, G. (2006), "Do modular products lead to modular organizations?", Strategic Management Journal, Vol. 27 No. 6, pp. 501-18.

Holweg, M., Pil, F.K. (2001), "Successful build-to-order strategies start with the customer", MIT Sloan Management Review, Vol. 43 No. 1, pp. 74-83

Jacobs, M., Vickery, S.K. and Droge, C. (2007), "The effects of product modularity on competitive performance. Do integration strategies mediate the relationship?", International Jour nal of Operations & Production Management, Vol. 27 No. 10, pp. 1046-68.

Jose, A. and Tollenaere, M. (2005), "Modular and platform methods for product family design: literature analysis", Jour nal of Intelligent Manufacturing, Vol. 16 No. 3, pp. 371-90.

Kallio, J., Saarinen, T. and Tinnilä , M. (2002), "Efficient change strategies – matching drivers and tracers in change projects", Business Process Management Journal, Vol. 8 No. 1, pp. 80-92.

Kumar, A. (2004), "Mass customization: metrics and modularity", International Journal of Flexible Manufacturing Systems, Vol. 16 No. 4, pp. 287-311.

Lampel, J. and Mintzberg, H. (1996), "Customizing customization", Sloan Management Review, Vol. 38 No. 1, pp. 21-30.

Lim, C., Han, S. and Ito, H. (2009), "Low-cost disruptive innovation by an Indian automobile manufacturer", Discussion Paper No. 280, Manufacturing Management Research Centre, University of Tokyo, Tokyo.

Maister, D.H. and Lovelock, C.H. (1982), "Managing facilitator services", Sloan Management Review, Vol. 23 No. 4, pp. 19-31.

Mikkola, J.H. and Gassmann, O. (2003), "Managing modularity of product architectures: toward an integrated theory", IEEE Transactions on Engineering Management, Vol. 50 No. 2, pp. 204-18.

Mikkola, J.H. and Skjøtt-Larsen, T. (2004), "Supply-chain integration: implications for mass customization, modularization and postponement strategies", Production Planning & Control, Vol. 15 No. 4, pp. 352-61.

Nextbillion.net (2008), "4 lessons to learn from Tata's Nano", Business Week Online, March 27, available at: www.nextbillion.net/news/4-lessons-to-learn-from-tatas-nano (accessed April 26, 2010).

Olhager, J. (2003), "Strategic positioning of the order penetration point", International Jour nal of Production Economics, Vol. 85 No. 3, pp. 319-29.

Pekkarinen, S. and Ulkuniemi, P. (2008), "Modularity in developing business services by platform approach", International Jour nal of Logistics Management, Vol. 19 No. 1, pp. 84-103.

Pine, B.J. II (1993), "Mass customizing products and services", Planning Review, Vol. 21 No. 4, pp. 6-15.

Ro, Y.K., Liker, J.K. and Fixson, S.K. (2007), "Modularity as a strategy for supply chain coordination: the case of US auto", IEEE Transactions on Engineering Management, Vol. 54 No. 1, pp. 172-89.

Salvador, F. (2007), "Towards a product modularity construct: literature review and reconceptualization", IEEE Transactions on Engineering Management, Vol. 54 No. 2, pp. 219-40.

Salvador, F., Rungtusanatham, M. and Forza, C. (2004), "Supply-chain configurations for mass customization", Production Planning & Control, Vol. 15 No. 4, pp. 381-97.

Sanchez, R. and Mahoney, J.T. (1996), "Modularity, flexibility, and knowledge management in organization design", Strategic Management Journal, Vol. 17, Winter Special Issue, pp. 63-76.

Schilling, M.A. and Steensma, H.K. (2001), "The use of modular organizational forms: an industry-level analysis", Academy of Management Journal, Vol. 44 No. 6, pp. 1149-68.

Simon, H.A. (1962), "The architecture of complexity", Proceedings of the American Philosophical Society, Vol. 106, No. 6, pp. 467-82.

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. 147-68.

Ulrich, K.T. (1995), "The role of product architecture in the manufacturing firm", Research Policy, Vol. 24 No. 3, pp. 419-40.

Ulrich, K.T. and Tung, K. (1991), "Fundamentals of product modularity", Proceedings of the 1991 ASME Winter Annual Meeting Symposium on Issues in Design/Manufacturing Integration, Atlanta, GA, pp. 1-14.

Vandermerwe, S. and Rada, J. (1988), "Servitization of business: adding value by adding services", European Management Journal, Vol. 6 No. 4, pp. 314-24.

van Hoek, R.I. and Weken, H.A.M. (1998), "The impact of modular production on the dynamics of supply chains", International Journal of Logistics Management, Vol. 9 No. 2, pp. 35-50.

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. 261-9.

von Corswant, F. and Fredriksson, P. (2009), "Sourcing trends in the automotive industry – a survey of car manufacturers' and suppliers' strategies and relations", International Journal of Operations & Production Management, Vol. 22 No. 27, pp. 741-58.

Voordijk, H., Meijboom, B. and de Haan, J. (2006), "Modularity in supply chains: a multiple case study in the construction industry", International Journal of Operations & Production Management, Vol. 26 No. 6, pp. 195-219.

Wagner, S., Bode, C. and Koziol, P. (2009), "Supplier default dependencies: empirical evidence from the automotive industry", European Journal of Operational Research, Vol. 199 No. 1, pp. 150-61.

Womack, J.P. (1993), "Mass Customization: The New Frontier in Business Competition, book review", Sloan Management Review, Vol. 34 No. 3, pp. 121-2.

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Executive summary and implications for managers and executives

This summary has been provided to allow managers and executives a rapid appreciation of the content of the article. Those with a particular interest in the topic covered may then read the article in toto to take advantage of the more comprehensive description of the research undertaken and its results to get the full benefit of the material present.

A firm's business excellence is often defined by its flexibility and responsiveness to customer needs. However, it is not always in the business interests of a firm to have customized offerings as demand for them has to exist for a mass customization strategy to be successful. It is important to recognize when mass customization is a feasible objective and to understand that despite its popularity it is not a panacea. What means could then be applied to analyze service models more comprehensively, taking into account other alternatives than mass customization? In "Framework for modularity and customization: service perspective", Anu Bask et al. take the automotive industry as their example to develop a framework discussing the degrees of customization and modularity separately.

They illustrate how the same service offerings can vary with respect to the degree of modularity and customization in three perspectives. Key perspectives at the customer interface creating the service component are the service offering, indicating how the products and services are offered to the customer, and service production processes as well as service production networks (outsourcing, in-house operations) for achieving the customer offerings.

In the proposed framework, the measure of the customization level for the service offering is the profundity of the customization experience for the customer. In service production, the measure is the deepness of customer involvement. The measure for modularity in the customer perspective is the product variants offered with different modules and service levels, and in the production perspective, the use of modularity principles in production. In the service production network perspective, the measure of network modularity comprises the responsibilities of the suppliers and the measure of customization the degree of dedication in supplier relations.

Four extreme categories emerge when the degree of modularity and customization are combined: 1 non-modular regular; 2 modular regular; 3 modular customized; and 4 non-modular customized.

In the automotive industry, where modularity has accompanied a major reorganization, component supplier network answers for up to 75 percent of the value created. There are different types of supplier networks with varying degrees of modularity and customization. The trend in car manufacturing has been on increasing the role and responsibility of first-tier suppliers and reducing the total number of suppliers.

In a non-modular regular network the suppliers have only a limited responsibility for the final product or service, and the network (if used) is generic. This would mean the use of generic components by several manufacturers to produce highly standardized cars. This would facilitate easy change of component suppliers for the manufacturers and the creation of a market for generic components.

In the case of modular regular networks, the supplier's responsibility is high and modules are produced in generic networks. The role of modules in the final product is much greater compared with the non-modular regular case. In the extreme case modules can be bought from market-based suppliers. The partner network is flexible and transforms according to the production of different service and product bundles. This mode of operation has been typical of the automotive industry for decades. The network typically consists of 100-300 main suppliers, with usually two to three suppliers for each main component. Volvo belongs to this class along with most other main car manufacturers. A main component, such as an engine, is used within the corporation in several product families, in each case with minor modifications.

In the modular customized case supplier's responsibility is also high, while customized networks are used. The manufacturer-specific well-defined service or product modules are outsourced to independent partners. Tata Nano has some 100 direct suppliers. Tata Nano is constructed of components that can be built and shipped separately for assembly at a variety of locations.

In the production of non-modular customized services the supplier's responsibility is limited and customized networks are used. Components are customized according to exact specifications of manufacturers. In some cases only a single supplier is responsible for any single component. In the most extreme case of Formula One cars, few standard components come from suppliers. In addition to in-house component manufacturing, the only manufacturer specification-based components are outsourced.

Smart car has seven first-tier suppliers on site who are responsible for modules such as space frame, doors, paint shop, cockpit, and plastic body panels; they provide their modules directly to the assembly line. Of the 2,200 workers of the factory, some 1,300 are employed by the supplier network. About 85 percent of the costs of the cars are accounted for by the supplier network, and the three main logistics partners work on site. Smart's suppliers are more involved in activities that are typically undertaken by the OEM.

The framework offered enables examining different combinations of modularity and customization degrees – also other than mass customization. Also, service models can contain different combinations of modularity and customization levels with respect to the three perspectives (service offering, production, network).

(A precis of the article "Framework for modularity and customization: service perspective". Supplied by Marketing Consultants for Emerald.)

PAPER 4

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Matching service strategies, business models and modular business processes

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Abstract

Purpose – In recent decades, supply chains have diverged and new types of services and operators have emerged in the logistics sector. The purpose of this paper is to focus on analyzing service strategies and service-related business models, as well as their modular business processes in logistic services. The aims are to describe these three levels and to match strategic service positioning with business models and modular business processes. Different types of services are analyzed and the analyses are conducted on both the industry and corporate levels.

Design/methodology/approach – The theoretical focus of the paper illustrates frameworks for service strategy, service positioning, business models, and business processes. The corporate level approach aims to describe the efficiency and quality of services and their processes, while the industry level approach focuses on service strategies in an industry and on the organization of business, i.e. business models. A case study is used to illustrate the strategic level divergence in logistic services and to match this with the business model framework and the business process approach.

Findings – The findings show that a match exists between service strategy, business models, and operational level business processes. Standardization, service productization and modularization of services, and also service production structures are useful tools for efficient service production and output.

Originality/value – Companies are currently examining new roles in supply chains and the logistics market. For management, the frameworks presented facilitate analysis of the different options available for the firm in terms of strategic positioning, structural business model portfolio, and modular business processes. Based on the theoretical frameworks, it is possible to evaluate past developments and also predict the future of services.

Keywords Corporate strategy, Supply chain management, Process management, Service levels

Paper type Research paper

1. Introduction

The business model approach has become popular in recent years (Osterwalder et al.,2005; Pateli and Giaglis, 2003), partly because continuously changing business processes, practices, and operations have to meet the needs of the marketplace. However, business models are relatively poorly understood in research (Linder and Cantrell, 2000; Osterwalder et al., 2005). Organizations can compete in the global environment by utilizing world-class electronic communication systems and by operating common simplified and standardized processes (Hamel and Prahalad, 1989). According to Barratt (2004), separate supply chains can be designed to meet the specific needs of the various customer segments if customers can be segmented according to their buying behavior and service needs. It will be of considerable interest to look at the supply chain relationships, development of

service processes, differentiation of services, and the channel interfaces from the perspective of supply chain management (SCM).

The types of value chains or business models are strongly dependent on the basic strategic choices made by companies – for example, cost leadership, differentiation, and focus strategy (Porter, 1980). The drivers behind business model changes have been listed often, and the most important factors include globalization, open markets, introduction of new technology, the internet and information and communication technology in general (Amit and Zott, 2001; Delfmann et al., 2002; Chesbrough, 2007). It seems to be difficult to prioritize these drivers or to place them in any specific order. The internet not only provides companies with a new channel in which to meet their customers, but also platforms for cooperation between companies and customers in developing and testing new services, technologies, and products. In addition to conventional channels, companies are able to choose among several digital channels, facilitating different strategic positions for services. This multi-channel environment poses new challenges, but also offers new opportunities.

On numerous occasions, researchers have brought up the differences and interconnections between strategy and business models on the one hand and business models and business process models on the other (Osterwalder et al., 2005; Stähler, 2002; Seddon et al., 2004). However, there is an increasing importance to increase research regarding interconnections of all these three levels: strategic level, business models, and business processes. Osterwalder (2004) states that strategy, business models, and process models address similar problems in different business levels. Strategy focuses on the corporate/group and planning level, business models on the business unit and architectural level, and business processes on the functional and implementation level.

This paper is organized as follows. We start by identifying the objectives and methodology of the study. Next, we present service process analysis (SPA), a strategic normative model for analyzing efficient service positioning. Then, we present a short review of business model literature and models developed in that field. After that, we briefly discuss business process analysis and modular business processes. To increase understanding of how these frameworks can be used in analyses of services, we use examples of selected logistics services and present a company case study. In the analysis, we connect SPA with Osterwalder's (2004) definitions and categorizations of business models and with the business process approach.

2. Objectives and methodology of the study

The objective of this paper is to increase understanding of the relationship between three modules: strategic level service positioning, service-related business models, and modular business processes. Our aims are to describe these three different level modules and to match the modules of strategic service positioning models with the frameworks of business models and modular business processes. In this paper, we inspect the strategic level from the perspective of strategic service repositioning. Several authors have analyzed the efficiency of services and service delivery, and many of them are based on the ideas presented originally by Hayes and Wheelwright (1979). We present a strategic normative model for analyzing efficient service positioning called SPA and originally developed by Apte and Vepsäläinen (1993) and Tinnilä and Vepsäläinen (1995). In SPA, efficient matching between services and channels is determined on the basis of the trade-off between the production costs and transaction costs involved. The aim of SPA is to synthesize different aspects of service processes in order to explain and predict the impacts of organizational and technological development on individual services and service firms, as well as on industrial organization and network infrastructures. The SPA model offers a tool for graphical representation of service positioning and also for appraisal of different repositioning strategies, much in the same way as manufacturing facilities can be

compared in the product-process matrix devised by Hayes and Wheelwright (1984). The SPA model describes efficient ways to connect the delivery channel of the service (type of channel) with the type of service. To summarize, SPA describes the strategic positioning of the service.

With the business model framework, services can be described in a concrete way. Business model tools illustrate and collect the diversified components needed for business architecture planning. For business model analysis, we use Osterwalder's (2004) business model building blocks framework. Osterwalder's model offers a useful framework for analysis of the different elements of the business model, as it contains many of the elements essential at the architectural level of business. However, it does not provide a tool for analyzing efficient service delivery or service processes. That is why we analyze the efficiency of the service delivery with SPA and business processes. The SPA model helps to bridge this gap and connects the business model framework with the mix of efficient service outputs by facilitating the analysis of efficient delivery channels.

The relation and interfaces between the three modules – SPA, the business model, and business process frameworks – can be described as follows: while SPA describes the value proposition on a general level by defining the type of service and the distribution channel, other more concrete elements also have to be defined by building a description of the business model and modular business processes (Figure 1).

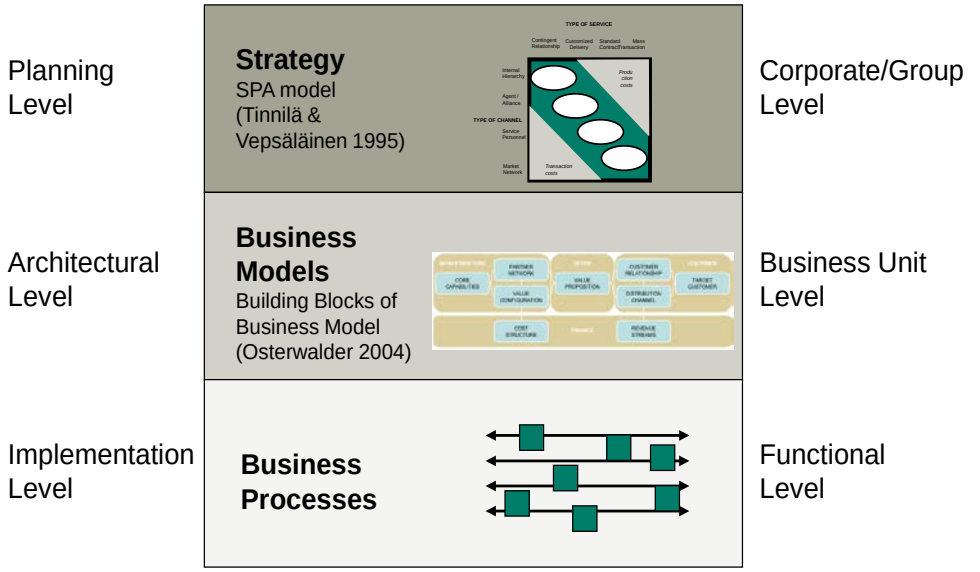

Figure 1. A framework illustrating interfaces and combining three modules: strategic service positioning, business models, and modular business processes.

To illustrate how to bridge the gap between the strategic view of the SPA model and business model-level analysis, the building blocks proposed by Osterwalder are used. We use SPA, Osterwalder's business model analysis framework and the concept of modular business processes to search for interconnections between frameworks for the strategic positioning of services, business model analysis, and business process analysis. Our aim is to promote the understanding of synergy and

interfaces between these three approaches and also to connect them to the modular approach. As SPA concentrates on the corporate and planning level and business models on the architectural and business unit level, the business process approach adds one more and the most concrete level, an implementation and functional level.

Methodology

We use a qualitative research strategy for illustrating the three levels of the framework in a real-life case environment. There has been growing interest in a research strategy that allows qualitative analysis and use of the case study method in business research (Yin, 1981, 1994; McCutcheon and Meredith, 1993; Ellram, 1996; Hudson et al., 2004). According to Voss et al. (2002), case research has been one of the most powerful research methods in operations management. Qualitative methods are preferred if the goal is to explain or to understand a phenomenon, i.e. the aim is to develop our understanding of real-world events (McCutcheon and Meredith, 1993; Sachan and Datta, 2005). Case studies may also be used to support, expand, test and generate theory or raise doubts about existing theories (Eisenhardt, 1989; McCutcheon and Meredith, 1993). Qualitative methods provide a depth and richness that allows the researcher to probe the how and why questions (Ellram, 1996). In addition, the case study method is useful in the early phases of research (description, concept development) where there may be no prior hypotheses or previous work that could be used for research (Sachan and Datta, 2005). Case studies typically combine data collection methods from primary and secondary sources such as archives, interviews, questionnaires, and observations (Eisenhardt, 1989; McCutcheon and Meredith, 1993). Case studies can provide description and prediction on a smaller scale and single or multiple case studies can be used to describe a phenomenon (Ellram, 1996; Yin, 2003). In this study, we use a single case study for describing, analyzing and illustrating the three levels of the framework. As our aim is to develop our understanding of the topic, we will first test whether the framework is useful in real-case environments for analyzing strategic service positioning, business models, and business processes and their connections. We have collected information through open sources (e.g. internet) and from company interviews and internal material.

3. Strategic service repositioning analysis

As service industries have begun to play an increasingly important role in the economy, there has been a call for more profound strategic thinking with regard to services (Kellogg and Nie, 1995). Several authors have analyzed the efficiency of services and service delivery, and much of their work is based on the ideas presented originally by Hayes and Wheelwright (1979). The matrix presentation and analysis tool has been adopted by Apte and Vepsäläinen (1993), Kellogg and Nie (1995), Tinnilä and Vepsäläinen (1995), Collier and Meyer (1998), Schmenner (1986, 1990, 2004), Silvestro et al. (1992), Buzacott (2000), Heim and Sinha (2001), Metters and Vargas (2000) as well as Johansson and Olhager (2006). Most of the frameworks presented have proposed a matrix for analyzing the position of services and the effect of changing the position, i.e. strategic repositioning. For this study, we chose to use the SPA framework developed by Apte and Vepsäläinen (1993), Tinnilä and Vepsäläinen (1995) and Kallio et al. (2001) as it offers a normative framework for analysis for different types of services. Next, we describe the strategic repositioning framework (SPA) in more detail and then illustrate it in the logistics service context, as the focus of this paper is on the analysis of logistics services at industry and company levels.

3.1 Strategic service repositioning framework

SPA is a framework for analyzing relationships and services at a strategic level (Apte and Vepsäläinen,

1993; Tinnilä and Vepsäläinen, 1995; Kallio et al., 2001). In the SPA model, efficient service processes are seen as combinations of service characteristics and service delivery channels. Service types range from mass transactions and customized services to contingent relationships, while service delivery channels range from internal hierarchies to open networks such as the internet. The service outputs that are located on the diagonal of the matrix represent efficient combinations of services and their service delivery channels (Figure 2).

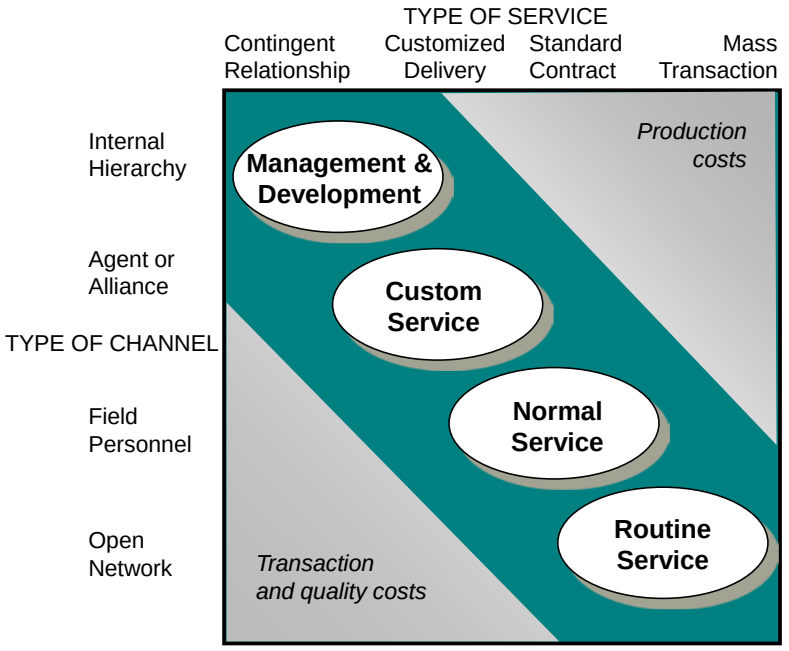

Figure 2.The SPA matrix: divergence of services (Sources: Apte and Vepsäläinen (1993); Tinnilä and Vepäsäläinen (1995); Kallio et al. (2001))

A pitfall commonly related to service processes is universal service, which refers to a variety of services offered to all customers using the same service channel, e.g. field personnel in branch offices. As a result of universal service, relationships with end-users are undeveloped. One type of inefficient service is to offer simple service with a close relationship because this leads to combination of high "production" costs and low levels of value adding activities. Another inefficient way is to offer complex services with a loose relationship leading to high-transaction costs and quality problems.

The SPA matrix can be used for positioning services at both industry and corporate levels. In terms of modularity, it divides different types of services and their efficient delivery structures in this module. At industry level strategic service repositioning constitutes a portfolio of modular service offerings. Moreover, at corporate level, the service portfolio is a mix of the company's modular service offerings. In this paper, we aim to describe the logistics service portfolio at both industry and corporate levels. Next, we focus on industry level strategic service repositioning of logistics services.

3.2 Strategic service repositioning in a logistics service context

As logistics is receiving increasing recognition as a competitive parameter, the focus is shifting to

more strategic considerations of service response and flexibility instead of simple make-or-buy decisions (Skjoett-Larsen, 2000). There are many good reasons to focus on research regarding logistics services. First, the outsourcing of logistics services is expected to increase (Ohmae, 1989; Coyle et al., 1992; Peters et al., 1998; van Laarhoven et al., 2000; Persson and Virum, 2001). Second, the logistics service industry is a young and emerging industry (Sink et al., 1996; Sink and Langley, 1997; Kuglin, 1998) which promises a positive future and new roles in supply chains and value networks for the logistics industry. This is supported, e.g. by Ojala et al. (2006); value added logistics services seem to be the fastest growing part of the transport industry. Moreover, e-commerce has created major changes in the structures and processes of distribution (Skjoett-Larsen et al., 2007). To summarize, in the future, logistics service providers are likely to continue to strengthen their value creation in supply chain networks both at global and local levels.

Meanwhile, we have seen that logistics and transportation services have been changing and diverging into several service segments. The multiple services provided earlier by transport and trucking companies have been broken down into several specialized services to attain lower costs (cut-rate trucking) or to offer value-added services (warehousing, packaging, price ticketing, final assembly, etc.) through third party and fourth party arrangements and alliances. Information technology has enabled new channels such as online services and real-time tracking of cargoes enabling customers to monitor their deliveries using data networks. At the other end of the spectrum, the management of customer relationships is the driving force of development. Contract logistics services with third and fourth parties, shared facilities, outsourcing and alliances provide a wide service mix from JIT-deliveries and distribution to full-scale services and supply chain solutions replacing the company-run order processing and warehousing functions. The continuing consolidation and deregulation within the logistics service industry has also resulted in the emergence of large companies that have the capabilities to offer sophisticated logistics solutions on a continental or even global scale. Recently, these logistics service providers strive to achieve a strategic role within the supply chain of clients, expanding their scale and scope of operations (Selviaridis and Spring, 2007). Consequently, it can be expected that these services provide a good setting for the analysis of service repositioning and new business models. One example of the divergence of logistic services and their repositioning in the strategic level SPA model at industry level is shown in Figure 3. This industry level analysis illustrates a portfolio of efficient service offerings.

