Aalto University
School of Economics

# Application of Service Modularity in Consulting Industry

Logistics

Master's thesis

Anastassia Ovtchinnikova

2011

Department of Information and Service Economy
Aalto University
School of Economics

Aalto University
School of Economics

# Application of Service Modularity in Consulting Industry

Master's Thesis
Anastassia Ovtchinnikova
20.10.2011
Logistics and Service Management

Approved in the Department of Information and Service Economy xx.xx.2011 and awarded the grade

Anu Bask

Mervi Lipponen

## TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

## ABSTRACT

Service modularity is gaining ground, as companies move away from simply offering traditional products to offering more services. Modularity offers a compromise and ability to combine customization and standardization in order to develop services more efficiently for the end customer. However, until now there has been limited research in the field of service modularity, mainly because of the heterogeneity of services, role of people in service personalization and customization and the nature of services as both products and processes. Therefore, there is a need to provide a more systematic point of analysis of modularity and customization in the pure service industry.

The objectives of this research is to revise the framework on combining modularity and customization proposed by Bask et al. (2011) by developing own measurement criteria for modularity and customization and applying it to the pure service industry. The framework is revised by looking from both service offering and service production perspective. Case study is chosen as the principal research strategy for empirical part of this study. Three consulting companies from different areas (IT, management and strategy) within the consulting industry were selected as case companies. Semi-structured interviews were used as the primary method to collect data and questions were pre-defined beforehand. According to the responses provided each company was placed within the revised framework.

The results of this study reveal that the revised framework is applicable in context of services. By developing and adding the measurement instrument with a well-defined scale the framework becomes more integrated and cohesive. According to the results each of the interviewed company fell into different quadrant within the revised framework and its position did not change significantly if looking from the service offering or service production perspective. IT and strategy consulting are seen as the brunches of consulting that moved the most towards modularization. Many companies can utilize this revised framework internally to evaluate their own strategy or/and benchmark against their competition in the market

**Key words:** modularity, mass customization, service production, service offering, service management

**Number of pages (including appendices):** 94

# 1 INTRODUCTION

## 1.1 Background

The focus of modularity in research literature has traditionally been on products, production processes and organizational design. Therefore, product modularity research has been quite extensive particularly in the manufacturing and automotive industry. Researchers have looked at various aspects of modularity including different strategies and advantages of adopting modular products. On the other hand service research on modularity has been scarce.

Hence, service modularity is a rather new and emerging research area which needs a more in depth study and analysis. This is especially true for current global economy where the significance of services has been growing substantially. For example current list of Fortune 500 companies contains more service companies and fewer manufacturing companies (Fortune 500 rankings 2011, CNN Money). Also products today have a higher service component than in previous decades. In the operations management literature this has been often described as servitization of products (Wilkinson, 2009). Simply put many products are being transformed into services. This phenomenon is becoming even more profound with the emergence of new forms of information technology. Needless to say customers empowered by advanced computing and networking technologies are demanding greater product variety at lower prices, which forces the movement away from traditional mass production toward modular, mass customizable products and services.

Moreover, service companies have been always caught somewhere between customization "tailor made" approach and standardization. Nowadays in the service industry it is not enough to adopt solely customized approach, on the contrary many service companies have been experiencing difficulty in increasing their productivity because of such tailor made approach (Sundbo, 2002). Modularization on the other hand offers a compromise and ability to combine customization and standardization in order to develop services more efficiently for the end customer. Findings from the Danish study (Table 1) give a good indication of a similar trend, moving away from standardization to modularization.

Table 1. Survey Results from Danish study (Sundbu, 2002)

| | *1992* | *1997* | *1999* |
|---|---|---|---|
| Customized | 35 | 59 | 69 |
| Modularized | 16 | 28 | 21 |
| Standardized | 50 | 13 | 8 |

Results summarized in Table 1 were obtained from two surveys. Firstly, a postal questionnaire was sent to Danish service firms representing all service industries (including wholesale and retail, transport, health care services, but not construction activity). The results from questionnaire were supplemented by the data from the survey made by Danish Ministry of Industry in 1999 based on telephone interviews. As can be seen the results show that majority of firms in 1997 and 1999 said that their service products are primarily customized. This was followed by modularization and standardization respectively. The trend has been that service production has become less standardized and more customized and modularized in the period 1992-1997. This tendency continued after 1997, however the number of firms offering modularized services well. A tendency towards increased customization is very clear while the tendency toward modularization is also present but not so clearly. Therefore, it is important to see if the trend prevails in the 21$^{st}$ century and that service companies are ripping the benefits from modularity.