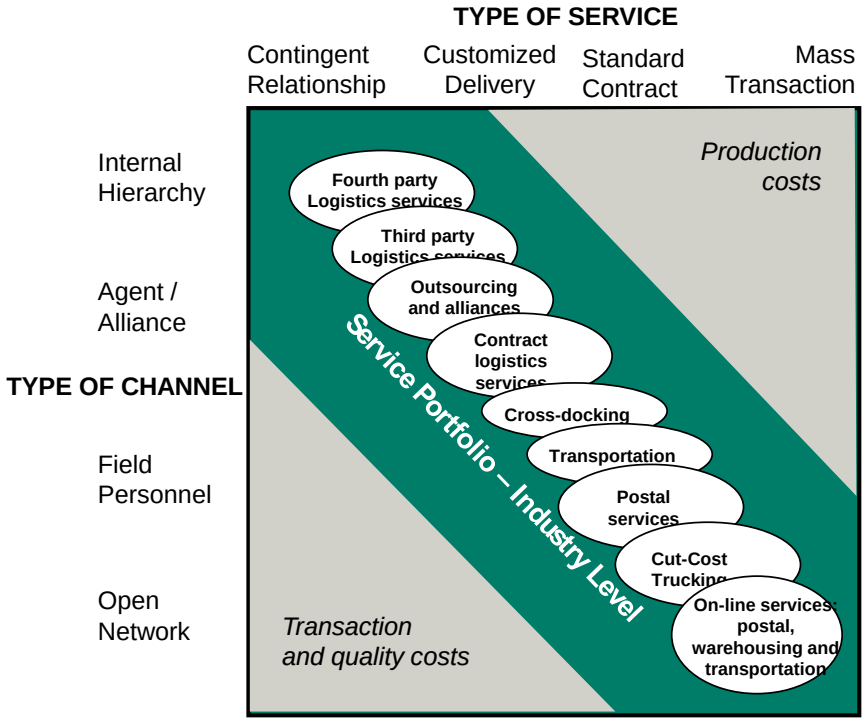

Figure 3. A Portfolio of efficient service offerings in the logistics service industry – an industry level analysis

At the industry and supply chain level, the SPA framework offers a useful starting point for designing efficient service and channel mix within and between organizations. The framework shows the development path, especially the divergence tendency. The tendency obviously adds to the challenges of SCM implementation and increases the need for separating, classifying, and prioritizing processes that have the greatest impact on supply chain performance. Pagh and Cooper (1998) call for effective management of a supply chain including creative thinking about how to integrate and perform logistics and manufacturing activities. For the best support of different business models this calls for a clear "packaging" of different types of logistics services, i.e. a clear segmentation of services. Later, we will analyze strategic service positioning at corporate level using the SPA model in the case of Itella Group and its logistics services. This is called corporate level analysis. Before taking up this kind of analysis, we will focus in the next section on the second module of the business model concept, as the aim of the paper is to match the strategic service positioning approach with the business model approach.

4. Business models

One of the great drivers changing the business environment has been the large-scale adoption and use of global digital networks. Global digital networks have led to reduced communication costs, new networks, joint value propositions, new distribution channel combinations and diversified and shared revenues – in other words, to an increasing number of possible business configurations, i.e. business models that a company can adopt. On the other hand, this has increased complexity and uncertainty

in business networks, the need for management concepts and tools, and the involvement of modularity aspects for managing these complex systems. Business has more stakeholders, becomes more complex, and is harder to understand and to communicate with (Osterwalder, 2004). This has increased the importance of business model research and its modularity aspect.

4.1 Definitions and positioning of the business model as a concept

The business model concept has become popular because today's managers have a wide variety of choices when it comes to defining their value proposition, configuring their value network, choosing their partners, looking for ways to reach the customer, and making many other similar decisions (Osterwalder, 2004). Generally, the purpose of developing any model is to assist in understanding, describing, or predicting actions in the real world by presenting a simplified representation of a particular entity or phenomenon. The business model is such an abstraction; it represents the business logic of a company. It is an abstract comprehension of the way a company makes money, in other words what it offers and to whom. Chesbrough (2006) notes that business models are challenging to develop, however effective business models are tremendously valuable asset to the company.

Relationships and interfaces between strategies, business models, and processes. Researchers have brought up the difference between strategy and business models in several studies (Stähler, 2002; Seddon et al., 2004). Most researchers recognize the relationship and interfaces between strategy and business models, while some also connect them to operative business processes. The distinction between strategy and the business model has received much attention. For example, Zott and Amit (2008) attempt a conceptual separation between strategy and the business model and state that "the business model is a structural template that describes the organization of a focal firm's transactions with all of its external constituents in factor and product markets." Casadesus-Mananell and Ricart (2007) maintain that "a company's strategy results in a particular set of choices, which, together with their consequences, constitutes a business model." Consequently, they regard business models as a reflection of strategy. Shafer et al. (2004) review articles on business models and classify the main components into strategic choices, value network, value creation, and value capturing. According to them, a business model is not a strategy, but reflects the strategic choices made and can be used to analyze and communicate the strategic choices. Along similar lines, Morris et al. (2003) link business models to strategic management by stating that strategic choices characterize a company, while business models make the choices explicit. They see that business models have elements of both strategy and operational effectiveness, i.e. processes. Tikkanen et al. (2005) recognize a company's network of relationships, strategy and structure, operations embodied in the company's business processes and resource base, as well as finance and accounting as the main elements of the business model. According to them, the components of the business model embody the strategy. Heikkilä et al. (2007) see three different interfaces between strategies, business models and networks, and maintain that companies are engaged in three adjustment processes: horizontally at the strategy-business model-interface between the companies, horizontally at the processes-business model-interface between the companies, and "vertically" within each company to align the strategies and processes to meet the challenges of cooperation.

Fjeldstad and Haanæs (2001) recognize that tradeoffs determine the fit between the competitive context of a firm and its internal value creation. This in essence means tradeoffs between strategic choices and value creating business models and processes. Fjeldstad and Ketels (2006) see value configurations as powerful tools for analyzing strategic positions and less important in the analysis of operations. They are of the opinion that strategic positioning relating to value configurations creates

value for customers.

To summarize the above discussion regarding strategy, business models and process models together, one can say that they address similar problems on different levels of business. The main difference is that the business model is a more concrete description of the operations of the company than the business strategy. Thus, a business model is positioned between business strategy and business processes. A business model is an expression of the company strategy in a concrete form, most often at a strategic business unit (SBU) level. In the business model, the vision and strategy of a company are translated into value propositions, customer relations, and value networks. Consequently, the business model is a suitable test-bed for the feasibility of the strategy. In the years of e-business hype, any new idea for a service was designated a "business model," often without any link to business strategy, and lacking an earning model.

Approaches on business models. Research in recent years has produced several business model definitions depending on the viewpoint taken. These range from a strategic level viewpoint to technological characterization. Business models can be seen for example as:

- a value configuration for attaining competitive advantage (Stabell and Fjeldstad, 1998; Fjeldstad and Haanæs, 2001; Pulkkinen et al., 2005);
- the organization or architecture of product, service, and information flows and the sources of revenues and benefits for suppliers and customers (Timmers, 1998) or reorganization of business structure (Walters, 2004);
- the product, service, information, and earning flows of the company, its position in the value network and a description of the advantages and income sources of different parties (Timmers, 1998; Rappa, 2000; Chapman et al., 2003; Kallio et al., 2006);
- an organization's core logic for creating value (Linder and Cantrell, 2000);
- a coherent framework that takes technological characteristics and potential as inputs and converts them through customers and markets into economic outputs (Chesbrough and Rosenbloom, 2002) and links ideas and technologies to economic outcomes (Chesbrough, 2006);
- a story that explains how an enterprise works (Magretta, 2002); and
- the implementation of strategy into a conceptual blueprint of the company's earning logic (Osterwalder and Pigneur, 2002; Osterwalder, 2004).

Several authors have proposed the main elements of business models, e.g. Pateli and Giaglis (2003) have grouped contributions into six different types of business models: definitions, components, taxonomies, representations, change methodologies, and evaluation models. According to Chesbrough (2003), a business model encompasses six functions: first, articulation of the value propositions that constitute the value created for users by the offering; second, identifying of market segment, i.e. the users to whom the offering and its purpose are useful; third, defining the structure of the value chain needed by the company to create and distribute the offering and define the complementary assets needed to support the company's position in this chain; fourth, specifying the revenue generation mechanism and estimating the cost structure and profit potential of producing the offering; fifth, describing the position of the company within the value network, linking suppliers and customers, including identification of potential complementors and competitors; and sixth, formulating the competitive strategy. Chesbrough (2006) identifies companies with six different types of business models those: with an undifferentiated business model, with some differentiation in their business model, developing a segmented business model, with an externally aware business model, integrating their innovation process with their business model, and with a business model that is able

to change and is changed by the market.

Rajala et al. (2001) depict a business model as consisting of four sub-models: a product development model, revenue logic model, sales and marketing model, and a servicing and implementation model. They also add competition, customers, resources and external financing as separate but important external influences on the operating environment. Fjeldstad and Haanæs (2001) present three different value creation types: value chain, value shop, and value network. Value chains sell products that are the outcome of a transformation process. Customers pay for the total quality of the product or product/service package. Value shops sell competencies and approaches to help solve unique problems. The customers pay for solutions to – or effort spent on – their problems. Value networks sell mediation between customers or places. The customers pay both for access to the network and for exchanges via the network. If the business is to function as an integrated unit, there must be a single dominant model that defines the value configuration model of the firm. In many cases, the overarching model is a strategic choice. It is not dictated by the industry. The choice of the dominant business model will determine not only a company's overall strategy but also the main drivers of operations. However, many companies have divided their businesses in separate divisions based on different business models.

Osterwalder (2004) strives to build a synthesis of the business model literature, and defines nine business model building blocks consisting of four pillars: Pillar 1 product/ offer (value proposition), Pillar 2 customer interface (target customer, distribution channel, relationship), Pillar 3 infrastructure management (value configuration, capability, partnership), and Pillar 4 financial aspects (cost structure and revenue model) (Table I).

Table I. The nine business model building blocks and their descriptions (Source: Osterwalder, 2004)

Pillar	Building block of business model	Description
Product	Value proposition	A value proposition is an overall view of a company's bundle of products and services that are of value to the customer
Customer interface	Target customer	The target customer is a segment of customers a company wants to offer value to
	Distribution channel	A distribution channel is a means of getting in touch with the customer
	Relationship	The relationship describes the kind of link a company establishes between itself and the customer
Infrastructure management	Value configuration	The value configuration describes the arrangement of activities and resources that are necessary to create value for the customer
	Capability	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer
	Partnership	A partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer
Financial aspects	Cost structure	The cost structure is the representation in money of all the means employed in the business model
	Revenue model	The revenue model describes the way a company makes money through a variety of revenue flows

Osterwalder refers to value configuration as a description of the arrangement of activities and resources that are necessary to create value for the customer. We point out that a company can use

three fundamentally different value configuration models as Stabell and Fjeldstad (1998), Chesbrough (2003, 2006) and Fjeldstad and Haanæs (2001) have proposed. These different value configurations influence both the business models and the services offered.

As the preceding discussion illustrates, the definition of a business model varies from author to author. There is no consensus or mutual understanding in academia how business models should be defined and what should be included. For testing how to bridge the strategic view of the SPA model with business model analysis we use Osterwalder's building blocks model as a tool, as it contains the main elements at the architectural level of business.

5. Business processes

The third module of our framework focuses on business processes. As globalized businesses face more competition, the cycle time for introducing products and services becomes shorter and customers more demanding. This drives enterprises to adopt systems and business models the not only provide operational efficiency, but also to add strategic value to their products and services (Ghodeswar and Vaidyanathan, 2008) and to redesign their supply chains (Rodrıguez-Dıaz and Espino-Rodrıguez, 2006). Recently, customer needs and expectations are changing rapidly and, e.g. logistics services are offered in a global market place. This has a profound influence on how the operational business processes should be organized for efficient service delivery. Consequently, a growing number of service users presently want fast, reliable, and cost-effective logistics processes (Persson and Virum, 2001). Besides, the distinction between strategy and business models, business models and business process models should also clearly be distinguished. A review of the business model literature shows that the business model concept is generally understood as a view of the company's logic for creating and commercializing value, while the business process model is more about how a business case is implemented in processes (Osterwalder et al., 2005).

Business processes are defined as activities that produce a specific output of value to the customer. Moreover, the process can be defined as a set of logically related activities and resources needed to transform inputs to outputs. In organizations, the focus is on processes that are critical to success. These processes are often referred to as "business processes," "principal processes," "core processes," or "key processes." Hanafizadeh and Moayer (2008) underline the importance of defining the strategic processes or processes with a strategic nature. These critical processes are often presented in a process map. At best, processes go from customer to customer through departmental and organizational boundaries as process thinking permeates organizational and functional boundaries. Typical core processes are, e.g. product and service development, customer commitment, order fulfillment, and customer support (Laamanen and Tinnilä, 2009). Both Cooper et al. (1997) and Lambert et al. (1998) suggest several key processes that could be linked across the supply chain: customer relationship management, customer service management, demand management, order fulfillment, procurement, manufacturing flow management, product development and commercialization, and returns. An important question is what processes should be linked with each of the supply chain members, and with what kinds of links (Cooper et al., 1997; Lambert et al., 1998; Lambert, 2006). Consequently, there is a need to define key business processes that are critical and beneficial to integrate and manage across the supply chain as well.

Business process reengineering (BPR) has been a popular research topic in recent decades. BPR aims at showing companies how to organize functionally separated tasks into unified horizontal business processes, creating value for customers (Hammer, 1990). The basic idea behind conceptualizing and categorizing business processes in organizations is to identify and design repeatable business processes that have enough elements of consistency (e.g. clearly identified inputs and outputs) to

justify developing a common, "averaged" process for an organization (Stoddard et al., 1996). This could be seen as a way to modularize business processes.

Being one of the core competences of logistics service companies, the delivery process encompasses activities ranging from placing orders to receiving products and services. An organization's delivery process might include activities such as order handling, procurement and production planning, production, testing, warehousing and transporting to the customer. Key issues in designing the process concern the extent to which products and services are standardized. Here, the main alternatives are standard product delivery from stock, predetermined components which are assembled according to the customer's order, and partly or totally customized project delivery (Laamanen and Tinnilä, 2009).

Baldwin and Clark (1997) divide modularity into modularity in the design of products and modularity in the use of products. They argue that modularity in production has a long history, as manufacturers have divided the manufacturing process into modules allowing a complicated process to be split up among different production facilities or even outsourced. According to Baldwin and Clark, a wide range of services is also being modularized. However, we see that the research towards modularity in services is still at an early stage.

Pekkarinen and Ulkuniemi (2008) identify "3D modularity" as:

- modularity in services;
- modularity in processes; and
- modularity in organization.

They claim that in order to use modularity in service development, each of these dimensions needs to be considered. A service, which is visible to a customer can be combined with one or several service modules. With regard to processes, a service production process is formed from one or several process modules that can, furthermore, either be related to information processing or physical operations. Finally, they see modularity in organization as a way to use the firm's own and other firms' resources in a flexible way. A modular organization is composed of organizational modules.

In the next section, we present the Itella Group case, where we will focus on three business processes that we have selected from the literature above (Cooper et al., 1997; Lambert et al., 1998): the customer relationship management process, the customer service management process and the manufacturing flow management process (in this case logistics service production process). The customer relationship management process focuses on identifying different types of customer groups. Customer service management illustrates the use of the modular services in the customer interface. On the other hand, describing the service production process clarifies how the service production has its base in the modular production structure (or processes).

6. A case example of logistic services, business models, and business processes

As markets become more competitive it is often necessary to increase service divergence, i.e. differentiate services to differing positions by offering a greater variety of services and channel options for the customers. "One size fits all" does not really need to be the solution for all relationships with supply chain members (Dyer et al., 1998; Lambert and Cooper, 2000). For background, during the past decade the European logistics service market has changed dramatically. One of the major drivers has been the deregulation of the European transport market. Mergers and acquisitions in the logistics service provider industry in Europe have led to a market with a few

dominant players with global coverage and diversified activities, and a large number of small and medium-sized service providers with a regional and a more specialized service portfolio. For example, the Denmark-based transport and logistics company DSV A/S has developed through aggressive organic growth and acquisition to become one of Europe's largest transport and logistics players. It now operates in 100 countries internationally. DSV's two largest acquisitions in the transport sector have been Samson Transport in 1997 and DFDS in 2000 (www.supplychainleaders.com/ providers/).

As our case company is Itella Group, the former Finland Post, we will now briefly illustrate the changes in European postal services that have resulted from the liberalization process. The liberalization process has been a challenge for the postal services in Europe and has caused many changes in this sector with corresponding service repositioning. For Itella many of the changes are due to Finland's accession to the European Union (EU) in 1995, and we describe Itella Group's position in this service sector. Since 1996, we have seen waves of mergers and acquisitions in the European postal sector. For example, the Dutch Post Office acquired TNT in 1996 (the global logistics provider), in 1999 Tecnologistica (an Italian TPL service provider), in 2000 CTI (a US-based logistics service provider specializing in automotive logistics), and in 2005 the Wilson Group (an international airfreight service provider) (Skjoett-Larsen et al., 2007). In 2005, it acquired TG þ , a leading Spanish domestic distribution company and in 2006 Speedage, an Indian domestic express company and Hoau Group, a nationwide road transport and freight business company from China. In 2006, TPG Post changed its name to TNT Post. Recently, the company focuses more on small packages deliveries. The other big player in European markets, Deutsche Post acquired Danzas in 1999 (the Swiss transport and forwarding company) and later the Swedish ASG, the US-based AEI (international airfreight forwarder), DHL (global integrator), and in 2005 the large UK-based logistics service provider Exel. All the acquired companies now use the common brand, DHL (Skjoett-Larsen et al., 2007, p. 279). In the Scandinavian countries, one of the latest developments is the merger of the Danish and Swedish postal services. The merger is necessary as both postal services were facing increasing competition from foreign actors such as Deutsche Post, Finland's Itella Group, and TNT of The Netherlands (www.iht.com/articles/ap/2008/04/01/business/EU-FIN-Denmark- Sweden-Postal-Merger.php). In this European playground, our case company Itella Group is a strong partner for mail order solutions in Scandinavia and the Baltic Countries. This is shown, e.g. by the recent alliance of Nordic Postal services within the Baltic countries (www.pannordic.com/en/Company/Press/Pressreleases/Pan-Nordic-Logistics-Nordic-post-alliance-expands-in-the-Baltic-Region/). Itella provides its customers business-to-business and business-to-customer solutions from the management and transport of goods and information to managing the accompanying financial transactions. Next, we analyze the services offered and modular processes used by the Itella Group. We analyze the services with Osterwalder's business model building block model and the SPA matrix.

6.1 Itella Group: the case company

In the case analysis, publicly available material (www.itella.com), as well as interviews and internal material were used. Itella Group is a logistics service company providing services for managing customers' information and material flows. The Group operates in ten Northern European countries, providing consumer services under the Posti brand in Finland and corporate services under the Itella brand at the international level. Key customer industries are the retail and wholesale trade, the media, the finance and telecommunications industries, and the public sector. In 2007, Itella Group reported net sales of e1,688 million and employed approximately 25,000 staff, of whom 8 percent, or some 1,900, work outside Finland. The Group's parent company is Itella Corporation, which is entirely owned by the Finnish State. In Finland, Itella serves 250,000 corporate customers and the post some 5.3 million consumer customers. Improving customers' experience is the key theme of Itella's strategy. While most of its direct customers are companies and organizations (95 percent), the

majority of the end-users of services are consumers (over 90 percent). The satisfaction of both customer groups is vital for success. Smooth flows of information and material are Itella's mission.

Itella produces added value for the businesses of corporate customers by supporting vital corporate processes with mail communication, information flow management, and service logistics solutions. Service logistics refers to goods flow management, i.e. freight, warehousing, and transport services, which are offered by Itella logistics. For consumers, Posti offers a wide range of multi-channel services for sending, receiving, e-transactions, and special occasions. In Finland, Itella's market leadership is based on an efficient service and delivery network, which allows it to offer extensive multi-channel services throughout the country. In the international market, innovative, technology-based services and customer-focused operations distinguish Itella from its competition. Factors that have a major impact on Itella's strategy and business include the progress of digitization, changes in customer behavior, global competition and ecological corporate responsibility requirements.

Itella Group's operations are organized into the following three business groups: Itella Mail Communication (51 percent of net sales in 2007) provides letter, direct-mail and magazine/newspaper delivery services in Finland and on a global basis through partners; Itella Information (12 percent of net sales in 2007) provides corporate customers in nine countries with solutions for boosting their information flow management. It receives, processes, converts, stores, archives, channels, and transmits information on behalf of its customers in both printed and electronic form. Its services are related to document communication and document management. Itella logistics (36 percent of net sales in 2007) is a service logistics provider in northern Europe and operates elsewhere through partners. Its services encompass freight and forwarding, contract logistics, and parcel services. Itella's intelligent logistics solutions can be integrated directly with the customer's own information systems. Moreover, for consumers Itella offers NetPosti, an electronic transaction service. NetPosti is an alternative to a physical mailbox coupled with a file archive.

Osterwalder's (2004) model helps us get a general view of Itella's business architecture (Table I) and to analyze some of its services (Table II) in a standardized and modularized way.

Table II. Nine business model building blocks of Itella Group (Sources: www.posti.fi; for building blocks see Osterwalder, 2004)

Building block of business model	Description
1. Value proposition	Itella Group is an intelligent logistics service company providing services for managing the customers' information and material flows Services for consumers: standard delivery includes all letters, newspapers, magazines, and parcels. Separately charged additional services: home delivery, delivery to a temporary address, chargeable standard delivery; NetPosti Services for businesses: letter, direct mail and newspaper delivery services, e-letter, contract logistics; service logistics provider, with partners enabling operations on a global basis, freight and forwarding, contract logistics and express and parcel services; information flow management
2. Target customer	Consumers and businesses (Separate brands). Approximately 96 percent of net sales from companies and organizations. International business accounts for 25 percent of net sales

3. Distribution channel	Sales Network: in 2007, 197 Itella's own post offices (plans to shut down 17 offices) and some 1,000 postal agency shops that operate in connection with a shop, kiosk, service station or other service company; delivery rounds
4. Relationship	Itella's basic task is to provide postal services for everyone in Finland through its nationwide delivery and outlet network
5. Value configuration	Mediation between customers or places and value is created through connecting customers with each other
6. Capability	About 25,000 employees. Partner network
7. Partnership	Partners enabling operations on a global basis
8. Cost structure	Fixed costs of network, staff, infra, equipment. Payments to partners
9. Revenue model	Fixed tariffs and rates for consumers. Contract prices for businesses

6.2 Strategic positioning of logistics services offered by Itella Group

The value propositions – in this case services of Itella Group – are shown in Figure 4 with the SPA matrix shown earlier in Figures 2 and 3. In Figure 3, we have shown an industry level analysis with a portfolio of efficient service offerings in the logistics service industry in general. This part presents a corporate level SPA analysis of Itella Group's service portfolio. The aim is to illustrate the strategic repositioning of Itella's services. The standard services, i.e. letter and package services are based on service personnel and they are very labor intensive. They are also mass transactions. The e-post service, which is designated for example, for mass mailing of bills and offered to public sector and large companies, also serves mass markets, but it is based more on open electronic networks combined with standard services. Mass mailing services are standardized services for the business-to-business market. Home deliveries are more customized services, and still based largely on personnel. Kiosk services (postal agency shops) are partly outsourced services, i.e. they are provided by other firms acting in alliance with Itella. Moreover, Itella offers several types of contract logistics services, e.g. transports and warehousing. In addition, more customized and more complete solutions for outsourced service are offered. In the matrix, many consumer services have been repositioned toward more standardized service types, while many company services have moved toward higher customization and alliance type relationships.

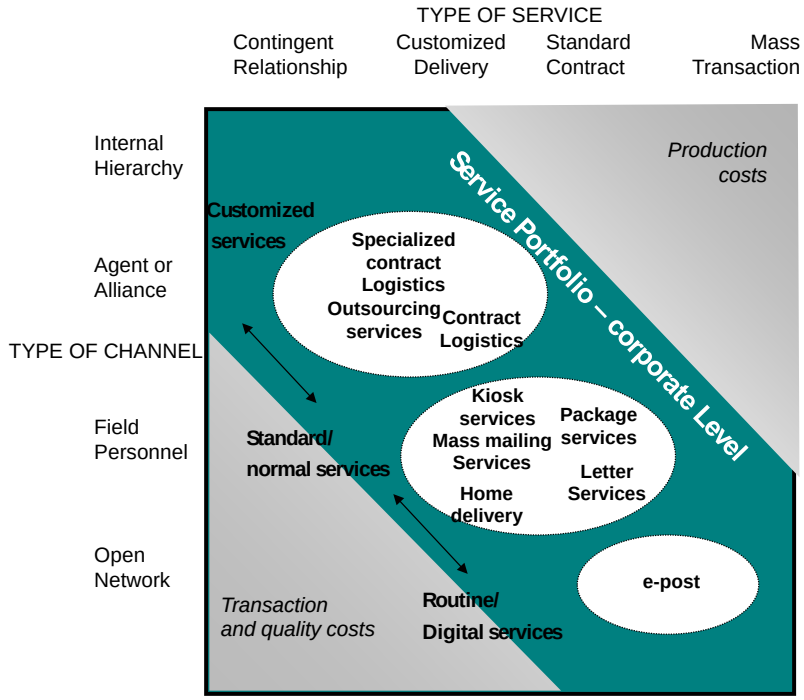

Figure 4. The portfolio of efficient service offerings in Itella Group – a corporate-level SPA analysis

6.3 Business models in logistics services offered by Itella Group

The services presented above are examples of the differentiated business models that Itella uses in its services. We have chosen four of them for an in-depth analysis of their building blocks with Osterwalder's model in Table III. This is a general level analysis, as the focus is on highlighting the differences in the building blocks. The value propositions show a degree of divergence in services, which is reflected in relationship types, distribution channels, cost structures, and revenue models. The detailed business model building block analysis facilitates understanding of the strategic positions held by services in the SPA matrix, while the SPA points out the underlying inefficiencies. The analysis of building blocks also reveals inconsistencies within a business model. For example, there should be a match between cost structures and revenue models and between value configurations and partnership types as well.

Table III. The divergence of Itella Group's services and business models analyzed with Osterwalder's model

Building block of business model	e-post	Letter service	Package service	Contract logistics
1. Value proposition	More efficient letter service by combining digital networks and letter service	Standard postal service	Standard postal service for different types of packages	Extensive logistic service package consisting of, e.g. warehousing services
2. Target customer	B-to-B mass mailers	Both consumers and firms	Both consumers and firms, but B-to-B dominant	B-to-B customers with outsourcing strategies
3. Distribution channel	B-to-B sales personnel	Shops (branch offices)	Shops (branch offices) and kiosks, contract services	Sales personnel
4. Relationship	Long term contract	Transaction based or contract	Transaction based or contract	Multiyear contract
5. Value configuration	Internet and letter service	Own postal network	Own postal network	Internal logistic services and partners
6. Capability	Internet and internal (Itella) network	Countrywide network	Countrywide network	European and global network
7. Partnership	Partnership with teleoperators	Own, internal network	Own, internal network	Internal network and partners
8. Cost structure	Fixed costs of network, very low per unit costs	High fixed costs of network, low unit costs	High fixed costs of network, low unit costs	Infrastructure and equipment costs
9. Revenue model	Contract fee with small unit fee	Unit fees/ contracts for B-to-B	Unit fees/contracts for B-to-B	Contract-based fee

6.4 Itella Group's processes

Strategy, business models, and process models address similar problems on different business levels. Strategy focuses on corporate/group and planning level, business models on the business unit and architectural level, and business processes on the functional and implementation level. Different types of standard and customized services can be produced by combinations of process modules. We argue that as there should be a match between strategic service position and business models, a corresponding match should exist between business models and their implementation level counterparts, i.e. business processes.

Next, we will focus on three business processes and their modularity in the business models of e-post, letter, package, and contract logistics services. The three processes depicted are customer relationship management process, customer service management process, and manufacturing flow management process (in this case logistics service production process).

The customer relationship management process focuses on identifying different types of customer groups. Itella Group focuses on two different types of customers: consumers and organizations – companies and public sector organizations. We can find some similarities (synergies) and differences regarding how different types of services are offered and organized to these customer groups.

Customer service management illustrates the use of modular services in the customer interface. Itella Group offers letter services to consumers and companies/ public organizations. Letter services for companies and public organizations are contract-based and may include letter pick up from an organization's premises while consumers deliver their letters themselves to mailboxes or post offices. The package (parcel) service for companies and public organizations is similar to the letter service (Figure 5). Typically, the same contract includes both types of services. E-post services are offered to companies and public organizations. In this service, customers send their e-letters electronically to the printing service unit where letters are either printed or forwarded in electronic form to customers. Contract logistics, e.g. warehousing services are typically based on more complex customized contracts and could include picking up and packing and final assembly.

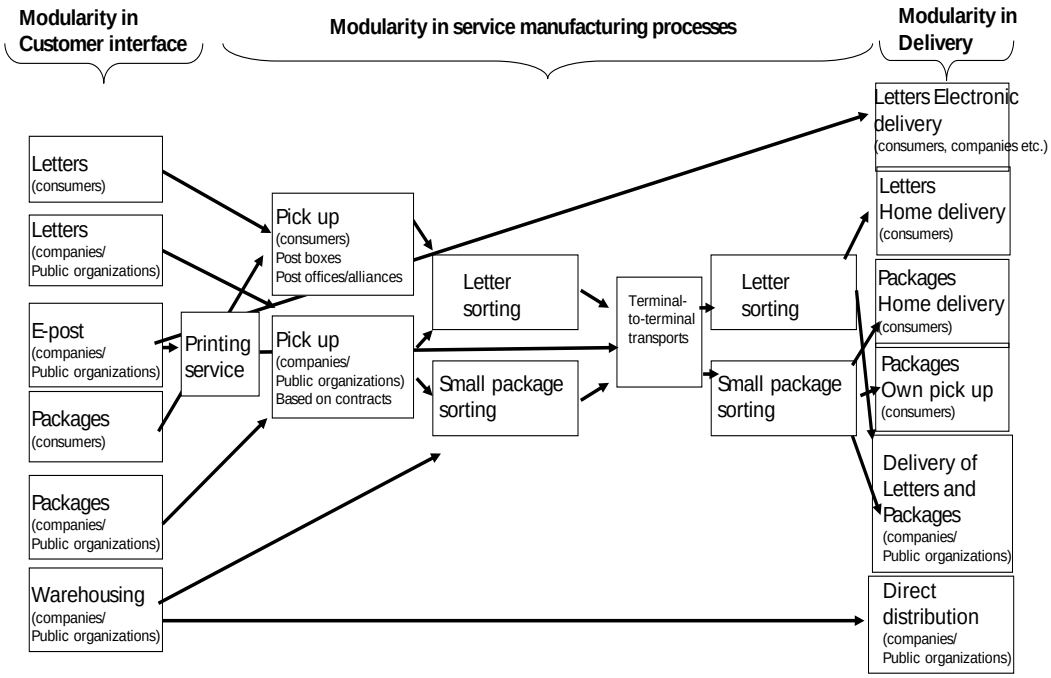

Figure 5. The modularity of Itella Group's business processes

The service production process clarifies how the service production has its base in the modular production structure and processes. For letters to consumers and company/public sector customers, the production process is the same in letter sorting module as well as terminal-to-terminal transport. The sorting process for small packages is different from the letter sorting process as it uses different types of machines. For contract logistics, warehousing services are typically done in warehouse premises and products are typically transported directly to customers of the company/public organization.

6.5 Analysis of the Itella Group

In the analysis of the illustrative case, we have used the frameworks for different levels. The Itella case emphasizes the need for matching strategies, business models, and processes. Restructuring of the logistics market and liberalization and opening of electronic channels have influenced the repositioning of the strategic position of Itella Group as a logistics service company, which is also in charge of postal services in Finland. Introduction of new innovative services has been partly necessitated by increased competition in previously unchallenged areas. New business models have been introduced in e-business logistics, e-post solutions and contract logistics.

However, the case study indicates that these changes are not yet fully reflected in business models. Several key building blocks of business models, such as value propositions and delivery channels, seem to have remained much the same, despite the strategic repositioning. For example, the distribution channel has not fully followed the change in strategy in all business models, as digital channels are not yet fully utilized. Similarly, cost structures have remained much the same, as Itella has the high-fixed costs of its own internal countrywide network, in addition to the new internet-based networks. Consequently, it seems that at the moment several business models are overlapping, as conventional and internet-based service (e.g. e-post) answer to the same customer needs.

New business processes have been introduced both in the customized services and in the routine digital services. Many of the production processes are based on joint processes, as shown in Figure 5, where the process flows have remained the same. The changes required are made by adding new process modules such as electronic letter delivery or by setting differentiated process requirements, e.g. in terms of throughput time. Some of the main processes, such as letter and package sorting, have large-scale economies and are consequently not easily changed.

7. Discussion and conclusions

The range and scope of logistics services have clearly extended during the recent decades. Consequently, a multitude of new business models in different strategic positions have emerged in the market. This paper analyzes the relation and match of frameworks for analysis of service strategies, business models, and business processes. Particularly, the aim has been to connect business model approach, i.e. analysis of different options for value creation, to analysis of efficient delivery of services. The background for both approaches is based on literature of business models, value creation, logistics services, service strategies, and efficient service deliveries. We have also connected the modular business process approach to frameworks for service strategies and business models. In summary, we have aimed to present a meta-framework about the relations of the approaches to each other and how to coordinate three levels of business frameworks at planning level, architectural level and implementation level.

Owing to increasingly complex business networks and supply chains, as well as, needs of more demanding customers, business model research has obtained increased attention. In this paper, we provide a way to connect business models with efficient delivery of services. We introduce a framework for developing business and services by connecting Osterwalder's (2004) nine business model building blocks with the service process positioning matrix (SPA) (Tinnilä and Vepsäläinen, 1995). Osterwalder's model offers a useful framework for analysis of the key elements of business. Although the benefits of business model thinking are clear, a drawback is that the interlinked connections between building blocks seem to fade. Business model thinking does not provide any tools for analyzing efficient delivery of services. The SPA model helps to bridge this gap and connects the business model framework with the mix of efficient service outputs by facilitating the analysis of

efficient delivery channels.

7.1 Theoretical implications

Strategy, business models, and process models are closely linked, as they focus on the same challenges in organization, although on different levels. Business models are concrete descriptions of how a company fulfils its value proposition in different businesses at the SBU-level, while strategy is a tool for planning and management at corporate level. By defining and executing different business models and their building blocks, such as value configurations, a company realizes its visions and strategic plans. The different types of services a company offers are produced by combinations of business processes and their modules. We maintain that a match should exist between the different levels, and thus strategies, business models and business processes need to be aligned to provide value to customers efficiently. At industry level, a corporation positions itself by defining a portfolio of value offerings to its customers. The value offerings are realized by business models consisting of different building blocks.

7.2 Managerial implications

We argue that the different value configurations influence both the service strategy and business models and processes. With the help of the framework presented it is possible to find a match between service strategy, business models, and operational level business processes. We maintain that the delivery channel, i.e. how the service is delivered to customers, should match with the value proposition and capabilities of the company. For example, a customized contract logistic service-package requires different capabilities than a standard delivery, with accordingly different processes. Standardization, modular services, and service production structures are useful tools for efficient service production and output. Frameworks help to find a match between strategic service position of the company and the types of business models, and a corresponding match between business models and their building blocks, including business processes. For the management, the frameworks presented facilitate analysis of the different options available for the firm.

The case analysis of a large logistic service company illustrates the challenges and practices of these three levels. The case comes from industry, where the market structure has changed significantly, and forces players into strategic repositioning. The logistics industry has undergone many of these repositionings due to mergers, market liberalization, and introduction of EU-wide markets. The recent economic depression will certainly result in more. Strategic repositioning can determine a suitable combination for providing the core competencies of a corporation to markets in a new situation. We also point out that when corporations reposition themselves at strategic level, they exert a direct impact on the business model and process levels. The levels should match for efficient structures and operations.

Figure 4 shows how the strategic repositioning creates needs to change the business models and their building blocks. These in turn necessitate changes in business process flows and measures. Quite often an analysis reveals inconsistencies between these levels. In the illustrating case example, the strategic level changes were not fully reflected in the changes of business models. As the business model has been defined as a tool for business unit level planning in choosing the right combination of building blocks, elements such as value proposition and configuration and delivery channel underwent only moderate change in the case. Similarly, as business processes are the practical elements needed for implementing the activities, the right process flows and measures must be chosen for each business model. The measures are the means for managing the processes and setting targets for them. In our case, for example, the variations in process flow between delivery processes

are small, although some measures, e.g. throughput or customer response times, differed more.

Figure 6 shows the interfaces and interdependence of the three levels recognized. For example, a strategic repositioning due to changed markets can be seen in the changed position in the SPA model. Consequently, some changes are needed to the building blocks of business models, e.g. increased standardization in value proposition. To match these changes, process flows and measures need to be changed. The trend is toward more streamlined processes with less variation in time to fulfill the more standard business model.

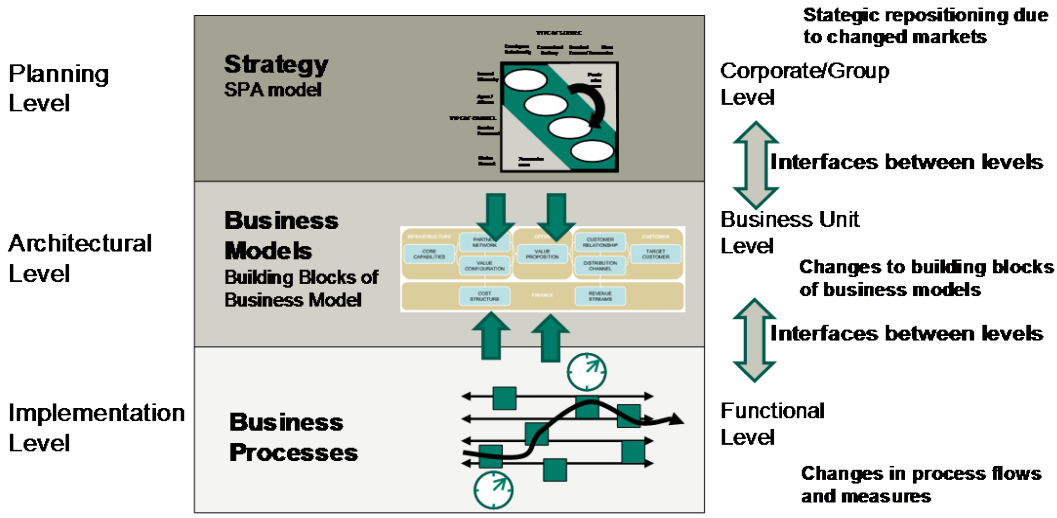

Figure 6. The framework showing the relationship between strategic service positioning, business models, and business processes

In this study, we have recognized the interdependence between the levels of strategic repositioning at corporate level, the architecture consisting of business models at business unit or divisional level, and the implementation of business at business process level. To successful provide value to customers, corporations must match these levels. This is of particular importance in strategic level repositioning, as the corresponding changes at business model and process levels are often omitted.

Managerially, recognition of the interconnections between these levels will facilitate better realization of strategic choices, as the framework will help management to find a match between the strategic service position of the company and its business model and the corresponding match with business processes. As companies are constantly evaluating the need to reposition and to develop new business models for increased earnings, the analysis brings to mind the need to revise business processes accordingly. The framework assists in the analysis of the different options available to the firm.

7.3 Future research topics

Further studies should be made on the relationship of the three levels recognized, as most of the

present studies have focused just on one of the levels. While the relationship of strategy and strategic position with business models has received some attention by several authors, the linkages between business models and business processes have received scant attention. Also, further empirical research should be made to facilitate modeling and measuring the relationships between the different levels. Furthermore, the possibilities created by modular business models and processes should be further analyzed.

References

Amit, R. and Zott, C. (2001), "Value creation in e-business", Strategic Management Journal, Vol. 22 Nos 6/7, pp. 493-520.

Apte, U.M. and Vepsäläinen, A.P.J. (1993), "High tech or high touch? Efficient channel strategies for delivering financial services", Journal of Strategic Information Systems, Vol. 2 No. 1, pp. 39-54.

Baldwin, C.Y. and Clark, K.B. (1997), "Managing in an age of modularity", Harvard Business Review, Vol. 75 No. 5, pp. 84-93.

Barratt, M. (2004), "Understanding the meaning of collaboration in the supply chain", Supply Chain Management, Vol. 9 No. 1, pp. 30-42.

Buzacott, J. (2000), "Service system structure", International Journal of Production Economics, Vol. 68, pp. 15-27.

Casadesus-Mananell, R. and Ricart, J. (2007), "Competing through business models", IESE Business School Working Paper No. 713, Harvard Business School Press, Boston, MA, November.

Chapman, R., Soosay, C. and Kandampully, J. (2003), "Innovation in logistic services and the new business model – a conceptual framework", International Journal of Physical Distribution & Logistics Management, Vol. 33 No. 7, pp. 630-50.

Chesbrough, H. (2003), Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press, Boston, MA.

Chesbrough, H. (2006), Open Business Models: How to Thrive in the New Innovation Landscape, Harvard Business School Press, Boston, MA.

Chesbrough, H. (2007), "Why companies should have open business models", Sloan Management Review, Vol. 48 No. 2, pp. 22-8.

Chesbrough, H. and Rosenbloom, R.S. (2002), "The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies", Industrial and Corporate Change, Vol. 11 No. 3, pp. 529-55.

Collier, D.A. and Meyer, S.M. (1998), "A service positioning matrix", International Journal of Production and Operations Management, Vol. 18 No. 12, pp. 1123-244.

Cooper, M.C., Lambert, D.M. and Pagh, J.D. (1997), "Supply chain management: more than a new name for logistics", The International Journal of Logistics Management, Vol. 8 No. 1, pp. 1-14.

Coyle, J.J., Bardi, E.J. and Langley, C.J. (1992), The Management of Business Logistics, West Publishing, St Paul, MN.

Delfmann, W., Albers, S. and Gehring, M. (2002), "The impact of electronic commerce on logistics service providers", International Journal of Distribution and Logistics Management, Vol. 32 No. 2, pp. 203-22.

Dyer, J.H., Cho, D.S. and Chu, W.J. (1998), "Strategic suppliers segmentation: the next best practice in supply chain management", California Management Review, Vol. 40 No. 2, pp. 57-77.

Eisenhardt, K.M. (1989), "Building theories from case study research", Academy of Management

Review, Vol. 14 No. 4, pp. 532-50.

Ellram, L.M. (1996), "The use of the case study method in logistics research", Journal of Business Logistics, Vol. 17 No. 2, pp. 93-138.

Fjeldstad, Ø.D. and Haanæs, K. (2001), "Strategy tradeoffs in the knowledge and network economy", Business Strategy Review, Vol. 12 No. 1, pp. 1-10.

Fjeldstad, Ø.D. and Ketels, H.M. (2006), "Competitive advantage and the value network configuration – making decisions at a Swedish life insurance company", Long Range Planning, Vol. 39, pp. 109-31.

Ghodeswar, B. and Vaidyanathan, J. (2008), "Business process outsourcing: an approach to gain access to world-class capabilities", Business Process Management Journal, Vol. 14 No. 1, pp. 23-38.

Hamel, G. and Prahalad, C.K. (1989), "Strategic intent", Harvard Business Review, Vol. 67 No. 3, pp. 63-74.

Hammer, M. (1990), "Re-engineering work – don't automate, obliterate", Harvard Business Review, Vol. 68 No. 4, pp. 104-12.

Hanafizadeh, P. and Moayer, S. (2008), "A methodology to define strategic processes in organizations: an exploration study in managerial holding companies", Business Process Management Journal, Vol. 14 No. 2, pp. 219-27.

Hayes, R. and Wheelwright, S. (1979), "Linking manufacturing process and product life cycles", Harvard Business Review, Vol. 57 No. 1, pp. 133-40.

Hayes, R. and Wheelwright, S. (1984), Restoring Our Competitive Edge: Competing Through Manufacturing, Wiley, New York, NY.

Heikkilä, J., Heikkilä, M. and Tinnilä, M. (2007), "The role of business models in developing business networks", in Becker, S.A. (Ed.), Electronic Commerce: Concepts, Methodologies, Tools, and Applications, Information Science Reference (an imprint of IGI Global), Hershey, PA.

Heim, G. and Sinha, K. (2001), "A product-process matrix for electronic B2C operations: implications for the delivery of customer value", Journal of Service Research, Vol. 3 No. 4, pp. 286-99.

Hudson, D., Lee-Hong, S., Hite, D. and Haab, T. (2004), "Telephone pre-surveys, self-selection, and non-response bias to mail and internet surveys in economic research", Applied Economic Letters, Vol. 11 No. 4, pp. 237-41.

Johansson, P. and Olhager, J. (2006), "Linking product-process matrices for manufacturing and industrial service operations", International Journal of Production Economics, Vol. 104 No. 2, pp. 615-24.

Kallio, J., Tinnilä, M. and Tseng, A. (2006), "An international comparison of operator-driven business models", Business Process Management Journal, Vol. 12 No. 3, pp. 281-98.

Kallio, J., Saarinen, T., Tinnilä, M. and Vepsäläinen, A.P.J. (2001), "Measuring delivery process performance", International Journal of Logistics Management, Vol. 11 No. 1, pp. 75-87.

Kellogg, D.L. and Nie, W. (1995), "A framework for strategic service management", Journal of Operations Management, Vol. 13 No. 4, pp. 323-37.

Kuglin, F.A. (1998), Customer Centered Supply Chain Management, AMACOM (American Marketing

Association), New York, NY.

Laamanen, K. and Tinnilä, M. (2009), Prosessijohtamisen kä sitteet (Terms and Concepts in Business Process Management), 4th ed., Teknova, Federation of Technology Industries, Helsinki.

Lambert, D.M. (Ed.) (2006), Supply Chain Management: Processes, Partnerships, Performance, 2nd ed., Supply Chain Management Institute, Sarasota, FL.

Lambert, D.M. and Cooper, M.C. (2000), "Issues in supply chain management", Industrial Marketing Management, Vol. 29, pp. 65-83.

Lambert, D.M., Cooper, M.C. and Pagh, J.D. (1998), "Supply chain management: implementation issues and research opportunities", The International Journal of Logistics Management, Vol. 9 No. 2, pp. 1-19.

Linder, J. and Cantrell, S. (2000), Carved in Water: Changing Business Models Fluidly, A working paper from the Accenture Institute for Strategic Change, available at: www.accenture.com/ Global/Research_and_Insights/Institute_For_High_Performance_Business/By_Subject/ Strategy/CarvedInWater.htm (accessed January 30, 2008).

McCutcheon, D.M. and Meredith, J.R. (1993), "Conducting case study research in operations management", Journal of Operations Management, Vol. 11, pp. 239-56.

Magretta, J. (2002), "Why business models matter", Harvard Business Review, Vol. 80 No. 5, pp. 86-92.

Metters, R. and Vargas, V. (2000), "A typology of de-coupling strategies in mixed services", Journal of Operations Management, Vol. 18 No. 6, pp. 663-82.

Morris, M., Schindehutte, M. and Allen, J. (2003), "The entrepreneur's business model: toward a unified perspective", Journal of Business Research, Vol. 58, pp. 726-35.

Ohmae, K. (1989), "The global logic of strategic alliances", Harward Business Review, Vol. 67 No. 2, pp. 143-54.

Ojala, L., Andersson, D. and Naula, T. (2006), "The definition and market size of third party logistics services", in Ojala, L. and Jämsä, P. (Eds), Third Party Logistics – Finnish and Swedish Experiences, Series Discussion and Working Papers 3:2006, Turku School of Economics, Turku.

Osterwalder, A. (2004), The Business Model Ontology, A Proposition in a Design Science Approach. These Pre´sente´e a` l'Ecole des Hautes Etudes Commerciales de l'Universite´ de Lausanne, available at: www.hec.unil.ch/aosterwa/PhD/Osterwalder_PhD_BM_Ontology. pdf (accessed January 28, 2008).

Osterwalder, A. and Pigneur, Y. (2002), "An e-business model ontology for modeling e-business", paper presented at 15th Bled Electronic Commerce Conference, available at: http://129.3.20.41/eps/io/papers/0202/0202004.pdf (accessed January 28, 2008).

Osterwalder, A., Pigneur, Y. and Tucci, C.L. (2005), "Clarifying business models: origins, present, and future of the concept", Communication of AIS, Vol. 16, article 1.

Pagh, J.D. and Cooper, M.C. (1998), "Supply chain postponement and speculation strategies: how to choose the right strategy", Journal of Business Logistics, Vol. 19 No. 2, pp. 13-33.

Pateli, A. and Giaglis, G. (2003), "A framework for understanding and analysing e-business models", paper presented at Bled Electronic Commerce Conference.

Pekkarinen, S. and Ulkuniemi, P. (2008), "Modularity in developing business services by platform approach", The International Journal of Logistics Management, Vol. 19 No. 1, pp. 84-103.

Persson, G. and Virum, H. (2001), "Growth strategies for logistics service providers: a case study", The International Journal of Logistics Management, Vol. 12 No. 1, pp. 53-64.

Peters, M., Cooper, J., Lieb, R.B. and Randall, H.L. (1998), "The third party logistics industry in Europe: provider perspectives on the industry's current status and future prospects", International Journal of Logistics: Research and Applications, Vol. 1 No. 1, pp. 9-25.

Porter, M.E. (1980), Competitive Strategy: Techniques for Analysing Industries and Competitors, The Free Press, New York, NY.

Pulkkinen, M., Rajahonka, M., Siuruainen, R., Tinnilä, M. and Wendelin, R. (2005), Liiketoimintamallit arvonluojina – ketjut, pajat ja verkot (Business Models in Value Creation – Chains, Shops and Networks), Teknologiateollisuus Ry, Helsinki (in Finnish).

Rajala, R., Rossi, M., Tuunainen, V.K. and Korri, S. (2001), Software Business Models: A Framework for Analyzing Software Industry, The National Technology Agency of Finland Tekes, Helsinki.

Rappa, M. (2000), "Business models on the web: managing the digital enterprise", North Carolina State University, available at: www.digitalenterprise.org/models/models.html (accessed February 28, 2008).

Rodrıguez-Dıaz, M. and Espino-Rodrıguez, T. (2006), "Redesigning the supply chain: reengineering, outsourcing, and relational capabilities", Business Process Management Journal, Vol. 12 No. 4, pp. 483-502.

Sachan, A. and Datta, S. (2005), "Review of supply chain management and logistics research", International Journal of Physical Distribution & Logistics Management, Vol. 35 No. 9, pp. 664-705.

Schmenner, R.W. (1986), "How can service business survive and prosper?", Sloan Management Review, Vol. 27 No. 3, pp. 21-32.

Schmenner, R.W. (1990), Production/Operations Management, 4th ed., Macmillan, New York, NY.

Schmenner, R.W. (2004), "Service businesses and productivity", Decision Sciences, Vol. 35 No. 3, pp. 333-47.

Seddon, P.B., Lewis, G., Freeman, P. and Shanks, G. (2004), "The case for viewing business models as abstractions of strategy", Communications of the AIS, Vol. 13, pp. 427-42.

Selviaridis, K. and Spring, M. (2007), "Third party logistics: a literature review and research agenda", The International Journal of Logistics Management, Vol. 18 No. 1, pp. 125-50.

Shafer, S.M., Smith, H.J. and Linder, J.C. (2004), "The power of business models", Business Horizons, Vol. 48, pp. 199-207.

Silvestro, R., Fitzgerald, L., Johnston, R. and Voss, C. (1992), "Towards a classification of service processes", International Journal of Service Industry Management, Vol. 3 No. 2, pp. 62-75.

Sink, H.L. and Langley, C.J. Jr (1997), "A managerial framework for the acquisition of third-party

logistics services", Journal of Business Logistics, Vol. 18 No. 2, pp. 163-88.

Sink, H.L., Langley, C.J. Jr and Gibson, B.J. (1996), "Buyer observations of the US third-party logistics market", International Journal of Physical Distribution, Vol. 26 No. 3, pp. 37-45.

Skjoett-Larsen, T. (2000), "Third party logistics – from an interorganizational point of view", International Journal ofPhysicalDistribution&LogisticsManagement,Vol.30No. 2, pp. 112-27.

Skjoett-Larsen, T., Schary, P.B., Hsuan Mikkola, J. and Kotzab, H. (2007), Managing the Global Supply Chain, 3rd ed., Copenhagen Business School Press, Copenhagen.

Stabell, C.B. and Fjeldstad, Ø.D. (1998), "Configuring value for competitive advantage: on chains, shops and networks", Strategic Management Journal, Vol. 19, pp. 413-37.

Stähler, P. (2002), "Business models as an unit of analysis for strategizing", Proceedings of the 1st International Workshop on Business Models.

Stoddard, D.B., Jarvenpaa, S.L. and Littlejohn, M. (1996), "The reality of business process reengineering. pacific Bell's centrex provisioning process", California Management Review, Vol. 38 No. 3, pp. 57-76.

Tikkanen, H., Lamberg, J., Parvinen, P. and Kallunki, J. (2005), "Managerial cognition, action and the business model of the firm", Management Decision, Vol. 43 No. 6, pp. 789-809.

Timmers, P. (1998), "Business models for electronic markets", Electronic Commerce in Europe, Vol. 8 No. 2.

Tinnilä, M. and Vepsäläinen, A.P.J. (1995), "A model for strategic repositioning of service processes", International Journal of Service Industry Management, Vol. 6 No. 4, pp. 57-80.

van Laarhoven, P., Berglund, M. and Peters, M. (2000), "Third-party logistics in Europe – five years later", International Journal of Physical Distribution & Logistics Management, Vol. 30 No. 5, pp. 425-42.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", International Journal of Operations & Production Management, Vol. 22 No. 2, pp. 195-219.

Walters, D. (2004), "A business model for the new economy", International Journal of Physical Distribution & Logistics Management, Vol. 34 Nos 3/4, pp. 346-57.

Yin, R.K. (1981), "The case study crisis", Administrative Science Quarterly, Vol. 26 No. 1, pp. 58-66.

Yin, R.K. (1994), Case Study Research: Design and Methods, 2nd ed., Sage, London.

Yin, R.K. (2003), Case Study Research: Design and Methods, 3rd ed., Sage, London.

Zott, C. and Amit, R. (2008), "The fit between product market strategy and business model – implications for firm performance", Strategic Management Journal, Vol. 29 No. 1, pp. 1-26.

Further reading

Hamel, G. (2000), Leading the Revolution, Harvard Business School Press, Boston, MA.

Web sites

www.supplychainleaders.com/providers/ (accessed June 2008).

www.itella.com (accessed April and June 2008).

www.iht.com/articles/ap/2008/04/01/business/EU-FIN-Denmark-Sweden-Postal-Merger.php (accessed June, 2008).

www.pannordic.com/en/Company/Press/Pressreleases/Pan-Nordic-Logistics-Nordic-post-alliance-expands-in-the-Baltic-Region/ (accessed February, 2009).

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PAPER 5

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Modularity and customisation in LSPs' service strategies

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Abstract: This paper has two objectives. The first is to classify the service strategies that logistics service providers (LSPs) apply. The second is to examine how modularity and customisation are used by LSPs in their implementation of strategies. We use a framework from literature that should help in illustrating different combinations of the degrees of modularity and customisation in service offerings, service production processes and service production networks. We first classify the service strategies of 23 companies. Then, after selecting five case companies from these, we examine in more depth the usability of the framework and develop a measurement system for modularity and customisation. Our preliminary findings show that the service strategies are reflected in differences relating to modularity and customisation in the service offerings, service production processes and service production networks of the LSPs. The results also help to give substance to the previously vague concepts of modularity and customisation in the service context.

Keywords: logistics service providers; LSPs; logistics services; service strategies; modularity; customisation.

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1 Introduction

Logistics services are a good example of the services offered to support operations in different stages of supply chains. Logistics service providers (LSPs) can contribute to improvements in service levels, service quality, service flexibility, costs, service speed, and operational efficiency and effectiveness (see e.g., Bask, 2001; Fabbe-Costes et al., 2009). In recent years various methods have been presented in the literature for analysing the services, operations and service strategies of LSPs (Berglund et al., 1999; Persson and Virum, 2001; Bask, 2001; Bolumole, 2003; Hertz and Alfredsson, 2003; Christopher, 2010; Cui and Hertz, 2011; Cabigiosu et al., 2012; Huemer, 2012). The reasons behind the growing interest in and importance of the logistics industry include, for example, the globalisation of manufacturing operations, the deregulation of import and export operations, and the increased outsourcing of transport operations and logistics functions. At the same time, the maturing of traditional services, i.e., basic transportation and warehousing, in the industry and the concomitant development of new service offerings have led to the increased strategic segmentation and divergence of the services of LSPs (Berglund et al., 1999; Van Hoek, 2000; Andersson and Norrman, 2002; Fabbe-Costes et al., 2009). Nowadays, the available services include, on one hand, the standard type of transport-oriented logistics services, and, on the other, value-added services offered through longer-term third party arrangements, partnerships and alliances (Berglund et al., 1999; Tinnilä and Vepsäläinen, 1995; Makukha and Gray, 2004; Fabbe-Costes et al., 2009; Bask et al., 2010; Yazdanparast et al., 2010). This development of divergence specialisation, division of labour, and outsourcing of tasks is apt to enhance modularity and customisation (Van Hoek, 2000; Persson and Virum, 2001; Bask et al., 2011b; Cabigiosu et al., 2012) in services, service offerings, production processes and networks in the logistics industry. However, the modularity and customisation aspects of services have not been extensively studied in previous research.

In the previous literature, modularity has often been seen as one of the most important methods enabling the cost-efficient mass customisation of products (Starr, 2010, 1965; Pine, 1993; Duray et al., 2000; Da Silveira et al., 2001; Voss and Hsuan, 2009; Bask et al., 2011a; Cabigiosu et al., 2012). There are different levels of the mass customisation of products and services, i.e., combinations of modularity and customisation. Therefore, we aim in this paper to separate the modularity and customisation concepts from each other, and by so doing, to offer new perspectives of service modularity and customisation in addition to those presented in the extant literature. By examining these two concepts separately, we expect that it will be possible to more thoroughly analyse the service offerings, production processes or service production networks of LSPs. Furthermore, an underlying assumption in this study is that LSPs with different service strategies use

different approaches, i.e., different combinations of modularity and customisation in the implementation of their strategies.

This paper has two objectives. The first is to classify the service strategies that LSPs apply. The second is to examine if and how modularity and customisation are used by LSPs in their implementation of strategies. For this purpose, we test a framework originally presented by Bask et al. (2011a), with which it should be possible to illustrate different combinations of the degrees of modularity and customisation in LSP service offerings, production processes or production networks. We also develop a measurement system for analysing modularity and customisation in the implementation of LSP strategies. Thus, the research questions are:

RQ1 How can LSP strategies be classified based on the literature and empirical data?

RQ2 How do different LSPs with different service strategies use modularity and customisation in implementing their strategies, and are there any differences in usage related to their service offerings, service production processes and service production networks?

The paper is organised as follows. First, we briefly discuss the methodology. Thereafter, we review the LSP strategies and their classifications presented in the existing literature, and concepts of modularity and customisation. In this part, we also discuss the measures that can be used as a basis for evaluating the degree of customisation and modularity. We also briefly introduce the framework for modularity and customisation developed by Bask et al. (2011a). Thereafter, we summarise the literature and build a foundation for further analyses in the logistics service setting. Based on the literature and findings from our data from 23 LSPs we suggest a classification of LSP strategies. We illustrate these four types of LSP strategy by using five in-depth cases from the Finnish logistics industry. The case companies chosen represent each type and are analysed for the modularity and customisation of their service offerings, service production processes and service production networks. The cases show, in the light of the above-mentioned framework, the differences related to modularity and customisation. The case examples are depicted from three perspectives: service and service offerings, service production processes and the service production network. In the discussion section, we discuss the implications of modularity and customisation in logistics services and their relationship to LSP strategies. Finally, at the end of the paper we provide conclusions and ideas for future research.

2 Methodology

In this paper, we aim *on one hand* at theory building, based on our empirical data and in terms of service strategies, and *on the other hand* at theory (framework) testing regarding modularity and customisation, and also the development of a measurement system for these two features. We apply the qualitative case study method, as our aim is to explain and understand the phenomenon (McCutcheon and Meredith, 1993; Sachan and Datta, 2005). This method also allows us to probe the how and why questions (Ellram, 1996). In the analysis of our empirical data, we use an approach based on 'systematic combining' as presented by Dubois and Gadde (2002). They describe systematic combining as "a nonlinear, path-dependent process of combining efforts with the ultimate objective of

matching theory and reality". The reality, theories, gradually evolving cases, and analytical framework are the four factors that affect and are affected by two processes: the process of matching theory with reality and the process of direction and redirection (Dubois and Gadde, 2002). This methodology has been earlier applied in logistics service research by, for example, Fabbe-Costes et al. (2006) and Huemer (2012). Systematic combining allows the evolution of the theoretical framework, empirical work and analyses at the same time, and, according to Dubois and Gadde (2002), it is especially suited for the development of new theories. Fabbe-Costes et al. (2006) argue that systematic combining is particularly useful in the meta-case analysis of processes dealing with several units of analysis. We have used the methodology in this study for these same reasons.

After going through the literature on LSP service strategies, modularity, customisation and the empirical material in the research group several times and interpreting it through different perspectives, "the pieces of data began to become clearer with every effort", as Dubois and Gadde (2002) put it. First, we looked at the LSP service strategy literature, while at the same time analysing companies' services, processes and networks based on the interviews. After going through the empirical data related to all 23 companies, groups of companies emerged that seemed to have similar features in, for example, size, role or the services offered – in other words, similar strategic positioning. After this observation, the aim of this research was to study whether LSPs that apparently reflect different service strategies, also apply modularity and customisation differently when implementing these strategies. For the last-mentioned reason we chose from the 23 companies five case companies that represent different service strategies for in-depth analysis of modularity and customisation. For testing we used the framework originally presented by Bask et al. (2011a) to illustrate different combinations of the degrees of modularity and customisation from the service offering, service production process and service production network perspectives. For the framework, we developed the measurement system further for modularity and customisation.

In the theoretical part, we present a literature review of LSP service strategies, and the concepts of modularity and customisation. The empirical data has been gained from semi-structured interviews (including both theme and structured questionnaires) of 23 LSPs operating in Finland. To get a general view of the LSP industry we included in the sample different kinds of companies related to size, geographical range, services, and operations – road, rail and sea transport, forwarding, warehousing, value-added logistics (VAL) services, etc. As we had assumed, the services offered by the interviewed companies were divergent, extending from overall integrated solutions for customers' supply chains to sub-contracting for larger LSPs.

3 Literature review

Next, we will present a short literature review on LSP service strategies, modularity and customisation. Our aim is firstly to provide a theoretical basis for analysing the case companies from our sample, and thus to identify typical logistics service strategies, and secondly to develop measures of modularity and customisation in order to analyse the case companies for their implementation of modularity and customisation.

3.1 Literature on LSP service strategies

Huemer (2012) point out that supply chain management literature has tended to focus not on the LSPs themselves, but on their clients, and on how logistics services can provide enhanced competitive advantage for manufacturing firms. Concerning structures and strategies, he argues that LSPs should rely on idea structures founded on the premise that they are actors in their own right (Huemer, 2012). That is why new idea structures specific for LSPs are needed. The strategies of LSPs in supply chains are changing. Bask et al. (2006) show that the development path has been from companies' own logistics operations to the procurement and outsourcing of logistics services. Van Hoek (2000) finds that supplementary services offered by LSPs, such as packaging and final assembly, are gradually becoming more common, and as they increase, they are expanding the role of LSP services within supply chains. This also necessitates deeper integration in supply chains (see e.g., Makukha and Gray, 2004; Fabbe-Costes et al., 2009).

In recent years researchers have made several attempts to categorise LSPs based on their service strategies. Selviaridis and Spring (2007) reviewed the literature on 'third-party logistics' (TPL, 3PL), i.e., the organisational practice of contracting-out some or all of the logistics activities that were previously performed in-house. Based on their review of 114 articles, they claim that, despite the growing interest, the literature appears to be empirical-descriptive, generally lacking a theoretical foundation, and disjointed. Different definitions and classifications in the field tend to emphasise different aspects of logistics outsourcing arrangements, although TPL is usually associated with offering a bundle of services, rather than just distinct transport or warehousing tasks (Selviaridis and Spring 2007). In the following paragraphs, we summarise some of the key articles that deal with LSP service strategies.

Berglund et al. (1999) distinguished between 'service providers' which offer low-cost basic services to many clients, and 'solution providers' which offer customised and complex services to a few key customers. Another distinction is between companies offering basic transportation and warehousing ('basic services') and companies offering 'VAL'. By combining these dimensions, they define four segments in the TPL industry. In their categorisation, the mission statement of *basic logistics services* is to support customers in being more competitive, whereas the mission statement of *value added logistics services* is to be value leaders in global integrated logistics. Basic logistics solutions provide customers with TPL solutions in basic transportation and warehousing, while *VAL solutions* are consultative solutions offered to customers. Berglund et al. (1999) categorised value creation by TPL providers for their clients as operational efficiency, integration of customer operations, vertical or horizontal integration, and supply chain management and integration.

Persson and Virum (2001) divided LSPs into four groups: logistics operators, TPL operators, logistics agents and logistics integrators, according to their variety-based vs. needs-based position in relation to their service offerings, and their physical asset vs. non-physical asset-based position in relation to their resources. A variety-based position emphasises the choice of service varieties rather than the serving of specific customer segments, whereas needs-based positioning means serving the needs of a specific group of customers. The first group, 'logistics operators', possesses its own physical assets and can offer a variety of services (variety-based positioning). This group can be divided into local and (inter)national logistics operators. The second group, 'TPL operators', also possesses its own assets, but offers needs-based targeted services

for targeted customers. The third group, 'logistics agents', has no physical assets and offers variety-based services. It has a wide variety of services and customers. Companies belonging to the fourth group 'logistics integrators' have no physical assets, and they have a needs-based position (i.e., they offer targeted services). They can be external logistics departments for only one customer or for a targeted group of customers. Bask (2001) studied the relationship between logistics service strategies and supply chain management strategies. She categorises efficient logistics services into three types according to the customer relationship and complexity of the service: routine, standard and customised services. She also concludes that LSPs should offer different types of service to different types of supply chain.

In her classification of logistics providers' roles in supply chains, Bolumole (2003) divides TPLs into six groups according to the strategic orientation of the outsourcing organisation, the extent of outsourcing, the client-3PL relationship, and the client's perception of the TPL role. These groups are 'functional service provider' (operational-level functions, internal focus, transactional relationship, cost-based perceptions), 'internal logistics department' (tactical-level function, internal focus, bilateral relationship, cost-based perceptions), 'logistics joint venture partner' (strategic-level functions, internal focus, partnership-type relationship, cost-based perceptions), 'third party logistics provider' (operational-level functions, external focus, transactional relationship, resource-based perceptions), 'supply chain logistics provider' (tactical-level functions, external focus, bilateral relationship, resource-based perceptions), and 'logistics process integrator' (strategic-level functions, external focus, partnership-type relationship, resource-based perceptions).

Hertz and Alfredsson (2003) presents four categories of 3PL providers according to their problem solving ability and customer adaptation: 'standard TPL providers' perform basic activities such as warehousing and distribution, 'service developers' offer advanced value-added services, 'customer adapters' take over complete control of clients' logistics activities, and 'customer developers' integrate themselves with the customer and take over their entire logistics function. Bask et al. (2006) studied the evolution of services in container transport and argue that efficient service strategies can be found by right combinations of the type of service and the type of channel. They describe the evolution of services in the container transport business from three perspectives: service offerings, transport chain management, and enabling technologies.

Christopher (2010, p.2) point out that the emergence of the value-conscious customer has changed the competitive environment of LSPs. In a matrix of increasing cost advantage on one axis, and increasing differentiation on the other axis, Christopher (2010, p.2) claims that LSPs have four competitive options, i.e., acting as a 'commodity provider', 'cost leadership provider', 'added value provider', or 'cost and value leadership provider'. According to him, the new competitive framework in logistics is characterised by four Rs – reliability, responsiveness, resilience and relationships – with which the logistics strategies should be formulated.

Cui and Hertz (2011) described and analysed three basic types of logistics service firms, i.e., carriers, logistics intermediary firms and TPL firms, and argue that these types of firms are complementary with each other in the logistics service supply chain, have different tasks and are situated on different levels of the logistics service supply chain. According to Cui and Hertz (2011) these basic types of logistics firm have different capabilities and network focuses. They argue that, although some logistics firms see opportunities to provide a wider scope of logistics services, such a strategic move is

costly and difficult, because the firm has to obtain new competences and adapt to a new value creation logic (Cui and Hertz, 2011).

The brief review above shows that there are several studies classifying LSP strategies. These are based on different combinations of skills and capabilities (Berglund et al., 1999; Bolumole, 2003; Hertz and Alfredsson, 2003; Christopher, 2010; Cui and Hertz, 2011), or assets (Persson and Virum, 2001) of the LSP, or customer relationships (Persson and Virum, 2001; Bask, 2001; Hertz and Alfredsson, 2003; Bolumole, 2003), or network relationships (Cui and Hertz, 2011), or type of service (Berglund et al., 1999; Bask, 2001; Bask et al., 2006; Christopher, 2010), or type of channel (Bask et al., 2006).

3.2 Literature on the concept of modularity

In their literature review of 125 research contributions on modularity, Campagnolo and Camuffo (2010) found three units of analysis:

a product design modularity

b production system modularity

c organisational design modularity.

Service modularity has also been described as consisting of three corresponding levels: modularity in services, service production processes and service production organisations/networks (Bask et al., 2011a). Modularity in the service context has received more attention in the research literature of recent years (Bask et al., 2011a). Particular attention has been paid to professional or knowledge-intensive services, for example, (see e.g., Pekkarinen and Ulkuniemi 2008, 2011; Nakano, 2011; Cabigiosu et al., 2012).

No consensus has yet been reached on measurements of modularity. Based on a literature review of over 100 articles, Salvador (2007) lists the commonly used definitional perspectives of product modularity as 'component commonality' 'component combinability', 'function binding', 'interface standardisation', and 'loose coupling'. Salvador concludes that none of the past works has provided a framework capable of merging the different definitional perspectives. Process modularity means that processes can be divided into sub-processes such as standard and customisation sub-processes. In the production of physical products, process modularity enables postponed manufacturing where the final assembly can be done in distribution centres or even on customer sites to ensure better responsiveness. In modular assembly lines, different process capabilities can be created by adding, removing or rearranging workstations and units (Tu et al., 2004). Tuunanen et al. (2012) suggests a typology for modular service design. Based on a literature review they provide definitions of service modules, service architecture and service experience. The typology of *service modules* consists of aspects such as communality, decomposition, reuse, substitution, and variation; *service architecture* of aspects such as service boundaries, composition, interfaces, standards, infrastructure, and shared and outsourced resources; and *service experience* of aspects such as customer's role perception, personalisation, task complexity, and value creation.

Table 1 Features, definitions, and measurement presented in the earlier literature on modularity

Paper	*Features mentioned*	*Definition, etc.*
Baldwin and Clark (1997, 2000)	Architecture	The visible design rules consist of three dimensions: *Architecture* specifies what modules will be part of the system and what their functions will be; *interfaces* describe in detail how the modules will interact, including how they fit together and communicate; and *standards* test a module's conformity to design rules and measure its performance relative to other modules.
	Interfaces Standards	Remarks: Modularisation means that information is categorised into visible design rules and hidden design parameters. The visible information must be widely shared and communicated whereas the hidden parameters need not be communicated beyond the boundaries of the module.
Mikkola (2006)		Four key elements should be considered when assessing the degree of modularity in physical product systems:
	Standard components	1 Types of components (ranging from standard to unique)
	Standardised interfaces	2 Interfaces (whether they are well specified and standardised or not)
	Degree of coupling among components	3 Degree of coupling (i.e., the tightness of coupling among components)
	Substitutability	4 Substitutability (i.e., the extent the unique components can be substituted across product families).
Jacobs et al (2007)	Disaggregation Re-combinability	Modularity is a systems concept defining the degree to which components may be disaggregated and recombined into new configurations
Lau et al. (2007)	Separateness/ dis-assemblability and re-combinability Specificity (in function) Transferability/re-usability	Product modularity is a continuum, describing separateness, specificity and transferability of product components in a product system. *'Separateness'* = degree to which a product can be disassembled and recombined into new product configurations without loss of functionality. *'Specificity'*= degree to which a product component has a clear, unique and definite product function with its interfaces in the product system. *'Transferability'* = degree to which product components in a product system can be handed over and reused by another system.

Table 1 Features, definitions, and measurement presented in the earlier literature on modularity (continued)

Paper	*Features mentioned*	*Definition, etc.*
Salvador (2007)	Component commonality	1 *'Component commonality'* refers to modularity as the designation of a standard kit of components to be used in a number of applications. In line with this aspect, modular product design consists of using standard parts and subassemblies in a variety of products.
	Component combinability	2 *'Component combinability'* is probably the most commonly understood meaning of product modularity. It refers to that different product configurations can be obtained by mixing and matching components taken from a given set.
	Function binding	3 *'Function binding'* denotes that product modules embed the capacity to perform specific functions.
	Interface standardisation	4 *'Interface standardisation'* leaves much freedom to the definition of module, because it focuses on the interface that is a set of design parameters describing how two objects mutually interact.
	Loose coupling	5 *'Loose coupling'* refers to that a modular system can be broken down into smaller units, or modules.
		Remarks: literature review of over 100 articles; none of the past researchers dealing with product modularity has combined in a single framework all of these perspectives
Voss and Hsuan (2009)	Standardised interfaces	There are five important dimensions associated with the study of modularity: interfaces, degree of coupling, components and systems, commonality sharing, and platform.
Bask et al. (2010)	Modules Interfaces Architecture Component replaceability System replicability System manageability	A modular system is a system built of components, where the structure ('architecture') of the system, functions of components ('elements', 'modules'), and relations ('interfaces') of the components can be described so that the system is replicable, the components are replaceable, and the system is manageable.
Tuunanen et al. (2012)	Service module	The typology consists of the key aspects and their definitions:
		Service module: communality, decomposition, reuse, substitution, and variation.
	Service architecture	Service architecture; service boundary, composition, interface, standard, infrastructure, and shared and outsourced resources.
	Service experience	Service experience: customer's role perception, personalisation, task complexity, and value creation.

This paper also deals with organisational and network modularity. In recent decades firms have begun to outsource more functions by using organisational components that lie outside the firm, and some authors, such as Schilling and Steensma (2001), argue on this basis that the entire production system is becoming increasingly modular. Contract manufacturing, alternative work arrangements, and alliances can be seen as methods of loose coupling (Schilling and Steensma, 2001). Modular supply chains make substitution and the creation of supply chain variations possible (Voordijk et al., 2006). The potential effects of product modularity on the organisational structure have been discussed in the literature. Hoetker (2006) remark that there seems to be an underlying assumption in the literature that increased product modularity can be associated with increased organisational modularity. Salvador et al. (2004) maintain that the production of modular products actually leads to tight rather than loose linkages, and high integration rather than modularity between a final assembler and its suppliers. This indicates that modular production often requires an integrated supply network. Also, Hoetker (2006) who tested this interlinkage empirically, found support for only part of the assumed relationship.

A modular service can be seen as a combination of one or more service modules (Pekkarinen and Ulkuniemi, 2008). Themes that have commonly been related to service modularity are, for example, the packaging of functionalities, the standardisation of interfaces, and the reusability and substitution of modules (Bask et al., 2010). Voss and Hsuan (2009) defined the degree of uniqueness of service modularity as a function depending on the total number of nodes (N) and the number of unique services (u) that can be replicated across service families (f). They consider nodes as service modules or service elements which can be either standard (n) or unique (u). Standard services are routinised and common in the industry. Unique services or service elements are unique within a firm and difficult to copy in the short term by competitors. In Table 1, we have collected some features and definitions presented in the earlier literature on modularity.

According to Salvador (2007) probably the most commonly understood meaning of product modularity is ‘component combinability’. This concept includes that products are modular when there is a given set of components which can be combined together in different ways. In practice component combinability usually also means that the interfaces between modules need to be standardised to obtain combinability. Another important feature of modularity often mentioned in the literature is ‘component commonality’. Related concepts are ‘transferability’, ‘re-usability’, etc. All these concepts denote that in modular systems the same standard parts or subassemblies can be used in a variety of products.

3.3 Literature on the concept of customisation

In recent decades manufacturing industries have faced more divergent customer needs, which has made the concept of customisation more important (see e.g., Starr, 1965; Pine, 1993; Kumar, 2004). Kumar (2004) has formulated metrics for measuring customisation. He has defined the degree of customisation as the ratio between the number of features that the company actually offers the customer a choice on, and the maximum number of functions or features on which a choice can be offered. Customisation in manufacturing has often been discussed as ‘mass customisation’. In their literature review on mass customisation, Da Silveira et al. (2001) state that mass customisation is “the ability to provide individually designed products and services to every customer through high

process flexibility and integration". They claim that the level of individualisation has been a major point in the discussion on mass customisation.

Lampel and Mintzberg (1996) argue that standardisation and customisation form poles of a continuum of manufacturing strategies. According to them, in the continuum between customisation and standardisation, customisation begins from a value chain's downstream activities, while standardisation starts upstream of the value chain. They identify five categories on the standardisation-customisation continuum: pure standardisation, segmented standardisation, customised standardisation, tailored customisation, and pure customisation. In pure standardisation, there is no customisation. In the other categories, customisation can reach distribution (in segmented standardisation), assembly (in customised standardisation), fabrication (in tailored customisation), and finally the design stages (in pure customisation). Lampel and Mintzberg remark that the alternative in which customisation reaches the assembly stage may also be called 'modularisation'.

Squire et al. (2006) measured customisation by using three levels of customisation: 'full customisation' involves customers at the design or fabrication stages, 'partial customisation' involves customers at the assembly or delivery stages, and 'standard products' do not involve customers at all. Also, in general, the discussion on customisation has often been related to the discussion on the order penetration point (OPP), which is the point where a product is linked to a specific customer order (Olhager, 2003). Duray et al. (2000) maintain that identifying the point of customer involvement is crucial for drawing conclusions on the degree of customisation. They also argue that the deeper the customer involvement goes in the production cycle, the higher the degree of customisation is. In fact, they use a matrix framework, where customer involvement and modularity are the dimensions that determine mass customisation types. The four groups or mass customisation types created by Duray et al. (2000) are fabricators, involvers, modularisers, and assemblers. They claim that modularity is pivotal in distinguishing mass customisation from pure customisation, as modularity limits the possible choices of the customer. However, they point out that customisation is not the same as merely offering a great variety.

Da Silveira et al. (2001) remark that the lack of studies on mass customisation in service operations is maybe one of the main gaps in the research literature on mass customisation. Based on the still limited literature, it can be claimed that the customisation of services seems to follow a slightly different logic than the customisation of physical products. De Blok et al. (2010) found that, at least concerning elderly care services, late client involvement allows for components to be adapted to client needs, leading to a high level of customisation of the final offering, whereas early client involvement only allows combinations of standard components. This is the exact opposite of what was presented in earlier literature on the customisation of products. De Blok et al. (2010) also state that whereas, in manufacturing, client involvement is generally a one-time event to specify the requirements, in care provision the client is involved in needs specification as well as, and especially during, delivery.

In the service context the mass production of services is still rather unusual, and it could be said that customisation instead of standardisation has been the typical approach in many services (Bask et al., 2011a), or at least this point of view has been emphasised in the literature (Cabigiosu et al., 2012). The significance of services in the world economy has increased fast, and this has led to pressure for more efficient service production. However, greater efficiency should also be combined with greater sensitivity

to individual customer needs. Da Silveira et al. (2001) argue that there are many special challenges for mass customisation in services, such as labour-intensity, sensitivity to quality errors, and short delivery times. Bask et al. (2006) maintain that there have also been successful applications of mass customisation strategies in services, as exemplified in logistics by the creative use of hub-and-spoke models, transshipments, cross-docking and vendor-managed logistics. They also state that, in the future, service production in the intermodal transport business will be built of modular elements linked efficiently and flexibly with service combinations. Cabigiosu et al. (2012) also found in their research that third-party LSPs seem to pursue both customisation and standardisation simultaneously by relying on modular services, and they maintain that, in fact, managing this kind of temporal separation between exploration and exploitation is evolving into a core competence for companies offering knowledge-intensive business services.

Table 2 Features, definitions, and measurement presented in the earlier literature on customisation.

Paper	*Features, measurements, definitions, etc.*
Lampel and Mintzberg (1996)	Standardisation and customisation are poles of a continuum of manufacturing strategies. There are five categories on the standardisation-customisation continuum: pure standardisation, segmented standardisation, customised standardisation, tailored customisation, and pure customisation. In pure standardisation, there is no customisation. In the other categories, customisation can reach distribution (in segmented standardisation), assembly (in customised standardisation), fabrication (in tailored customisation), and the design stages (in pure customisation).
Duray et al. (2000)	The point of customer involvement is crucial for the degree of customisation. The deeper the customer involvement goes in the production cycle, the higher the degree of customisation is. Customer involvement and modularity determine the mass customisation types: fabricators, involvers, modularisers, and assemblers.
Da Silveira et al. (2001)	Mass customisation is 'the ability to provide individually designed products and services to every customer through high process flexibility and integration'. The level of individualisation is a major point in the discussion on mass customisation.
Kumar (2004)	The degree of customisation is the ratio between the number of features that the company actually offers the customer a choice on, and the maximum number of functions or features on which a choice can be offered.
Squire et al. (2006)	There are three levels of customisation: 'full customisation' involves the customer at the design or fabrication stages, and 'partial customisation' at the assembly or delivery stages, and 'standard products' do not involve the customer at all in the production process.
Voss and Hsuan (2009)	Customisation in services can be implemented by combining a set of processes and products to create a unique service (combinatorial customisation), or by selecting one of several existing services or products to meet the customer's needs (menu-driven customisation)
De Blok et al. (2010)	Late client involvement allows for components to be adapted to client needs, leading to a high level of customisation of the final offering. In care provision the client is involved in needs specification as well as, and especially during, delivery.

Voss and Hsuan (2009) argue that customisation in services can be not only menu-driven, but also combinatorial, which refers to cases where a unique service is created by combining a set of processes and products. They also imply that personalisation must be separated from customisation, as personalisation means that front-line personnel modify their interpersonal behaviour in response to interaction with the customer, whereas customisation means that the goods or services are modified or chosen from a set of available services. To provide effective customisation, as opposed to personalisation, service architecture is required (Voss and Hsuan 2009). Sony and Mekoth (2012) builds a typology for frontline employee adaptability to gain an understanding of customisable services. In Table 2, we summarise some of the discussion presented in the earlier literature on customisation.

There are issues that have not been properly addressed in the earlier literature. Park and Nahm (2012) claim that in the literature on mass customisation the role of particular functions (e.g., marketing, operations and/or strategy) has been over-emphasised to the detriment of the socio-technical system (STS) perspective, such as work-related and organisational factors. They build a classification model for the effective management of these factors. It can also be concluded that greater understanding of the mass customisation of services and their measurement is still needed.

It seems that in the studies cited above, the essential issues related to evaluating the degree of customisation are the alternative products or services that the customer can choose from, and the customer's involvement in the production of them.

4 Framework for modularity and customisation

Bask et al. (2011a) have presented a framework for combining degrees of modularity and customisation. The framework reveals four extreme categories: 'non-modular regular', 'modular regular', 'modular customised' and 'non-modular customised'. They have argued that the framework is applicable from three perspectives: the customer (service offering), service production, and the service production network. They have presented the following measurements for modularity and customisation at different levels of their framework (see Table 3). For the application they use examples from the automotive industry.

Table 3 Measurements for modularity and customisation at different levels of their framework as presented by Bask et al. (2011a)

	Customer perspective	*Production perspective*	*Network perspective*
Modularity	Product variants offered with different modules and service levels	Use of modularity principles in production	Responsibilities of the suppliers
Customisation	Customisation experience for the customer	Deepness of customer involvement	Degree of dedication in partnership relations

In this paper, we test the application of the framework in the context of logistics services. By so doing we aim at developing useful measurements for the analysis of LSP service strategies.

4.1 Summary of the literature and the formulation of approaches for further analysis

In this research, we have used a systematic combining approach (Dubois and Gadde, 2002) for building a categorisation of LSP service strategies. The reason for this was the finding that none of the strategy categorisations presented in the earlier literature matched our data as such. To give one example, we found that we could not make a distinction between 'service providers' offering low-cost basic services to many clients, and 'solution providers' offering customised and complex services to only a few key customers, as presented by Berglund et al. (1999). Our findings suggest that, on one hand, large global LSPs may offer both solutions and basic services, while, on the other hand, small companies offering basic services often have only a few customers. After going through the empirical data of 23 LSPs we identified groups of companies that seemed to have similar features. Thus, four groups of LSPs emerged: 'subcontractors', 'integrators', companies offering 'outsourced manufacturing', and companies that are '*affiliates*' of their customer companies. To the best of our understanding, these groups represent different service strategies, expressed in the degree of specialisation of their offerings (focused vs. wide service offering) and the proximity of customer relationships (close vs. loose). Next, we introduce these groups in more detail.

1 *Subcontractors* can be either small companies delivering rather standard tasks specified by their customers *(general subcontractors)*, or companies offering fixed services with specific infrastructure and knowledge, such as sea, rail and air transportation *(specialised subcontractors).* These companies are not involved in the supply chain planning, and, because of their role in the service network, they typically deliver a single specific service component of the logistics chain, for example transportation from one place to another. The customers of subcontractors are either manufacturing or trading companies that typically manage their own supply chain planning themselves, or other LSPs that use the services of subcontractors. General subcontractors are often small local companies that perform the tasks specified by their customers. General subcontractors could be characterised as 'service providers' as presented by Berglund et al. (1999), offering low-cost basic services, but with the difference that, in practice, they usually have only a few customers. Specialised subcontractors offer fixed services with specific infrastructure and knowledge; there are often only a few companies offering these kinds of service in a certain area, and this gives them a strong position related to their customers.

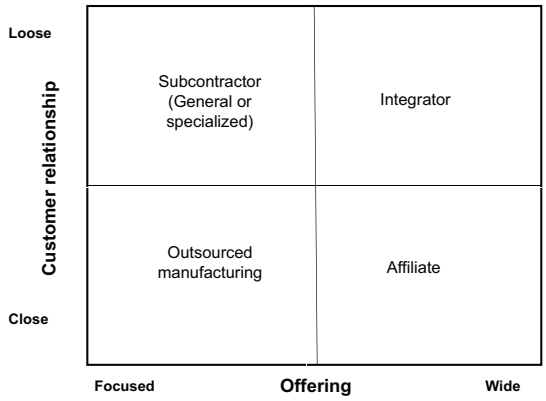
2 In the group of *integrators* we include large LSP companies offering a wide variety of services, ranging from simple logistics services to supply chain planning and value-adding turnkey solutions for large customers. These companies, besides coordinating their own resources, have the capability to orchestrate large domestic and international partner networks built of companies belonging to group 1. Thus, in this study we define integrators somewhat differently than Persson and Virum (2001), who define integrators as companies that offer targeted services for a targeted group of customers and have no physical assets. Rather, our definition of an integrator encompasses the definitions of both an (international) 'logistics operator' and a 'VAL operator' given by Persson and Virum (2001).

3 Companies offering *outsourced manufacturing* have rather recently risen in the sphere of logistics services (Van Hoek, 2000). These companies offer services that were previously performed by the manufacturers themselves or sometimes by retail stores. Their services include light assembly, adjustment and testing, packaging or unpackaging, ticketing, labelling, etc., all of which are necessary for getting items into selling condition. As these services almost always require the development of specialised processes and significant investments in special equipment, these companies typically specialise in serving customers in only a few manufacturing industries. This group is rather similar to what Hertz and Alfredsson (2003) presents as 'service developers', offering advanced value-added services. However, we suggest that the development of outsourced manufacturing services is, in practice, more often manufacturer-driven than LSP-driven.

4 *Affiliates* belong to the business ecosystems of their customers and coordinate logistics operations mainly or solely for these firms. Their offering is wide, but their role is rather focused; i.e., they do logistics planning, but do not implement the logistics by themselves as they do not have their own resources for that. Instead, they buy basic logistics services from other LSPs. This group resembles an 'internal logistics department' as presented by Bolumole (2003).

Figure 1 illustrates these four groups: 'outsourced manufacturing' companies have focused service offerings and close customer relationships, whereas 'subcontractors' have focused service offerings, but usually rather loose customer relationships. 'Affiliates' have close customer relationships and wide service offerings, and 'integrators' rather loose customer relationships and wide service offerings. Loose customer relationships imply that it is rather easy for the customer to replace the operator. Focused service offerings are typically based on the service provider's own resources, while wide service offerings combine the service provider's own services and those of partners.

Figure 1 Four types of LSP service strategy, classified by types of service and types of customer relationship



Now, we will turn to RQ2, i.e., how modularity and customisation are used by LSPs in implementing their strategies, namely in their service offering, service production and organisation, in particular their service production network levels. For the analysis we first need to develop a measurement system. As presented in the literature, modularity and customisation are matters of degree, and consequently there are high and low degrees of modularity and customisation (e.g., Brusoni and , 2001; Salvador et al., 2004; Ernst, 2005; Mikkola and Skjøtt-Larsen, 2004). In their framework, Bask et al. (2011a) measured the degree of modularity in terms of the product variants offered with different modules and service levels (the customer service offering perspective), in terms of the use of modularity principles in production (the service production perspective) and in terms of the responsibilities of suppliers (the service production network perspective). From the same perspectives, they measure the degree of customisation through, respectively, the customisation experience for the customer, the deepness of customer involvement, and the degree of dedication (see Table 3).

In this article, we have adapted and aim to further develop the framework of Bask et al. (2011a). We aim to present a first draft of a measurement system for modularity and customisation in the LSP service context, and to measure the degrees of modularity of the service offerings, production processes and production networks of LSPs. In addition to this, the degrees of customisation of the service offerings, production processes and networks of the case companies are evaluated. From the literature, we have selected *commonality* and *combinability* as measures of modularity, due to the fact that, firstly, these features are among the most commonly mentioned measurements of modularity in the earlier literature (see Table 1). The second and a more practical reason is that we had included several questions about these aspects in our questionnaire. Customisation on the other hand has been more challenging to measure, since we actually had only one question in our questionnaire about the customisation of services. Another issue is that the customisation (or mass customisation) measurements presented in the current literature have been formulated for evaluating production process strategies in the physical product manufacturing context. As we have stated above, these measurements rely on the stage of customer involvement in the production process, and are probably not applicable as such in the context of service production (De Blok et al., 2010). In the previous literature, measurements have been presented for evaluating customisation levels in the context of production processes, not offerings or organisational issues. This is why we use the measurements presented by Bask et al. (2011a) directly, and the evaluation of the degree of customisation relies on the overall judgement of the researchers based on all the available information about the companies.

We have defined service modularity measurements – as well as customisation – at three levels, i.e., at the level of networks, processes and service offerings. As a first attempt to build a measurement system we propose that,

1 Concerning the modularity of *service* offerings, *commonality* means that the same service or service module can be used for many different service offerings, and that *combinability* related to service offerings can be defined as the changeability/replaceability of service modules. The *customisation* of service offerings means that customers are offered possibilities to receive customised offerings.

2 Concerning *process* modularity, *commonality* means that the same process modules can be used in many production processes, and that *combinability* related to processes can be defined as the changeability/replaceability of process modules. The *customisation* of processes allows the involvement of customers in service production.

3 Concerning *network* modularity, *commonality* means that the same supplier or subcontractor is 'universal' and can be used for the production of several services, and that *combinability* related to networks means that suppliers or subcontractors are easy to replace and relations between partners are close to 'plug-and-play'. The degree of *customisation* related to networks can be measured by the dedication or exclusivity in the partnership relations.

A summary of the measurement criteria used at different levels in this research is presented in Table 4.

Table 4 Summary of the measurements of modularity and customisation developed for this study

	Customer perspective	*Production perspective*	*Network perspective*
Modularity	Commonality: the same service or service module can be used for many different service offerings. Combinability: changeability/ replaceability of service modules.	Commonality: the same process modules can be used in many production processes. Combinability: changeability/ replaceability of process modules.	Commonality: the same supplier or subcontractor can be used for the production of several services. Combinability: suppliers or subcontractors are easy to replace.
Customisation	Customisation: customer's possibilities to receive customised offerings.	Customisation: deepness of the involvement of customers in service production.	Customisation: dedication or exclusivity in the partnership relations.

Next, we present our analysis of the companies in terms of their service strategies and modularity and customisation.

5 Analysis of the companies in terms of their service strategies, and modularity and customisation

During the analysis we first went through the interview data to get an overview of the degree of modularity and customisation in the companies' services, processes and networks. The analysis was conducted in such a way that researchers first presented their judgements on each company based on the measurement system presented above. During this process we realised that some of the companies seemed to have rather similar strategic positioning to each other. The following table (see Table 5) presents an overview of the LSP strategic groups and a preliminary analysis of the modularity and customisation of the services, processes and networks of the companies.

Table 5 An overview of the sample of LSP strategic groups, and preliminary judgements on the degree of modularity and customisation in their services, processes and networks

Strategy group	Service	Service	Service	Process	Process	Process	Network	Network	Network
	Commonality	Combinability	Customisation	Commonality	Combinability	Customisation	Commonality	Combinability	Customisation
*General subcontractor	High	High	Low	High	Low	Low	High	High	High
General subcontractor	Low	Low	High	N/A	High	N/A	Low	High	N/A
General subcontractor	High	High	High	High	High	Low	Low	N/A	Low
General subcontractor	High	High	Low	High	High	Low	High	High	Low
General subcontractor	High	High	High	High	High	Low	High	High	High
General subcontractor	High	High	High	High	High	Low	High	High	Low
Specialised subcontractor	Low	N/A	Low	N/A	N/A	Low	Low	N/A	Low
Specialised subcontractor	High	High	High	High	High	Low	High	High	Low
Specialised subcontractor	N/A	N/A	Low	N/A	N/A	Low	Low	Low	Low
Specialised subcontractor	High	High	High	High	High	Low	Low	N/A	High
*Specialised subcontractor	High	Low	Low	High	N/A	Low	N/A	Low	High
Specialised subcontractor	High	High	High	High	High	Low	Low	Low	Low

Table 5 An overview of the sample of LSP strategic groups, and preliminary judgements on the degree of modularity and customisation in their services, processes and networks (continued)

Strategy group	Service Commonality	Service Combinability	Service Customisation	Process Commonality	Process Combinability	Process Customisation	Network Commonality	Network Combinability	Network Customisation
Integrator	*High*	*High*	*High*	*High*	*High*	*Low*	*High*	*High*	*High*
Integrator	*High*	*High*	*High*	*High*	*High*	*N/A*	*Low*	*High*	*High*
Integrator	*High*	*High*	*High*	*High*	*High*	*Low*	*Low*	*High*	*N/A*
Integrator	*High*	*High*	*High*	*High*	*High*	*Low*	*High*	*High*	*Low*
Outsourced manufacturing	High	High	High	High	N/A	Low	Low	N/A	High
Outsourced manufacturing	High	High	High	High	High	N/A	Low	Low	High
*Outsourced manufacturing	High	High	High	Low	Low	High	Low	N/A	N/A
Outsourced manufacturing	High	Low	High	High	Low	Low	High	High	Low
Outsourced manufacturing	High	High	High	High	High	Low	High	Low	High
**Affiliate*	*N/A*	*Low*	*N/A*	*High*	*Low*	*N/A*	*High*	*High*	*High*
Affiliate	*Low*	*High*	*High*	*Low*	*High*	*High*	*High*	*High*	*Low*

After this preliminary analysis, and in order to simplify the multifaceted issue and to more thoroughly study how companies with different service strategies use modularity and customisation to implement these strategies in their service offerings, production processes and production networks, we decided to select and analyse five case companies in more detail. The case companies are shown by asterisks in Table 5.

5.1 Case studies

We decided to use five case companies representing, as we understood it, different LSP strategies, to get a more in-depth view of the use of modularity and customisation in the implementation of these strategies. The five companies were selected because we had the most information on them, based on interviews and publicly available material.

The biggest group of companies in our sample was the subcontractors, including six *general subcontractors* and six *specialised subcontractors*. For the more in-depth analysis we chose two case companies in the subcontractor's category in order to include both general and specialised subcontractors. Our sample had four companies that could be described as *integrators,* and we chose one of them for in-depth analysis. From the five companies in our sample that offer *outsourced manufacturing* (i.e., conduct activities that can be described as manufacturing rather than logistics and that had previously been done by the manufacturers themselves or sometimes by retail stores), we chose one for in-depth analysis. Likewise, we chose one of the two case companies that could be described as *affiliates* of their customer companies for in-depth analysis.

Thus, we chose five case companies representing each of the four LSP strategies, and analysed them thoroughly for their use of modularity and customisation. To structure the discussion on modularity, the commonality and combinability features are discussed separately. The chosen companies are examined from three perspectives, i.e., service offering, service production process and service production network. We aimed to study whether the different strategies used by the case companies also imply differences in modularity and customisation in these three aspects.

5.1.1 Case 1a (a general subcontractor)

Case 1a is a network of independent road transport service providers that own the trucks used for services. As a network coordinator, the company handles sales, marketing, billing and other services for its owners. The service offered to the customer is a transportation module that the customer requires for its supply chain. The trucks can even be entirely in the customer's use for certain periods. Because it operates as a network, the case company has the advantage of flexibility and a large pool of trucks available to execute customer orders.

The commonality of the *services* is rather high, as service modules can be used in many different entities. The transportation module is the backbone of the different delivery services. However, as the company's services typically consist of only a few modules, combinations of modules are not common (i.e., combinability is rather low). The customisation of services is also fairly low, since road transportation is a rather simple and standard service and the case company has limited potential to differentiate. However, there are some customised services (for example, trucks and drivers offered for the customer's use for certain periods).

The case company offers non-labelled transportation that is neutral with respect to producer brands and can even deliver competitors' products. Thus, there is rather high commonality in *processes*, as the trucks are standard and any truck can deliver any customer's products. Despite all efforts, process interfaces are not as standardised as they could be, and the modules in some cases cannot easily be combined or replaced (i.e., combinability is rather low). Processes are mainly not customised, which is seen as contributing to efficiency. However, some variation is present, due to individual owner companies and special customised services for some customers.

Commonality is high in the *network*, as in principle any company in the network can be used for any customer's order (within the limits set by geographical location and availability). Combinability is also high, as the companies are rather widely replaceable and combinable, and offer standard transportation services. As a network, case 1a seems rather customised; i.e., small transportation companies own the case 1a company, and are dedicated to its operations (but not necessarily exclusively).

5.1.2 Case 1b (a specialised subcontractor)

Case 1b company offers services based on its specialised infrastructure and knowledge. The commonality of its *services* is quite high because they can be offered as modules for several customers' delivery chains. However, the combinability of services is rather low, as the service offerings consist of only a few modules, and combinations of modules are not common. The transportation services are not customised, but fixed and standardised even with regard to pick-up and delivery points, because they are predefined by the infrastructure.

From the *process* perspective there is some commonality (opportunity to use the same infrastructure and equipment for different services) and combinability, because process interfaces are standardised and processes can be combined quite easily, although there are not many supplementary value-adding services that can be added to the basic process. The customisation of processes is low.

The cooperation *network* consists of other operators internationally, ports and owners of the equipment, for example. The network commonality is fairly high, because partners and personnel are not specialised (in serving particular customers), and can be used in the production of many services. The network members are not easily combinable otherwise than within the somewhat fixed network structure. The network is rather fixed and stable, and long-term contracts are in place. Therefore, it can be said that the network is somewhat customised and dedicated, but does not exclusively operate for case 1b.

5.1.3 Case 2 (an integrator)

Case 2 is the most typical integrator in our sample. It is a Finnish affiliate of a large international conglomerate offering transportation, warehousing, and value-added services in Finland, as well as import and export transport and related services. It has over one thousand employees of its own and a network of over 500 independent SMEs as subcontractors, typically offering general road transport services. It has a large customer base and offers a wide variety of services for divergent needs, both standard and customised services.

Most of the *services* of case 2 are productised, and their commonality is high, as the company uses the same services as modules in different product packages. The combinability of services is also high, because services can be easily combined with each other. A light (combinatorial) customisation of services is possible if supplementary services are added to the basic services. One example is the home delivery service, to which an installation service can be added if the end customer wants it.

The *processes* of case 2 consist of modules such as pick-up transport, warehousing, consolidation, terminal-to-terminal transport, sorting and re-packing, delivery transport, and related information services. The case company has thorough process descriptions that are used for instance when new subcontractors or temporary employees are initiated. The commonality of processes is high, as most services are produced using partly joint process steps. Terminal-to-terminal transports, which are shared for almost all services, are one example. The combinability of process modules is also high, and is seen as an important process development criterion. The customisation of processes is neither needed nor encouraged, but process modules can be combined to achieve light customisation. As the customer base is large, the company uses customer segmenting, and to some extent segment-specific processes.

The production *network* of case 2 has high commonality, as the same network modules can be used in the production of different kinds of services. Combinability is also high, as the network modules can easily be combined with each other and the company emphasises clear process descriptions and interfaces with partners in its large network. The customisation of the network is high, as SMEs offering general transportation services are highly dedicated to case 2; they have been trained by the integrator, the trailers are painted in the colours of the integrator, and they rely essentially on the focal company's resources, such as IT infrastructure. A couple of large network partners also offer transportation services in particular geographical areas and have their own subcontractor networks.

5.1.4 Case 3 (outsourced manufacturing)

Case 3 is part of a large global logistics company offering a wide variety of logistics services, but specialises in offering warehousing and outsourced manufacturing for particular industries. These services include country-specific packaging for electronics manufacturing.

The commonality of modules in the *services* of case 3 can be considered high, as there are opportunities to provide similar services in several service packages offered to certain customers, and similar types of service can even be duplicated and offered to several customers. The combinability of services is also rather high, because services can be quite easily combined with each other to form packages for customers. All of the service products are customised for particular customers. Thus, the customisation of its services is high.

Likewise, the production *processes* of services are highly customised. The commonality and combinability of process modules are low, however, because processes are designed for certain customers. Thus, in most cases, there are not too many shared processes for several customers (low commonality), and there is only a rather limited need for new combinations of process modules, as services are produced for only one customer (low combinability). One example of the low commonality and combinability

of processes is the use of customer-specific IT systems, since the IT systems of the focal manufacturing companies are used by the case company.

Case 3 has a *network* structure that is not modular, as the commonality and combinability of network modules is low. This originates from the fact that a significant number of the company's operations are implemented for particular customers with specialised networks and personnel. These network modules are specialised and cannot easily be combined with other modules or used in the production of services offered to other customers. The network and organisation are customised to meet the specific needs of particular customers.

5.1.5 Case 4 (an affiliate)

Affiliates offer services mainly or solely to the firms that own them. Case 4 is a large affiliate mainly serving the warehousing and transport needs of its parent company operating in the wholesale trade, and of the parent company's customers operating in retailing. The company has organised its delivery transport services through a large partner network consisting of 300 SMEs. Warehouses and terminals are owned by the company and are run by its own personnel.

The *services* of case 4 have high commonality in the captive customer base, as they can be offered as modules for several customers' delivery chains. However, in the wider perspective, commonality is low. The combinability of services is low, as the needs of the customers are somewhat stable from day to day, and there is only a limited need for combining services into new and different service packages. The customisation of services can be viewed from two contradictory angles: the service entity as a whole is highly customised for the focal parent company and its customers, but the services, as such, are highly standardised and not customised for individual retail stores.

The commonality of *process* modules is moderate or high, as there are many shared process modules for many retail stores. The combinability of process modules is low, as processes can be combined in only a limited way and in a certain sequence, and are not too flexible since there is only a limited range of value-adding services that can be added to the basic process. The production processes are highly standardised and not customised for individual retail stores. Standardisation and efficient processes are needed as the retail stores must meet tight schedule demands. However, the whole production process system is customised for the parent company.

The production *network* of case 4 has rather high commonality of network modules, as they can be used in the production of several different delivery services. The network has quite high combinability, as the company emphasises clear process descriptions and interfaces, and the network modules can be replaced or combined with each other fairly easily. The customisation of the network is high, as SMEs are dedicated to and trained by the case company, and trailers are usually painted in the colours of the integrator. Furthermore, small network partners use the IT systems of case 4.

5.2 Summary of the case study findings

Our findings suggest that the type of service strategy is reflected in differences relating to modularity and customisation in service offerings, processes and networks when the strategy is implemented.

There were three somewhat surprising findings: firstly, only case 2, representing an integrator, managed to apply modularity and customisation (i.e., mass customisation) at every level, i.e., the service, process and network levels. The mass customisation of services in the case companies was not a rule, and this was rather unexpected. The offerings of subcontractors (cases 1a and 1b) consisted of quite simple service entities, and they used their own fairly fixed resources to produce services. Thus, they had fewer opportunities, or even reasons, to build their services from modules or to customise them for several principals. Their services went into their principals' offerings or customers' supply chains as modules, though. In outsourced manufacturing (case 3), services were designed for each customer, but were usually combined with rather standard modules to form a service package; i.e., they were mass-customised. Affiliates (case 4) worked in an integrated manner for their customers, with offerings that were customised and usually not too modular. But they also designed service entities for their principals from modules offered by other LSPs.

Secondly, the processes of the case companies seemed to be rather inflexible. In some cases they were somewhat modular, but were not/could not be customised, while in other cases they were customised, but not modular. Case 2, the integrator, had mass-customised processes. For the above-mentioned service-related reasons, subcontractors (cases 1a and 1b) and affiliates (case 4) usually had few opportunities or reasons to build their processes from modules, or to customise them for several principals. In outsourced manufacturing, and in particular in case 3, the biggest reason for the non-modularity of processes was that, as these companies typically offer services for a particular industry (including competitors), they had to have separate processes and dedicated, specially trained personnel for serving each customer.

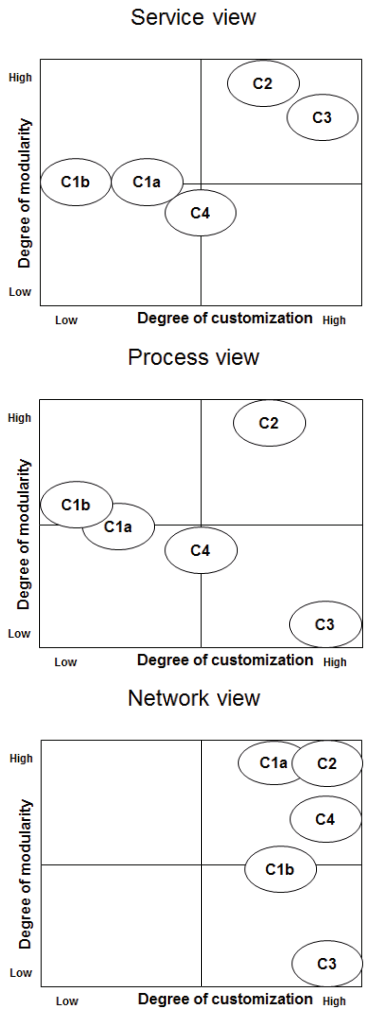
The third observation was that the network relations of almost all the case companies seemed to be rather modular and customised, thus representing 'mass customisation' at this level. One explanation is that, in the logistics industry, the roles of actors are fairly clear, the markets work fairly well, and it is rather easy to replace partners. The only exception was case 3, because outsourced manufacturing is based on long-term investments in special equipment and knowledge, and, as a consequence, on long-term network relationships. However, in practice, the production networks of all the case companies were rather stable, meaning that the potential of modularity was not exploited to the full.

This study shows that companies with different strategies implement modularity and customisation differently. There were differences between the case companies in different strategy groups with respect to their use of modularity and customisation in services, processes and networks. However, there are presumably also differences between the companies inside a single strategy group. Thus, it is difficult to draw definitive conclusions about dependencies, causes, effects, etc., based on our limited data. A summary of the case study findings is presented in Table 6 and Figure 2. The frameworks presented in Figure 2 facilitate visualisation of the different combinations of modularity and customisation at three levels (service offerings, service production processes, and the service production network).

Table 6 Summary of the case companies analysed for their modularity (commonality and combinability) and customisation (final analysis)

Case	*Service*			*Process*			*Network*		
	Commonality	*Combinability*	*Customisation*	*Commonality*	*Combinability*	*Customisation*	*Commonality*	*Combinability*	*Customisation*
1a	Rather high	Rather low	Rather low	Rather high	Rather low	Rather low	High	High	Rather high
1b	Rather high	Rather low	Low	Rather high	Rather high	Low	Rather high	Rather low	Rather high
2	High	High	Rather high	High	High	Rather high	High	High	High
3	High	Rather high	High	Low	Low	High	Low	Low	High
4	High/low	Rather low	High/low	Rather high	Low	Low/high	Rather high	Rather high	High

Figure 2 The case companies presented in frameworks



Source: Frameworks adapted from Bask et al. (2011a)

6 Discussion and conclusions

In this paper, we have analysed and classified the service strategies applied by LSPs. In addition, we have examined how modularity and customisation are used by LSPs when they implement their strategies. From a set of 23 LSPs we chose five companies representing different service strategies for in-depth analysis. These five case companies were analysed using a framework originally developed by Bask et al. (2011a).

The main aim of this paper was to analyse whether the framework for visualising different combinations of the degrees of modularity and customisation related to services, processes and networks, originally developed by Bask et al. (2011a), could be applied to companies representing the Finnish LSP industry. For this purpose, and in order to achieve a more generalisable result than just examining individual companies, the surveyed and interviewed companies were categorised according to the service strategies they employed. The strategy types used in the analysis emerged when examining the data. The companies differed in terms of the extent of their offering (focused – wide) and customer relationship (close – loose) so that four distinct groups could be formed: subcontractors, integrators, outsourced manufacturing and affiliates.

Berglund et al. (1999) forecasted that tiering in the TPL industry could significantly increase as the industry matures. In fact, in the Finnish markets today, there is a rather small group of large multinational conglomerates acting as integrators that are closely linked to their customers, and individual links in their networks are provided by a group of second-tier general or specialised subcontractors. As pointed out earlier, there are also other strategies available for the LSPs. Besides integrators and subcontractors, we have identified strategies based on offering outsourced manufacturing, and 'affiliates' that work in close cooperation with their customers and offer close to total logistics services for only a single or a restricted group of customers.

As the main result, after positioning the companies in a modularity-customisation framework with three levels (service, process and network perspectives), it was found that the type of service strategy applied by LSPs seems to reflect how each company is positioned in the framework. Based on this result, it seems that the framework is applicable to LSP companies; at least if it can be assumed that the Finnish LSP industry is representative of the industry in general.

Regarding positioning, the five case companies were positioned, according to their service offerings, service production processes and service production networks in the frameworks, into four categories: non-modular regular, modular regular, modular customised and non-modular customised. Applying the criteria that illustrate each of the categories in the three different perspectives (service, process, and network), it became clear that the positioning of the case companies differs depending on the perspective from which it is analysed. Our findings show that different approaches towards the comprehensiveness of service offerings or customer relationships are reflected in differences in the modularity and customisation of service offerings, processes and networks. In particular, this indicates that service strategies other than just mass customisation can be feasible, depending on the situation and perspective. One particular observation we have made on the basis of our interviews is that, although Finnish LSPs usually aim for rather standardised products and processes, the networks they use to execute the services are rarely standardised, but are rather customised.

Modularity and customisation have often been treated as interconnected in the previous research literature. We can see, based on our interviews, that the interconnection

of the concepts of modularity and customisation is also common among practitioners in the logistics sector. Our interviews further show that people refer to customer services, LSP processes, and even the network through which the services are executed, when they speak about modularity. Thus, quite apart from theoretical reasons, there are strong practical reasons to separate, on one hand, the concepts of modularity and customisation, and, on the other hand, the service offering, production process and production network perspectives. This kind of distinction between concepts and perspectives facilitates more profound analyses of different strategies and different strategy implementation modes that the LSPs may choose.

As a contribution to modularity theory, we have illustrated that a structured analysis, using frameworks illustrating different aspects, can be helpful in bringing more clarity to rather vague concepts. In order to analyse LSP strategies we have also developed a measurement system for three aspects of service modularity. We expect that this will be valuable, as it seems that there is a lot of interest in both the academic community and the industry on how these concepts could be applicable in the service context. Researchers and practitioners alike have expected strategies combining modularity and customisation to be beneficial. But the prerequisite to accomplish this is to understand the essence of these concepts in different managerial contexts. With respect to managerial practice, we have shown in this study that the frameworks developed by Bask et al. (2011a) and applied in this paper in an empirical context may help the managers of LSPs when they plan the implementation of service strategies. While it is possible to choose different strategy types and implementation modes regarding modularity and customisation than those exhibited in the group of LSPs studied, the observed connection between the strategy and the positioning in the framework may indicate an effective and efficient way of implementing strategy. As a future study, it could be interesting to examine the strategy-implementation connection in terms of the profitability of companies, for example.

All-in-all, it should be noted that this study is limited to the extent that we have used companies from the Finnish LSP industry, and that the testing of the framework should be extended to other service industries and countries. Moreover, the analysis has been done on the basis of upper level criteria developed in this study, and should be operationalised further into more exact measures.

Thus, while this study suggests that there is a connection between the service strategy type and the position in the modularity-customisation framework, one aim of future research could be to further operationalise the framework, to develop more profound measures for modularity and customisation in the different aspects, and to present more case analyses from different service-based industries in order to test and illustrate the relations between, on one hand, different service strategies and, on the other hand, approaches to modularity and customisation.

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References

Andersson, D. and Norrman, A. (2002) 'Procurement of logistics services – a minutes work or a multi-year project?', *European Journal of Purchasing and Supply Management*, Vol. 8, No. 2, pp.3–14.

Baldwin, C.Y. and Clark, K.B. (1997) 'Managing in an age of modularity', *Harvard Business Review*, Vol. 75, No. 5, pp.84–93.

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

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2010) 'The concept of modularity: diffusion from manufacturing to service production', *Journal of Manufacturing Technology Management*, Vol. 21, No. 3, pp.355–375.

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2011a) 'Framework for modularity and customization: service perspective', *Journal of Business & Industrial Marketing*, Vol. 26, No. 5, pp.306–319.

Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2011b) 'Modularity in logistics services: a business model and process view', *International Journal of Services and Operations Management*, Vol. 10, No. 4, pp.379–399.

Bask, A.H. (2001) 'Relationships between 3PL providers and members of supply chains – a strategic perspective', *Journal of Business and Industrial Marketing*, Vol. 16, No. 6, pp.470–486.

Bask, A.H., Juga, J. and Laine J. (2006) 'Evolution of services, relationships and technologies in container transport', in Ojala, L. and Jämsä, P. (Eds.): 'Third party logistics – Finnish and swedish experiences', Turku School of Economics and Business Administration, Series Discussion and Working papers, Vol. 3, pp.109–132.

Berglund, M., van Laarhoven, P., Sharman, G. and Wandel, S. (1999) 'Third-party logistics: is there a future?', *International Journal of Logistics Management*, Vol. 10, No. 1, pp.59–70.

Bolumole, Y.A. (2003) 'Evaluating the supply chain role of logistics service providers', *The International Journal of Logistics Management*, Vol. 14, No. 2, pp.93–107.

Brusoni, S. and Prencipe, A. (2001) 'Unpacking the black box of modularity: technologies, products and organizations', *Industrial and Corporate Change*, Vol. 10, No. 1, pp.179–205.

Cabigiosu, A., Campagnolo, D., Furlan, A. and Costa, G. (2012) 'Balancing customization and standardization in knowledge intensive business services: the use of modular service architectures', Working paper No. 11/2012, September, ISSN: 2239-2734, 36pp, Universita Ca'Foscari Venezia, Department of Management.

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.

Christopher, M. (2010) 'New directions in logistics', in Waters, D.J. (Ed.): *Global Logistics: New Directions in Supply Chain Management*, 6th ed., pp.1–13, 536pp, ISBN 9780749457037 Kogan Page Publishers.

Cui, L. and Hertz, S. (2011) 'Networks and capabilities as characteristics of logistics firms', *Industrial Marketing Management*, Vol. 40, No. 6, pp.1004–1011.

Da Silveira, G., Borenstein, D. and Fogliatto, F.S. (2001) 'Mass customization: literature review and research directions', *International Journal of Production Economics*, Vol. 72, No. 1, pp.1–13.

De Blok, C., Luijkx, K., Meijboom, B. and Schols, J. (2010) 'Modular care and service packages for independently living elderly', *International Journal of Operations & Production Management*, Vol. 30, No. 1, pp.75–97.

Dubois, A. and Gadde, L-E. (2002) 'Systematic combining – an abductive approach to case research', *Journal of Business Research*, Vol. 55, No. 7, pp.553–560.

Duray, R., Ward, P.T., Milligan, G.W. and Berry, W.L. (2000) 'Approaches to mass customization: configurations and empirical validation', *Journal of Operations Management*, Vol. 18, No. 6, pp.605–625.

Ellram, L.M. (1996) 'The use of the case study method in logistics research', *Journal of Business Logistics*, Vol. 17, No. 2, pp.93–138.

Ernst, D. (2005) 'Limits to modularity: reflections on recent developments in chip design', *Industry and Innovation*, Vol. 12, No. 3, pp.303–345.

Fabbe-Costes, N., Jahre, M. and Rouquet, A. (2006) 'Interacting standards: a basic element in logistics networks', *International Journal of Physical Distribution & Logistics Management*, Vol. 36, No. 2, pp.93–111.

Fabbe-Costes, N., Jahre, M. and Roussat, C. (2009) 'Supply chain integration: the role of logistics service providers', *International Journal of Productivity and Performance Management*, Vol. 58, No. 1, pp.71–91.

Hertz, S. and Alfredsson, M. (2003) 'Strategic development of third party logistics providers', *Industrial Marketing Management*, Vol. 32, No. 2, pp.139–149.

Hoetker, G. (2006) 'Do modular products lead to modular organizations?', *Strategic Management Journal*, Vol. 27, No. 6, pp.501–518.

Huemer, L. (2012) 'Unchained from the chain: supply management from a logistics service provider perspective', *Journal of Business Research*, Vol. 65, No. 2, pp.258–264.

Jacobs, M., Vickery, S.K. and Droge, C. (2007) 'The effects of product modularity on competitive performance. Do integration strategies mediate the relationship?', *International Journal of Operations & Production Management*, Vol. 27, No. 10, pp.1046–1068.

Kumar, A. (2004) 'Mass customization: metrics and modularity', *The International Journal of Flexible Manufacturing Systems*, Vol. 16, No. 4, pp.287–311.

Lampel, J. and Mintzberg, H. (1996) 'Customizing customization', *Sloan Management Review*, Vol. 38, No. 1, pp.21–30.

Lau, A.K.W., Yam, R.C.M. and Tang, E.P.Y. (2007) 'Supply chain product co-development, product modularity and product performance. Empirical evidence from Hong Kong manufacturers', *Industrial Management & Data Systems*, Vol. 107, No. 7, pp.1036–1065.

Makukha, K. and Gray, R. (2004) 'Logistics partnerships between shippers and logistics service providers: the relevance of strategy', *International Journal of Logistics: Research and Applications*, Vol. 7, No. 4, pp.361–377.

McCutcheon, D.M. and Meredith, J.R. (1993) 'Conducting case study research in operations management', *Journal of Operations Management*, Vol. 11, No. 3, pp.239–256.

Mikkola, J.H. (2006) 'Capturing the degree of modularity embedded in product architectures', *The Journal of Product Innovation Management*, Vol. 23, No. 2, pp.128–146.

Mikkola, J.H. and Skjøtt-Larsen, T. (2004) 'Supply-chain integration: implications for mass customization, modularization and postponement strategies', *Production Planning & Control*, Vol. 15, No. 4, pp.352–361.

Nakano, D. (2011) 'Modular service design in professional services: a qualitative study', *International Journal of Services and Operations Management*, Vol. 9, No. 1, pp.1–17.

Olhager, J. (2003) 'Strategic positioning of the order penetration point', *International Journal of Production Economics*, Vol. 85, No. 3, pp.319–329.

Park, Y. and Nahm, A.Y. (2011) 'Classification of mass customisation: a socio-technical system perspective', *International Journal of Services and Operations Management*, Vol. 8, No. 3, pp.322–334.

Pekkarinen, S. and Ulkuniemi, P. (2008) 'Modularity in developing business services by platform approach', *The International Journal of Logistics Management*, Vol. 19, No. 1, pp.84–103.

Pekkarinen, S. and Ulkuniemi, P. (2011) 'Creating value for the business service buyer through modularity', *International Journal of Services and Operations Management*, Vol. 8, No. 2, pp.127–141.

Persson, G. and Virum, H. (2001) 'Growth strategies for logistics service providers: a case study', *The International Journal of Logistics Management*, Vol. 12, No. 1, pp.53–64.

Pine, B.J. II (1993) 'Mass customizing products and services', *Planning Review*, Vol. 21, No. 4, pp.6–15.

Sachan, A. and Datta, S. (2005) 'Review of supply chain management and logistics research', *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 9, pp.664–705.

Salvador, F. (2007) 'Towards a product modularity construct: literature review and reconceptualization', *IEEE Transactions on Engineering Management*, Vol. 54, No. 2, pp.219–240.

Salvador, F., Rungtusanatham, M. and Forza, C. (2004) 'Supply-chain configurations for mass customization', *Production Planning & Control*, Vol. 15, No. 4, pp.381–397.

Schilling, M.A. and Steensma, H.K. (2001) 'The use of modular organizational forms: an industry-level analysis', *Academy of Management Journal*, Vol. 44, No. 6, pp.1149–1168.

Selviaridis, K. and Spring, M. (2007) 'Third party logistics: a literature review and research agenda', *The International Journal of Logistics Management*, Vol. 18, No. 1, pp.125–150.

Sony, M. and Mekoth, N. (2012) 'A typology for frontline employee adaptability to gain insights in service customisation: a viewpoint', *International Journal of Services and Operations Management*, Vol. 12, No. 4, pp.490–508.

Squire, B., Brown, S., Readman, J. and Bessant, J. (2006) 'The impact of mass customisation on manufacturing trade-offs', *Production and Operations Management*, Vol. 15, No. 1, pp.10–21.

Starr, M.K. (1965) 'Modular production – a new concept', *Harvard Business Review*, Vol. 3, No. 1, pp.131–142.

Starr, M.K. (2010) 'Modular production – a 45-year-old concept', *International Journal of Operations & Production Management*, Vol. 30, No. 1, pp.7–19.

Tinnilä, M. and Vepsäläinen, A.P.J. (1995) 'A model for strategic repositioning of service processes', *International Journal of Service Industry Management*, Vol. 6, No. 4, pp.57–80.

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.

Tuunanen, T., Bask, A. and Merisalo-Rantanen, H. (2012) 'Typology for modular service design: review of literature', *International Journal of Service Science, Management, Engineering, and Technology (IJSSMET)*, Vol. 3, No. 3, pp.99–112.

Van Hoek, R.I. (2000) 'The role of third-party logistics providers in mass customization', *The International Journal of Logistics Management*, Vol. 11, No. 1, pp.37–46.

Voordijk, H., Meijboom, B. and de Haan, J. (2006) 'Modularity in supply chains: a multiple case study in the construction industry', *International Journal of Operations & Production Management*, Vol. 26, No. 6, pp.195–219.

Voss, C.A. and Hsuan, J. (2009) 'Service architecture and modularity', *Decision Sciences*, Vol. 40, No. 3, pp.541–569.

Yazdanparast, A., Manuj, I. and Swartz, S.M. (2010) 'Co-creating logistics value: a service dominant logic perspective', *International Journal of Logistics Management*, Vol. 21, No. 3, pp.375–403.

PAPER 6

Rajahonka, M. and Bask, A. (201x), "Development of outbound logistics services in the automotive industry – case SE Mäkinen", paper has been sent for review.

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Development of outbound logistics services in the automotive industry – case SE Mäkinen

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Short bios:

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Development of outbound logistics services in the automotive industry – case SE Mäkinen

Purpose: Until now, research on the automotive industry has primarily been conducted from the manufacturers' perspective and has discussed manufacturing systems, manufacturers' supplier networks and inbound supply chains. Manufacturers' attempts to gain more efficiency and apply mass customization by means of modularity principles have been among the popular research themes. However, only a few studies have examined outbound logistics, or adopted the automotive logistics service providers' (LSPs') point of view. Furthermore, there are no studies on the usage of modularity principles by LSPs in mass customizing services or service models. Our objective in this paper is to fill these research gaps.

Design/methodology/approach: This paper is based on an analysis of a single case study. The case company chosen is SE Mäkinen, a Finnish LSP specializing in automotive logistics.

Findings: In this paper we examine the case company's service model and its development over time. Our findings show how the company has moved towards a more multifaceted service model in outbound logistics in the automotive industry supply chain. Moreover, the results show how the case company uses modularity principles to gain efficiency in its processes and effectiveness in its services.

Research limitations/implications: This research is based on a single case study, and concentrates on outbound logistics in the automotive field in a specific geographical area. This decreases the generalizability of the findings outside this context. However, a single case study has the potential to offer in-depth insights.

Practical implications: The analysis may help other LSPs and service companies in their service development. The use of modularity principles enhances the offering of mass customized services, the developing of efficient processes, and the dividing of labor between partners, in order that tasks can be done at the most appropriate points of supply chains.

Originality/value: This paper fills a research gap by examining outbound logistics services in the automotive supply chain and by taking an LSP's point of view.

Keywords: Logistics; outbound logistics; automotive industry; logistics service provider; service model; modularity

Paper type – Research paper

1. Introduction

The automotive industry can be described as one of the largest and most multinational of all industries (The automotive sector at a crossroads, 2004). The research literature on the automotive industry has mainly concentrated on the manufacturers' perspective, namely on manufacturing, supply networks and inbound logistics (Holweg and Miemczyk, 2003; Lasserre, 2004; Pfohl and Gareis, 2005; Fredriksson, 2006; Suthikarnnarunai, 2008; Trappey et al., 2010; Dias et al., 2010). Among the popular research themes have been modularity, and how applying modularity principles in car manufacturing is reflected in manufacturers' supplier networks and in inbound logistics. The broad literature describes e.g. the development of the automotive industry towards more customer orientation, including mass customization strategies, and towards efficiency by the means of the outsourcing of manufacturing operations, leading to networking, tiering and supplier park models (Holweg and Miemczyk, 2003; Pfohl and Gareis, 2005; Fredriksson, 2006; Reichhart and Holweg, 2008). Automotive manufacturers have reduced the number of sub-contractors and at the same time increased the outsourcing of activities to external sub-contractors (Svensson, 2001; 2003). This development has been enhanced by the widespread application of modularity principles in the automotive industry (Doran, 2004).

Thus, only a few researchers have focused on the outbound logistics of the automotive supply chain and even fewer on the logistics service providers' (LSPs') role between manufacturers and dealers, or on how their service models have developed over the decades. The research agendas presented in the recent literature have emphasized the expanding of boundaries, and the importance of analyzing supply chains in a network or industry range (Roth and Menor, 2003; Selviaridis and Spring, 2007; Stank et al. 2011). Consequently, in order to gain a holistic view of the automotive supply chain, it is essential to also analyze the downstream of the automotive supply chain.

It is important to study the outbound logistics services offered by LSPs to the automotive industry for several other reasons, too. First, although manufacturers may take care of their outbound logistics operations themselves, they have in fact been focusing on their core businesses, while LSPs have become increasingly important as links between the manufacturers and the retailers that operate close to the end-users of cars. Second, as customer needs become more divergent and expectations regarding responsiveness increase, service providers can develop new services that respond to these changes. From the end-customer's perspective, based on Ro et al. (2007), these opportunities have not yet been fully exploited. Moreover, reducing manufacturing lead-time is of little impact, if the logistics and their lead-times are not addressed (Daugherty and Pittman, 1995; Holweg and Miemczyk, 2003).

For the above-mentioned reasons, we take an LSP perspective. We have studied a case company and the outbound logistics services it has developed over time for the automotive supply chain. We are particularly interested in studying how modularity and customization have been used in the outbound logistics services by the case company. The modularity aspect is interesting, as it has been used for decades when considering the mass customization of products, including those of the automotive industry (Doran, 2004; Fredriksson and Gadde, 2005).

By means of a single case study we aim to gain an in-depth understanding, in the automotive outbound logistics context, of the services and service models, the history and development of the service offerings (the development path), and the future opportunities. The research questions of this study are: 1) How do the case company's services for the automotive industry reflect modularity and customization? 2) How and why has the service model of the case company been developed over time, and how has the case company used modularity in its service model development?

The paper is organized as follows: we start with the methodology part and then move on to the literature on the automotive industry and its outbound logistics. After that, the single case study is presented and analyzed. Then we discuss the future opportunities for LSPs offering outbound logistics services in the automotive supply chain, based on the literature and our case analysis. Finally, concluding remarks and future research topics are presented.

2. Methodology of the study

To address our research questions we use the qualitative research approach. Due to the fact that there is only a limited amount of research available on automotive outbound logistics, we decided to use a single case study. In business research, there has been a growing interest in research strategies based on qualitative analysis and the use of the case study method (Yin, 1981, 1994; McCutcheon and Meredith, 1993; Ellram, 1996; Hudson et al., 2004). Qualitative methods are particularly justifiable if the goal is to explain or understand a phenomenon, or to develop understanding of real-world events (McCutcheon and Meredith, 1993; Sachan and Datta, 2005). The case study method is useful in the early phases of research (description, concept development) where there are no prior hypotheses or much literature that could be used for research (Sachan and Datta, 2005). The case study approach has the potential to offer in-depth insights on the "why" and "how" questions (Yin, 1994). Case studies typically combine data collection methods from primary and secondary sources such as archives, interviews, questionnaires, and observations (Eisenhardt, 1989; McCutcheon and Meredith, 1993).

Ellram (1996) has pointed out that a single case study tends to be specific, but multiple case study results may be more generalizable. Ellram (1996) also argues that a single case is appropriate if that case represents an extreme or unique case, or a case which exposes a previously unreachable phenomenon. According to Dubois and Gadde (2002), learning from a particular case in its context should be considered a strength of case studies, since the interaction between the phenomenon and its context can be understood through an in-depth case study. Voss et al. (2002) remark that the fewer the case studies, the greater the chance for in-depth observations. According to them, single in-depth case studies are often used in longitudinal research. Healy and Perry (2000) also point out that case studies can be either intrinsic, where the case itself is the focus, or instrumental, where the case is used for the purpose of understanding a phenomenon, and this constitutes the distinction between case studies used in constructivism and in realism.

In this paper we concentrate on outbound logistics in the automotive field in a specific geographical area. The case company is SE Mäkinen, a Finnish logistics service provider (LSP) offering outbound logistics services for the automotive industry. SE Mäkinen has specialized in automotive logistics in Finland, the Baltic countries and

Russia. In this research the case study is used in an instrumental manner and in the spirit of a critical realistic research paradigm. Our aim is to increase understanding of the previously scarcely studied setting of service-related modularity. In the context of automotive outbound logistics, SE Mäkinen is a good choice for a single case study. There are several reasons for this. It is an innovative service provider, and has a long history of offering services for the automotive industry. Its visionary position has also been recognized, as SE Mäkinen has received many national and international prizes for its operations. Today, SE Mäkinen has an approximately 80 % share of the vehicle transportation market in Finland. Furthermore, the Finnish vehicle logistics market can be viewed as very suitable for case-study-oriented research, due to Finland's geographical characteristics: practically all vehicle flows to the Finnish market arrive over the Baltic Sea. This peculiarity offers an opportunity to study a wide variety of activities, i.e. maritime transportation, port and terminal operations, technical and administrative services, inland transportation and delivery. SE Mäkinen is actively involved in all of these service areas.

Information regarding the case company has been gathered from company interviews and observations, from open sources (e.g. the Internet and magazine articles), and the company's internal material. The in-depth interviews were conducted over three years and lasted on average for three hours. The interviews were recorded and transcribed. The key informant was one of the directors of the case company, and was highly knowledgeable on its history as well as on its current strategy and operations. He commented on the article draft on several occasions as the writing process proceeded. The interview themes included the history of SE Mäkinen, developments in the automotive market, and the services offered by SE Mäkinen for this market. One of the themes was how modularity and customization are reflected in the automotive logistics services of the case company, i.e. in the service, process and organizational contexts. This theme was also elaborated by the researchers.

3. The automotive industry and its outbound logistics

In this chapter we first discuss the role of outbound logistics in the automotive supply chain based on the research literature. After that, to gain a holistic understanding of the automotive supply chain from the modularity point of view, we describe how modularity principles have changed the automotive industry, and discuss the implications of modularity for the outbound logistics services offered for the automotive industry.

3.1. Role of outbound logistics in the automotive supply chain

The main function of outbound logistics in the automotive supply chain is to deliver completed vehicles from the factory to the dealers or end-customers (Holweg and Miemczyk, 2003). Car manufacturers can take care of the outbound logistics themselves, but nowadays they often outsource the delivery of new vehicles to LSPs (Holweg and Miemczyk, 2002). The manufacturers have had different policies in outsourcing outbound logistics. Toyota, for example, uses a combination of in-house and outsourced logistics operations, where Toyota plays the role of the lead logistics provider (LLP) (Sriraman, 2010) and takes responsibility for logistics management. Renault has not outsourced logistics management to LSPs, but uses almost one hundred transport service providers for transportation. Nissan, meanwhile, has

outsourced logistics management and the purchasing of logistics services to four operators (ALE, 2010).

The 3DayCar Research Programme studied the idea of three-day lead times: one day for receiving orders and informing suppliers, one day for manufacturing, and one day for delivering the finished vehicle to the customer (Holweg and Miemczyk, 2002). Holweg and Miemczyk (2002; 2003) explored the organization and processes of delivery, as well as the delivery routes and lead times of finished cars in the UK. They found that the vehicle delivery lead times from factory to dealer are around 3-4 days (Holweg and Miemczyk, 2002; 2003) in the UK. However, much of the overall delivery lead time is not used for the actual delivery, but to plan and cumulate the loads for efficient transport. (Holweg and Miemczyk, 2003). There are some typical routes from the assembly plant onwards that are used: routes through regional distribution centers and national compounds account for approximately 90 %, and customers coming to pick up the vehicle at the dealership account for 65% (Holweg and Miemczyk, 2002; Suthikarnnarunai, 2008).

Holweg and Miemczyk (2003) conclude that information flows are the main barrier to more responsive delivery of vehicles: the logistics company receives information relating to the total volumes and types of vehicles in advance, but the exact requirements regarding time and place of delivery are usually not known in advance. Lack of adequate information also causes uncertainty when vehicles are transported by sea, because it is not known exactly which vehicles will arrive by ship. In addition, delivery fleets seem to be too inflexible for future requirements. The current delivery trucks are ideal for high-volume, high-efficiency and low unit-cost transportation (Holweg and Miemczyk, 2003). But for more customer-oriented build-to-order production, the logistics system should be able to transport vehicles in smaller lots (Suthikarnnarunai, 2008). Holweg and Miemczyk (2003) estimate that moving from a 3-4 day delivery to a rapid 1-day delivery would result in a 30% increase in outbound logistics costs. On the other hand, it has been argued that benefits would be obtainable from a more responsive logistics chain. These benefits include lower inventory costs in the chain, especially for dealerships, as well as increased customer satisfaction (Suthikarnnarunai, 2008).

Nowadays, LSPs operating in the outbound logistics chain are able to provide a wider range of services than just transportation operations – such as pre-delivery inspections (PDI), late-configuration of some parts of the vehicle (e.g. decals, rear spoilers, fitting of radios or alarms) and other aspects specific to the market. LSPs have also undertaken some tasks related to the re-marketing of vehicles, such as preparing them for re-sale. (Holweg and Miemczyk, 2002)

3.2. Modularity and customization in the automotive industry

In this section we discuss modularity in the automotive supply chain. The justification for this is that the modularity of products has enhanced the outsourcing of manufacturing, and that this has changed the roles of different actors in many industries in recent decades (Schilling and Steensma, 2001; Starr, 2010). In many cases, suppliers have gained an extended role in manufacturing operations (Fine, 2000). It is important to understand the changes in the wider industry range to gain an understanding of outbound LSPs' roles and service models in the automotive industry. An interesting issue to study is whether there are differences in how the modularity

approach is employed in outbound logistics services, compared to automotive manufacturing and its inbound logistics.

Modularity has been viewed as a means of increasing supply chain efficiency and flexibility, and can be seen as a driver causing changes in the roles of supply chain actors (Doran, 2004; Salvador, 2007; Campagnolo and Camuffo, 2010; Bask et al. 2010). "Loosely coupled", modular product architecture has been seen as an enabler of the division of labor leading to modular organization structures, as well as the outsourcing of tasks across firms, the modularity of supply chains and modular structures even at the industry level (Sanchez and Mahoney, 1996). Flexibility and the responsiveness of the supply chain have also been pursued in the automotive industry through automotive supplier parks, where the manufacturer acts as a focal company and its most important suppliers are located near each other (Pfohl and Gareis, 2005; Fredriksson and Gadde, 2005). Doran (2003) suggests that, in the future, some automobile manufacturers could become "modulizers" that shift the complexity of products to suppliers. Thus, the vehicles of the future could be assembled by a loose affiliation of module suppliers, rather than the automotive manufacturers (Doran, 2004).

Modularity has been considered by several manufacturing industries and by several researchers as the critical factor in achieving customization at low cost (Pine, 1993; Ro et al., 2007; Starr, 2010). In recent decades many automotive manufacturers have aimed at more thorough customer orientation by applying modularity and mass customization logics (Fredriksson and Gadde, 2005, Ro et al., 2007). The efforts of manufacturers on behalf of customization and build-to-order operations have been described, for example, in the reports of the 3DayCar Research Programme (www.3daycar.com). The programme discovered that only a few volume vehicle manufacturers were actually able to build to customer orders. In Europe at the beginning of the 21st century, half of all volume vehicles were built to order (Holweg and Miemczyk, 2002; Holweg and Miemczyk, 2003). The remainder was sold from stock. In the USA, vehicles have normally not been customized at all, as only 5% are built to order (Ro et al., 2007). Most cars, 95%, are sold from the stock. Ro et al. (2007) argue that, in fact, among automotive manufacturers in the USA there appears to be greater emphasis on the cost and lead-time savings that modularity could bring, and less emphasis on providing what the end-consumer really wants.

Today, there are some manufacturers that offer customization at the level of assembly and their lead times are shorter than more traditional car manufacturers. The most famous example of this is the Smart car. The customer can configure the Smart car by choosing from a limited set of standard modules, including colored plastic body parts that can even be changed afterwards. The lead time in the factory's assembly line is only 4.5 hours (Case study - Smart car). However, to date, this example of customer-oriented production logics seems not to have gained much popularity among other car manufacturers. Moreover, some of the original plans – such as performing some of the final assembly tasks at five European distribution centers (i.e. postponed manufacturing) (van Hoek, 1998) – have not yet been realized, even in the case of Smart.

Regarding manufacturing, the discussion on customization has often been related to the discussion on the order penetration point (OPP), which is the point where a specific product is linked to a specific customer order (Olhager, 2003). A general hypothesis has been that the deeper is the customer involvement in the production

cycle, the higher is the degree of customization (Duray et al., 2000). In their matrix framework, Duray et al. (2000) determine four mass customization types that differ in their relation to customer involvement and modularity. According to them, modularity restricts the range of possible customer choices, and in that way limits the degree of customization of the product. This, in turn, distinguishes mass customized products from pure customized products.

However, the customization of services seems to follow a different logic: De Blok et al. (2010) maintain that, at least concerning elderly care services, early client involvement allows for only a combination of standard components, leading to a low level of customization, but conversely client involvement late in the service production cycle allows for adaption of the components to client needs, leading to a high level of customization of the final offering. Thus, this conclusion is the exact opposite of that obtained in the case of the customization of products. De Blok et al. (2010) also state that, in care provision, the client is involved in the process several times – in needs specification as well as, and especially during, delivery – but in manufacturing the client involvement is generally a one-time event to specify the requirements.

The roles of LSPs in outbound automotive supply chains and the implications of modularity on outbound logistics are seldom researched areas, and therefore, in the next chapter, we provide an in-depth case analysis of an LSP, SE Mäkinen, that offers services for the automotive industry. We also analyze in more detail the prospective future opportunities of LSPs in the discussion part of this paper.

4. Outbound logistics – the case study of SE Mäkinen

SE Mäkinen is a Finland-based, family-owned company that offers logistics services for the automotive industry in Finland, Russia, Estonia, Latvia and Lithuania. SE Mäkinen started its operations in 1952 as a newspaper transportation company. Later, the company specialized in the transport of vehicles, and nowadays it has an approximately 80 % share of the vehicle transportation market in Finland. In addition to its vehicle transport services, the company offers storage and value added services such as pre-delivery inspections (PDI), post-production operations (PPO) on vehicles, and administrative services related to vehicle importing, pre-registration, vehicle taxation, etc. In 2010 SE Mäkinen had a turnover of about 30 million euros.

Today, SE Mäkinen's clients include manufacturers, logistics subsidiaries of manufacturers, automobile importers, dealer chains and independent dealers, rental and leasing firms, and individuals. Almost all the vehicle manufacturers whose vehicles are sold in Finland, the Baltic countries and Russia use the services of SE Mäkinen. Occasionally, LSPs specializing in vehicle transport in Central Europe also use SE Mäkinen's services in Finland. In addition to the standardized and long-term deliveries of big contract customers, the company also provides non-recurring transportation services for private customers. Flexibility is assured by flexible fleet and IT systems that are designed for managing lean material flows.

The competitive situation of SE Mäkinen is diverse. The competitors of the company include service companies offering transportation or value added services for car manufacturers. Some of these operators are owned by the manufacturers or automotive importers. For example, in the harbors there are several operators that offer PPOs and PDIs for vehicles. At the same time, car dealers also do PPOs and

PDIs. If the vehicle transportation market is viewed more widely, the competitors also include towing truck companies which, in addition to moving non-running vehicles, are also involved in normal vehicle movements between car dealers. One of the most important competitors is the Avelon Group, which offers services to manufacturers, importers and dealers: car handling, document services, PDIs, additional installation services, storage and transport in the Baltic Sea region. (www.avelongroup.com).

4.1. The services of SE Mäkinen

Typically, almost all vehicles arrive in Finland by ship. Their *transportation* is normally organized and coordinated by a manufacturer or its logistics subsidiary. This includes transportation from factory to port, the storage of vehicles at ports, sea shipping to Finland, car handling, and technical work and transportation to dealers. The manufacturer or its subsidiary buys these services from LSPs and sea shipping firms, etc. According to our case company, the LSP usually gets tentative forecasts of transport volumes for the next quarter of the year, or for the next month. For some flows SE Mäkinen has precise pre-information on the approaching shipments, but for other flows only tentative volume figures for inland transport release. The latter is especially true in cases where value added services are produced by a third party within the port, and not by SE Mäkinen. Thus, the information on arriving vehicles gets more accurate over time, enabling gradual planning of transport and service operations. There are framework contracts with the manufacturer or its representative, and then forecasts of the amounts of arriving vehicles within a particular time, but gradually these aggregated amounts turn into particular vehicles requiring particular handling and heading towards particular destinations. This kind of incomplete information seems to be usual for automotive deliveries in Europe (Holweg and Miemczyk, 2003). However, this situation is not only negative, but can also offer opportunities for service modularization and customization near customers. As plans gradually become more accurate, this allows service customization at the latest possible point in the service supply chain, but only if the services and processes are flexible enough and have been designed according to modularity principles. SE Mäkinen has built its operations and information systems to cope with this kind of gradually targeted service system.

According to SE Mäkinen, after the arrival of a vehicle in Finland and placing of the transport order, the vehicle is, in normal cases, delivered to the dealers within one to three days. Deliveries normally take one to two days to southern Finland, a maximum of three days to mid-Finland and a maximum of about five days in other specific areas (see Figure 1), the average being about 1.5 days. The actual driving times are shorter, but these delivery times ensure that an economically feasible consolidation of loads is reached for transport, and re-loading if necessary. Express deliveries are also offered in addition to these delivery windows. Thus, there is a lot of flexibility in the delivery times offered to customers. The lead times commonly promised to customers by our case company seem to align with the lead times presented by Holweg and Miemczyk (2002; 2003) in the UK. However, in considering the actual total lead times from manufacturer to customer we must take into account the relatively longer overall supply chain that exists from manufacturing sites to dealer outlets in Finland compared with the UK. The sea shipping of vehicles produces significant challenges for the logistics of vehicles (Holweg and Miemczyk, 2003).

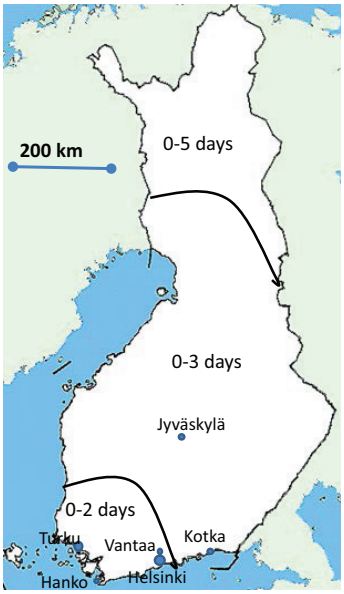


Figure 1. SE Mäkinen's car delivery times to dealers in Finland.

The supply chain structure of SE Mäkinen is illustrated in Figure 2. The figure shows the possible routes that automobiles arriving in the Finnish harbors can take before reaching the end-customer. About 65% of imported cars are transported directly and about 35% go via an inland hub for storage, technical work or load consolidation.

In 2008 SE Mäkinen opened a new logistics hub in Luhtaanmäki Vantaa at the intersection of the most important delivery roads in the Helsinki Metropolitan Area (Mäkinen, 2009). Both new and second-hand vehicles are processed at the hub. To locate the hub outside the harbor was a new and innovative way of thinking in a country where all cars are imported and automobile manufacturing is insignificant. The hub has a central location related to the automotive dealers, so that the final point of delivery of most vehicles is in the neighborhood of the hub. The location is also appropriate considering value added services, PDIs and PPOs, etc. The centralization of value added services provides opportunities for economies of scale – benefiting both SE Mäkinen and its customers. The rationale behind this is that, as cars arrive at many harbors in Finland (mainly Turku, Hanko, and Helsinki), it is very economical to arrange volume value-added services at one centralized high-volume service factory that is not in any of the harbors. In the harbors, only inspections of possible transport damage are conducted, and then the vehicles are loaded onto trucks and transported either straight to dealers, or to the logistics hubs of SE Mäkinen in Vantaa or Jyväskylä in central Finland where another hub for load consolidation is located (i.e. the reloading compound in the hub-and-spoke model). Reloading compounds are important in Finland to ensure the achievement of economies of scale.

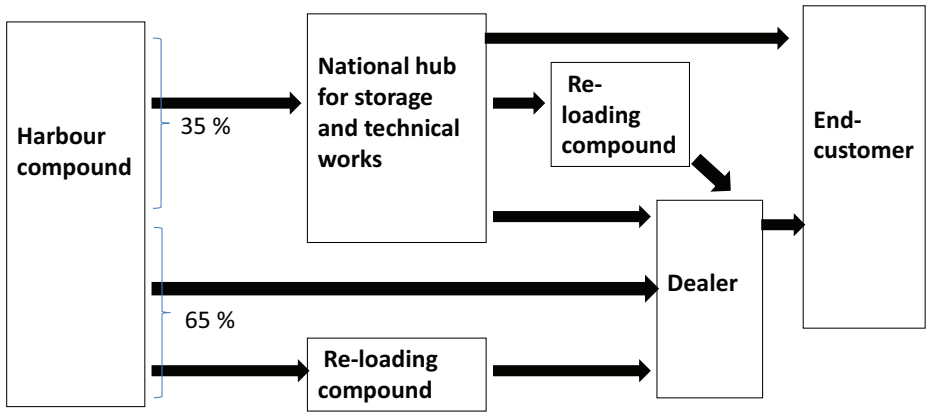


Figure 2. SE Mäkinen's vehicle distribution structure in Finland.

Because the shipments are consolidated for sea shipping, there are large lot sizes of vehicles arriving and ready for road transport or PDIs. Thus, there are significant peaks of PDI and transport needs as the ships arrive in Finland – usually for example one day a week for a certain make of car. This situation differs from the situation in the UK, where the locally manufactured vehicle flows are more stable and continuous.

Value added services, PDIs and PPOs, are customer-specific services, and they include different services for different customers. PDIs may include manufacturer-specific inspections of vehicles, removal of shields that have protected the vehicles during transportation, defining the condition and possible damage, as well as washing and cleaning of the vehicle. PPOs usually include services that aim at improving the vehicles' suitability for Finnish conditions, such as assemblies of internal and engine heaters, winter tires, or towing hitches. The distribution of materials (manuals, equipment) is also possible. Typically, vehicle manufacturers have been reluctant to do this kind of small-scale work on top of their high volume assembly operations at the factories and thus many of these functions are taken care by the subsequent supply chain. In Finland, the high tax on motor vehicles has also been a factor influencing which work can rationally be done by the manufacturer and which by operators in Finland. Some operations are also carried out at the dealer outlets by the sales organization.

Concerning the *other services* performed at the hub in Vantaa, the case company offers e.g. queuing and buffer areas to balance the fluctuations in import and customer deliveries or peak demand in repair services, premises and services for demonstrations and winter tire tests (www.se-makinen.fi). The majority of services are targeted at new vehicles delivered from the manufacturer, but the company also offers services for car leasing companies at the end of the leasing period and services for car dealers for processing second-hand cars, including vehicle enhancement, inspections and light repairs. In addition to the handling services, SE Mäkinen offers services related to administrative work, including for example pre-registration or taxation of new vehicles for the automotive importers. An important task provided by SE Mäkinen is the coordination of customers' material and information flows.

The Finnish automotive outbound logistics market differs from Central European markets in two ways: In Finland there are no high volume automobile manufacturing plants, and the country is sparsely populated with long distances between urban

centers. Consequently, the material flows are weak, originating from the southern ports and heading inland. Thus, economies of scale in transportation can be reached only if the vehicles of several customers are consolidated for transportation in the same delivery trucks. There are vehicles of many different manufacturers and/or dealers in the same trucks of SE Mäkinen, heading to several destinations, but each individual delivery is made in accordance with individual instructions concerning time and the point of delivery, for example. This kind of operating model reflects the mass customization of services achieved by modularization of processes. Thus, the platform process is combined with customer specific features. This supports the findings of de Blok et al. (2010) – namely that client involvement late in the service production cycle allows adaption of the components to client needs, leading to a high level of customization. Another example of the same logic is the assembly of towing hitches conducted by SE Mäkinen at Luhtaanmäki: the hitches are highly make-specific, and even model-specific, and so are the assembly instructions. However, the actual assembly work is a rather standard procedure, consisting of rather similar steps, and can be done by the same staff for many makes. An interviewee at SE Mäkinen described SE Mäkinen as "a production machine" capable of conducting precision tasks for each individual customer.

Currently, our case company is planning future services that integrate industrial scale vehicle processing and services for retailing. It has started a project called "Luhta2" in cooperation with car dealers. According to the plans, "Luhta2" would become the largest vehicle processing and retailing center for used and new cars in Finland.

4.2. Development of SE Mäkinen's service model over time

In the 1950s SE Mäkinen specialized in delivering newspapers to the provinces, offering same-day delivery of newspapers from Helsinki to the whole of Finland. At that time, overnight newspaper transportation was a new and innovative service model. The founder of the company saw a business opportunity in overnight deliveries so that consumers could receive their newspapers on the same day they were printed. This innovative service model totally changed the prevailing newspaper delivery system in Finland.

Later, in the 1960s, SE Mäkinen expanded its service model and started transporting vehicles from Finnish ports to district car dealers. The background for this was the fast increase in car imports due to their deregulation. By the early 1970s, the company had a very strong market position in the newspaper delivery business, but realized that the growth and development opportunities in that business area were relatively limited. Therefore, it started investing heavily in vehicle transportation services. Consequently, by the middle of the 1980s, transport connections were extended from all the Finnish entry ports to all the retailing locations and cities.

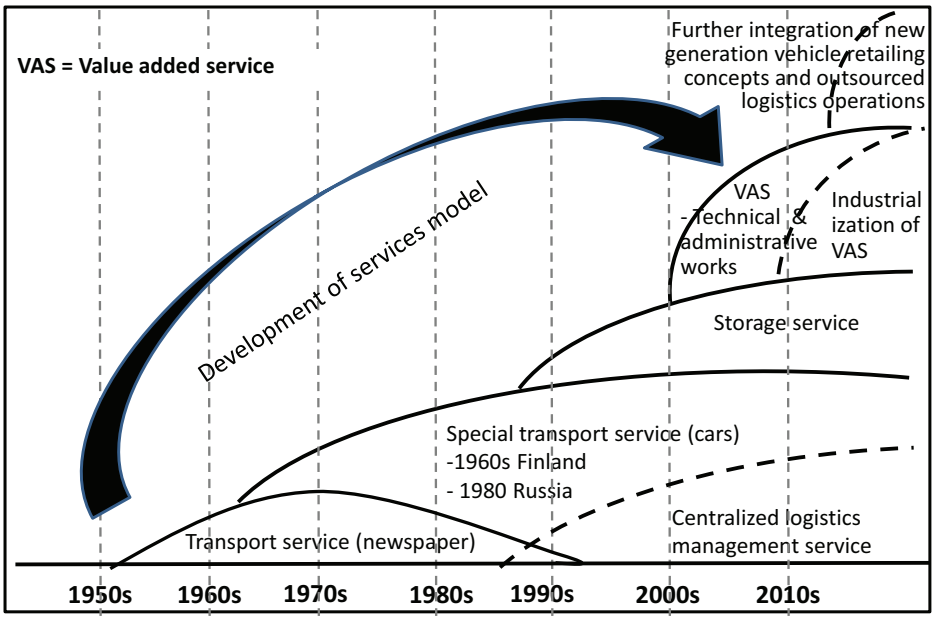
The logistics management systems of newspaper and vehicle transports were very different. While the newspaper transports were based on standard and tightly scheduled overnight transports, vehicle transportation depended on developing a holistic transport management system, including consolidation of flows and joint operations planning for several customers. Car transportation into the former Soviet Union was initiated in 1980. At the end of the decade, SE Mäkinen started to offer a new service for car dealers, namely storage, which extended its service model again. As the regional satellite printing press concept was launched at the end of the 1980s, it

practically ended the need for long haul newspaper transportation from the capital, and the company decided to move out of the newspaper delivery business.

The early 1990s was a dramatic era in Finland due to economic recession, bank crises and the collapse of the Soviet Union. The volume of car transports in the Finnish market was reduced between 1989 and 1993 by 75 %. However, in this period, SE Mäkinen increased its market share from 50% to 90%. The reason was that, at the same time, vehicle importers started to play a bigger role in national transport operations and, due to the recession, the efficiency of logistics was emphasized. In this new situation SE Mäkinen changed its business contract model and started to offer centralized logistics management services to the vehicle importers. This new service responded to customers' needs for efficiency in their transport systems in the difficult economic times. SE Mäkinen also started investing in IT and delivery systems. Thus, the practice of transport contracts between SE Mäkinen and district dealers was gradually replaced by the practice of centralized logistics management contracts with large dealer chains or vehicle importers operating in large geographical areas or the entire country. At this stage, some of the competitors, i.e. SMEs operating in the automotive transport market, joined the SE Mäkinen Group. Moreover, the market knowhow and operational readiness of SE Mäkinen in vehicle transport to the East proved to be valuable, especially after the collapse of the Soviet Union and the resulting rapid growth in the Russian car market (www.se-makinen.fi).

At the beginning of the 21st century, SE Mäkinen again extended its service model by offering other value added services (VAS) such as pre-delivery inspections (PDI) and post-production options (PPO); both closely linked to transportation services.

The evolutionary path of SE Mäkinen's service model is illustrated in Figure 3. The company has built its service model gradually, based partly on its old model, but also partly by adding new elements (modules) whenever it has seen new opportunities opening up in the market. The evolutionary path shows that there are elements (modules) that are common to both the old and the new models, but significant new elements have also been added.



Essential elements in the old model (CV = customer value; RO = resources and operations of SE Mäkinen)	**Newspaper transportation** CV: Customer-specific overnight service RO: Tight scheduling, standardization	**Newspaper transportation** CV: Customer-specific overnight service RO: Tight scheduling, standardization **Vehicle transportation** CV: Cost-efficiency RO: Consolidation of flows and joint operations planning for several customers; special equipment; flexibility	**Vehicle transportation** CV: Cost-efficiency RO: Consolidation of flows and joint operations planning for several customers; special equipment; flexibility **Centralized logistics management** CV: Customer-specific logistics operations planning RO: Flexible IT systems	**Vehicle transportation** CV: Cost-efficiency RO: Consolidation of flows and joint operations planning for several customers; special equipment; flexibility **Centralized logistics management** CV: Customer-specific logistics operations planning RO: Flexible IT systems **Storage** CV: Balancing fluctuations RO: Special personnel, equipment and facilities	**Vehicle transportation** CV: Cost-efficiency RO: Consolidation of flows and joint operations planning for several customers; special equipment; flexibility **Centralized logistics management** CV: Customer-specific logistics operations planning RO: Flexible IT systems **Storage** CV: Balancing fluctuations RO: Special personnel, equipment and facilities **VAS** CV: Cost-efficiency of technical and administrative works RO: Special personnel, equipment and facilities
Essential elements in the new model (CV = customer value; RO = resources and operations of SE Mäkinen)	**Vehicle transportation** CV: Cost-efficiency RO: Consolidation of flows and joint operations planning for several customers; special equipment; flexibility	**Centralized logistics management** CV: Customer-specific logistics operations planning RO: Flexible IT systems	**Storage** CV: Balancing fluctuations RO: Special personnel, equipment and facilities	**VAS** CV: Cost-efficiency of technical and administrative works RO: Special personnel, equipment and facilities	**Industrialization of VAS** CV: Cost-efficiency RO: Special personnel, equipment and facilities **New retailing concepts** CV: Cost-efficiency, marketing power RO: Special personnel, equipment and facilities

Figure 3. Development of SE Mäkinen's service model.

Innovativeness and proactiveness have been important competitive advantages for SE Mäkinen throughout its history. The innovations include technology-related innovations, such as those for transportation efficiency and road safety of the trucks, trailers and drivers, use of information technology and development of information systems, but also new business-related innovations, for example new service module development in the business model. SE Mäkinen has been a pioneer in designing and developing tailor-made information systems to support transportation management and operations. The company investigated the use of information technology as far back as the latter half of the 1980s. Today the company uses an extensive tailor-made information system to coordinate its operations and to communicate with its customers' data networks. IT systems are valued as one of the most important competitive advantages of the company. The operational information systems are also the very core of the company's ISO-audited quality- and environmental management systems. For more information about the ERP system of SE Mäkinen, please look at Rönkkö et al. (2007).

The company has been awarded many times. For example, it received the Finnish Logistics Award 2000, and the Automotive News Europe Logistics Award in 2003. Furthermore, it has been awarded by its customers, the Ford Motor Company in 2003, and Toyota Motor Europe in 2008 (www.se-makinen.fi). The justification for the Finnish Logistics award was the entire service model of the company for the Finnish car sales channel and how it was supported by IT. In addition, the Automotive News Europe Logistics Award was given in the innovation and technology series, due to the innovative management system of the company based on the ERP system that the company had developed. The Ford Motor Company award based its justification on the achieved service quality levels, with a special remark on the advances made in information technology. In May 2011, SE Mäkinen was awarded for its corporate governance model (Kauppalehti, 2011; Öhrnberg, 2011; Mäkinen, 2011).

5. Discussion on future trends

Based on the literature review and the case study we observe that there are at least three trends related to automotive supply chains. First, automotive manufacturers are attempting to establish more responsive supply chains (Daugherty and Pittman, 1995; Holweg and Miemczyk, 2003). Second, there is a potential shift of power away from manufacturers to their global suppliers (Doran, 2004). In addition, sales and distribution structures are changing, partly because of supply chain actors' attempts to become more efficient and effective, but also because the Internet is changing customer behavior. All of these changes are apt to create new opportunities for LSPs and change their service models. If LSPs as service providers understand the trends in the automotive supply chain in a wide industry range, and consequently manage to offer innovative services for their customers' changing and divergent needs, their role in the automotive supply chain may become stronger in the future. For example, some of the tasks nowadays conducted by car importers, dealer chains and dealers could shift to LSPs.

Nowadays, related to the first trend, the consumer has to make a choice of either selecting a new car from the stock, or waiting several weeks or even months for the vehicle to be built (Holweg and Pil, 2001; Ro et al., 2007). However, many manufacturers are attempting to implement mass customization strategies. This development could mean that LSPs, and our case company, could take a wider role in

PPOs, and would move from light customization towards more profound participation in production.

The second trend implies that LSPs in outbound logistics chains may start to offer new innovative value added services for global module suppliers. In the extreme case, even final vehicle assembly services could be done by an LSP closer to the end-customers. This would be a reasonable option in cases like Smart car – in other words for vehicles that have been designed with easy customer-specific configurations and modularity principles in mind. In addition, our case study shows that trends concerning car dealers may lead to wider roles for LSPs. Nowadays, PDIs or light customization are often conducted at dealers' premises, but as the dealers are compelled to search for greater efficiency, these services could, in the future, be conducted by applying economies of scale and modularity principles mainly in the centralized facilities of LSPs. LSPs can provide the same type of services for several customers by only adding customer-specific modules to a pretty standard platform service, while the dealers can allocate their resources to technically demanding repair jobs on customers' vehicles.

The increased use of the Internet in marketing new cars has already had a significant impact on automobile dealers, as consumers can easily access vehicle reviews, compare models, features, and prices. Due to the better availability of information, consumers are generally better informed and spend less time meeting salespersons (Career Guide to Industries). It is possible that, in the future, dealers will have fewer stores with large car inventories. They may have to search for more efficient logistics solutions, including centralized storage and direct transport of customized vehicles to end-customers. These services can most efficiently be done by LSPs.

There are also trends that have not been much discussed in the research literature, but that were discussed in the interviews. There are indications that an ownership-oriented attitude towards vehicles could be gradually changing to a more practically oriented attitude towards personal transportation, especially in densely populated areas (Collin-Lange and Benediktsson, 2011). These attitudes could lead to wider use of co-ownership or hourly car rental models, which could increase the need for LSPs' delivery and pick-up services. Finally, the perspective of the whole lifecycle of cars has mainly been disregarded in the literature. In Finland the amount of used cars sold per year is 2-3 times larger than the amount of new cars sold (Tuulilasi, 2011). The market for used cars is not make-specific. For dealers, the sale and repair of used cars is not far from a necessary evil. The Internet is already used by dealers as the main marketing channel for used cars, and this has changed the buying habits of consumers. The market is now countrywide. All this could lead to new opportunities for LSPs in taking a more all-embracing role in value added services related to used cars. For example all inspections and repairs of used cars could in the future be conducted by LSPs. The future plans of our case company about building a large vehicle processing and retailing center for used and new cars are compatible with more than one of the trends mentioned above.

LSPs act as middlemen between different actors in the automotive supply chains. There are several actors in the automobile supply chain, namely manufacturers with different strategies, suppliers, importers and dealers, other intermediaries, and all of these groups have distinct and variable logistic needs and requirements (Trappey et al., 2010). At the beginning of the 1990s, most of SE Mäkinen's customers were independent dealers. In the Finnish recession of the early 1990s, central management

of the vehicle importers took over. In the 2000s, automobile manufacturers or their subsidiaries have begun to contract directly with LSPs. Nowadays the vehicle importers usually work as brand owners or representatives of them. They also support local retailers by organizing e.g. technical training, and assistance in marketing and taxation, etc. However, it is important to note that some importers own their own outlets, and this will lead to more miscellaneous roles and interests. All in all, the evolution over the last decade has been towards the centralized control of manufacturers over the logistics chains. On the other hand, local retailing organizations are also rethinking their own operating concepts and back-yard logistics. Strategic thinking relative to the automotive supply chain in a wide industry range is quite exceptional (Stank et al., 2011), but may offer LSPs new perspectives. Thus, an LSP can find many lucrative positions in this field, if it is able to rethink its role as the market positions and needs of other actors in the supply chain change.

6. Conclusions

Automotive industry research has focused on the actual manufacturing of cars, manufacturers' supplier networks and the inbound logistics chain. One of the interesting themes in the literature has concerned the impact of the application of modularity principles. Only a few studies have discussed outbound logistics or LSP service models between manufacturers and dealers. The automotive industry has mainly used modularity principles to enhance efficiency, and has pursued better customer service or mass customization by means of modularity principles much less (Ro et al., 2007). However, reaching the optimal degree of customer service, i.e. effectiveness, is important. In service production, late customization often provides opportunities for customized service offerings.

The case study of SE Mäkinen describes the development path of the company's service model since the 1950s. Today, SE Mäkinen offers a wide variety of services. In addition to transportation services, the company provides storage services, logistics management services, and value added services, for example post-delivery inspections (PDIs) and post-production operations (PPOs). It has built its service model gradually, based on its old model, but it has also added new elements to it, whenever new opportunities have opened up.

Our case study shows that offering outbound logistics services efficiently for the automotive industry requires that the LSP builds flexible processes, so that it can cope with information that is gradually becoming more accurate. At least in Finland, where the material flows are weak, economies of scale can be achieved only if the flows of several customers are consolidated in transportation and technical work. The essential means of managing this situation efficiently is mass customization, by employing a modular approach. The weaker the flows are, the more customization is needed, and the more a modular approach and consolidation is required in order to achieve satisfactory economies of scale.

This paper also sheds light on the future options of LSPs as society moves towards more demand-driven services in the automotive industry. The case company has a clear vision of itself as a part of the automotive industry, and of the services that it can offer and develop to increase not only its own competitiveness, but also that of the whole industry. Thus, the case company presents strategic thinking relative to the automotive supply chain in a wide industry range, which is still quite exceptional.

References

ALE 2010 - Automotive Logistics Europe, Change and lots of it emerges from the crisis. 2010 Conference report. http://www.automotivelogisticseurope.com/67/2010%20homepage/, accessed 9 July 2011.

Bask, A., Lipponen, M., Rajahonka, M., Tinnilä, M. (2010), "The concept of modularity: diffusion from manufacturing to service production", *Journal of Manufacturing Technology Management,* Vol. 21, No. 3, pp. 355-375.

Campagnolo, D., 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.

Career Guide to Industries, Automotive Dealers, 2010-11 Edition, United States Department of Labor, www.bls.gov/oco/cg/cgs025.htm, accessed 19 August 2011.

Case study - Smart car, www.ifm.eng.cam.ac.uk/ctm/idm/cases/smart.html, accessed August 15, 2011.

Collin-Lange, V., Benediktsson, K. (2011), "Entering the regime of automobility: car ownership and use by novice drivers in Iceland", *Journal of Transport Geography,* Vol. 19, No. 4, pp. 851-858.

Daugherty, P.J., Pittman, P.H. (1995), "Utilization of time-based strategies: creating distribution flexibility/responsiveness", *International Journal of Operations & Production Management*, Vol. 15, No. 2, pp. 54–60.

De Blok, C., Luijkx, K., Meijboom, B. and Schols, J. (2010), "Modular care and service packages for independently living elderly", *International Journal of Operations & Production Management,* Vol. 30 No. 1, pp. 75-97.

Dias, J.C. Q, Calado, J.M.F., Mendonça, M.C.(2010), "The role of European «ro-ro» port terminals in the automotive supply chain management", *Journal of Transport Geography*, Vol. 18, No. 1, pp. 116-124.

Doran, D. (2003), "Supply chain implications of modularization", *International Journal of Operations & Production Management*, Vol. 23, No. 3, pp. 316-326.

Doran, D. (2004), "Rethinking the supply chain: an automotive perspective", *Supply Chain Management: An International Journal*, Vol. 9, No. 1, pp. 102 – 109.

Dubois, A. and Gadde, L-E. (2002). "Systematic Combining - An abductive approach to case research", *Journal of Business Research*, Vol. 55, pp. 553-560.

Duray, R., Ward P.T., Milligan, G.W. and Berry, W.L. (2000) "Approaches to mass customization: configurations and empirical validation", *Journal of Operations Management*, Vol. 18, No. 6, pp.605–625.

Eisenhardt, K. M. (1989), "Building Theories from Case Study Research", *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Ellram, L. M. (1996), “The use of the case study method in logistics research”, *Journal of Business Logistics*, Vol. 17, No. 2, pp. 93-138.

Fine, CH (2000) Clockspeed-based strategies for supply chain design. Production and Operations Management 9(3):213-221.

Fredriksson, P. (2006), “Operations and logistics issues in modular assembly processes: cases from the automotive sector”, *Journal of Manufacturing Technology Management*, Vol. 17, No. 2, pp. 168-186.

Fredriksson, P. Gadde, L.-E. (2005), “Flexibility and rigidity in customization and build-to-order production”, *Industrial Marketing Management*, Vol. 34, pp. 695-705.

Kauppalehti, “Hallitus toi perheyhtiöön uutta puhtia”, 3.6.2011

Healy, M. and Perry, C. (2000),"Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm", *Qualitative Market Research: An International Journal*, Vol. 3 Issue 3, pp. 118-126.

van Hoek, R.I. (1998), “Logistics and virtual integration. Postponement, outsourcing and the flow of information”, *International Journal of Physical Distribution & Logistics Management*, Vol. 28 No. 7, pp. 508-523.

Holweg, M., Miemczyk, J. (2002), “Logistics in the “three-day car” age - Assessing the responsiveness of vehicle distribution logistics in the UK”, *International Journal of Physical Distribution and Logistics Management*, Vol. 32, No. 10, pp. 829-850.

Holweg, M., Miemczyk, J. (2003), “Delivering the ‘3-day car’— the strategic implications for automotive logistics operations”, *Journal of Purchasing & Supply Management*, Vol. 9, pp. 63–71.

Holweg, M., Pil, F. K. (2001), “Successful Build-to-Order Strategies Start With the Customer”, *MIT Sloan Management Review*, Vol. 43, No. 1, pp. 74-83.

Hudson, D., Seah, L.-H. Hite, D., Haab. T. (2004), “Telephone Pre-Surveys, Self-Selection, and Non-Response Bias to Mail and Internet Surveys in Economic Research”, *Applied Economic Letters*, Vol. 11, No. 4, pp. 237-241.

Lasserre, F. (2004), “Logistics and the Internet: Transportation and Location Issues are Crucial in the Logistics Chain”, *Journal of Transport Geography*, Vol. 12, No. 1, pp. 73-84.

Mäkinen, T. (2009), ”SE Mäkinen Logistics – Luhtaanmäki, Suomeen uusi täyden palvelun ajoneuvologistiikkakeskus”, *Presentation in Finnish at Finpro Kivi seminar*, 15 December, 2009.

Mäkinen, T. (2011), “SE Mäkinen Logistics”, *Presentation at Kultainen Nuija Award Ceremony*, 31 May 2011.

McCutcheon, D. M., Meredith J. R. (1993), “Conducting Case Study Research in Operations Management”, *Journal of Operations Management*, Vol. 11, No. 3, pp. 239-256.

Öhrnberg, P. (2011), ”Ensimmäinen Kultainen nuija jaettiin”, 03.06.2011, www.kauppalehti.fi/5/i/yritykset/yritysuutiset/?oid=20110677673, accessed 29 June 2011.

Olhager, J. (2003) “Strategic positioning of the order penetration point”, *International Journal of Production Economics*, Vol. 85, No. 3, pp.319–329.

Pfohl, H.-C., Gareis, K. (2005), “Supplier parks in the German automotive industry: A critical comparison with similar concepts”, *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 5, pp. 302–317.

Pine, B J. II. (1993), “Mass customizing products and services”, *Planning Review*, Vol. 21, No. 4, pp. 6-15.

Reichhart, A., Holweg, M. (2008), “Co-located supplier clusters: forms, functions and theoretical perspectives”, *International Journal of Operations & Production Management*, Vol. 28 No. 1, pp. 53-78.

Ro, Y. K., Liker, J. K., Fixson, S. K. (2007), “Modularity as a strategy for supply chain coordination: The case of U.S. auto”, *IEEE Transactions on Engineering Management*, Vol. 54, No. 1, pp. 172-189.

Roth, A. V., Menor, L. J. (2003), Insights into service operations management: a research agenda, *Production & Operations Management*, Vol. 12 Issue 2, pp.145-164.

Rönkkö, M., Kärkkäinen, M., Holmström, J. (2007), “Benefits of an item-centric enterprise-data model in logistics services: A case study”, *Computers in Industry*, Vol. 58, No. 8-9, pp. 814-822.

Sachan A., Datta S. (2005), “Review of Supply Chain Management and Logistics Research”, *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 9, pp. 664-705.

Salvador, F. (2007), “Towards a product modularity construct: literature review and reconceptualization”, *IEEE Transactions on Engineering Management*, Vol. 54, No. 2, pp. 219–240.

Sanchez, R. and Mahoney, J.T. (1996), “Modularity, flexibility, and knowledge management in organization design”, *Strategic Management Journal* (1986-1998), Vol. 17(Winter), pp. 63-76.

Schilling, M. A. and Steensma, H.K. (2001), “The use of modular organizational forms: An industry-level analysis”, Academy of Management Journal, Vol. 44, Iss. 6, pp. 1149-1168.

Selviaridis, K. and Spring, M. (2007), “Third party logistics: a literature review and research agenda”, *The International Journal of Logistics Management*, Vol. 18 No. 1, pp. 125-150.

Sriraman, P. (2010), “Optimizing Automotive Logistics - Revisiting the OEM-LSP Relationships”, Date Published: 8 Feb 2010, www.frost.com/prod/servlet/market-insight-top.pag?Src=RSS&docid=192115100, accessed 9 July 2011.

Stank, T. P., Dittmann, J.P. and Autry, C.W. (2011), “The new supply chain agenda: a synopsis and directions for future research”, *International Journal of Physical Distribution & Logistics Management,* Vol. 41, No. 10, pp.940 – 955.

Starr, M.K. (2010.), “Modular production – a 45-year-old concept”, *International Journal of Operations & Production Management,* Vol. 30, No. 1, pp. 7-1

Suthikarnnarunai N. (2008), “Automotive Supply Chain and Logistics Management”, *Proceedings of the International MultiConference of Engineers and Computer Scientists 2008, Vol II, IMECS 2008, 19-21 March, 2008, Hong Kong*.

Svensson, G. (2003), “The principle of balance between companies’ inventories and disturbances in logistics flows - Empirical illustration and conceptualization”, *International Journal of Physical Distribution & Logistics Management*, Vol. 33 No. 9, pp. 765-784.

Svensson, G. (2001) "The Impact of Outsourcing on Inbound Logistics Flows", *International Journal of Logistics Management*, Vol. 12 Iss: 1, pp.21-35.

The automotive sector at a crossroads (2004), European Foundation for the Improvement of Living and Working Conditions. http://www.eurofound.europa.eu/emcc/publications/2004/sf_auto_1.pdf, accessed 25 January 2013.

Trappey, C.V., Trappey, A.J.C., Chang, A.-C. and Huang, A.Y.L. (2010), “Clustering analysis prioritization of automobile logistics services”, *Industrial Management & Data Systems*, Vol. 110, No. 5, pp. 731-743.

Tuulilasi (2010), Vuosi 2010 uusien autojen markkinoilla, (The year 2010 in the new car market (in Finnish), www.tuulilasi.fi/artikkelit/vuosi-2010-uusien-autojen-markkinoilla, accessed 16 June 2011.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), “Case research in operations management”, *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 195–219.

www.3daycar.com, accessed 19 August, 2011.

www.avelongroup.com, accessed 14 July 2011.

www.se-makinen.fi, accessed 7 April 2010, 29 September 2010 and 10 August 2011.

Yin, R.K. (1981), “The Case Study Crisis”, *Administrative Science Quarterly*, Vol. 26, No. 1, pp. 58-66.

Yin, R.K. (1994), Case Study Research: Design and Methods, 2nd Ed., Sage Publications, London, UK.

Although the concept of modularity has long been used in the context of physical products, research on service-related modularity is still rare. This dissertation discusses the applicability of modularity in the service context, particularly related to logistics services. It aims at theory building, introduces frameworks and illustrates them with examples and qualitative case studies. The developed frameworks clarify the relationships between modularity and the related concepts, and help to analyze services, service processes and organizations (i.e. service business models) related to modularity. This research offers new views on some of the basic principles, as well as practical examples of using modularity in the service context.

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