Indicators that modularity can offer fruitful approach to service development can be also found in the limited but yet existing service operations literature. For example, in banking, disaggregating of the value chain into independent functional units, referred to as modules, ensures the benefits of service orientation (Pekkarinen and Ulkuniemi, 2008). Banking is just one out of many examples where modularity serves as a means to achieve better performance in services. Hence, modularity can be seen as a way to develop services and manage variability in demand, but yet there are no well-defined measurement criteria that can be used for categorizing service companies and evaluating modularity and customization of their services. Despite that, there are several authors that have begun to investigate modularity from the measurement point of view and have provided ways of measuring modularity. For instance, Voss and Hsuan (2009) proposed a service modularity function which measures the degree of modularity of service

architectures by taking into account uniqueness of the service elements, degree of coupling and reliability factor.

As can be seen there are some measurement criteria that have been put forward by researchers, however the research in service modularity still lacks concrete criteria and definitions on what is modularity and customization and how it can be measured from customer offering and service production point of view. That is why it deserves further research attention and greater empirical understanding.

## 1.2 Research Gap, Problem, Research Questions and Method

The best method of achieving mass customization – minimizing costs while maximizing individual customization – is by creating modular components that can be reconfigured into a wide variety of end products and services (Pine, 1993). Hence, modularity is a method to achieve customization and quite often these two concepts have been discussed in an intertwined manner in previous research literature. However, Bask et al. (2011) propose a framework based on examples from automotive industry which actually separates the two concepts and portrays that some services can be modular and not customized and vice versa. Yet, there is a need to explore this framework further and conduct empirical studies in order to provide a more systematic approach to measuring modularity and customization in the pure service industry. This is done by bringing together qualitative and quantitative studies on modularity and customization and developing own measurement criteria.

Therefore the objectives of this research is to apply the framework on combining modularity and customization developed by Bask et al. (2011) to pure service industry and determine if the framework is applicable and effective in this setting. This is achieved by bringing qualitative and quantitative studies on modularity and customization together and developing own measurement criteria that is incorporate into initial framework proposed by Bask et al. ( 2011). Additional aim of this research is to use this measurement criterion for modularity and customization in order to bring more clarity into analyzing service modularity by separating the two concepts. Consulting industry has been chosen as a case study field for this research because it represents a good example of the pure service industry. In order to support the above objectives and develop a solid analysis of the findings there are a number of research questions that need to be addressed. These questions can be divided into theoretical and practical. The theoretical questions are as follows:

- How can modularity and customization be measured/characterized from the customer offering point of view?
- How can modularity and customization be measured/characterized from the production point of view?
- How are different consulting companies positioned within the framework based on these two dimensions?

The theoretical contribution of the research is to provide measurement criteria for modularity and customization from two perspectives: customer offering and production point of view. The theoretical research in this study is conducted by analyzing the existing theory on modularity starting from the fundamental concepts such as product modularity, followed by a rather new research area of service modularity. Similar approach is taken in reviewing literature on customization. Firstly the concept of mass customization is studied independently and later in context of various industries. The main goal of theoretical study is to identify the characteristics which are inherent to modularity and customization by reviewing existing literature and taking those characteristics as measurement criteria for evaluating companies within the framework developed by Bask et al. (2011). However, since theories almost always just focus on one specific industry for example automotive industry some research is done to find examples from other industries.

Practical questions are as follows:

- What are the current strategies used in service offering and service production in consulting industries?
- Does the position of companies' remains the same or differs by looking from customer offering point of view and production point of view?
- Is there a tendency towards modularization in service production? And if so could it be explained as a necessity caused by market developments or as a specificity of the industry?

The main goal of the empirical study is to identify what are the current strategies used by consulting companies in developing and offering their services. Do the companies use pure customization "tailor made" approach, modularization, standardization or a hybrid approach. In addition, part of the study aims to see if the strategies have changed over time or not. For example, have the companies moved from productization to servitization or from customization to modularization. This automatically leads to the next question of whether the shift towards modularization has been a result of market development or it is just a common feature of consulting industry. Overall, the expected results of this study are to describe the types of strategies that companies have in their service offering and service production. And demonstrate that even though modularity is a rather new concept in service industry it is gaining more popularity not only in the manufacturing but also service industry. Companies are moving away from standardized

services towards modularized or hybrid services to developing and offering their services. In addition, it is expected that modularity is used in one way or another within the consulting services, however it might not be an appropriate strategy for everyone depending on the area of expertise within the consulting industry.

Case study research has been chosen as the empirical research strategy for this study. Three case companies have been selected and analysed based on the pre-defined measurement criteria. According to (Eisenhardt, 1989) case study research is considered as the most appropriate in situations where research and theory are still forming. Therefore, case studies are meaningful especially when there is limited prior knowledge or the existing knowledge seems inadequate (Eisenhardt, 1989). This is especially true for this study as service modularity and customization is a novice field of research which still lacks solid theoretical background. Semi - structured interviews were used as primary method for collecting data for this study. This method allows more flexibility while interviewing the candidate then for example questionnaire but at the same time keeps the interview organized and key questions answered. Therefore, semi-structured interviews represent a perfect compromise between open and completely structured interviews (Vuorela, 2005). Furthermore, according to Wengraf (2001) a research focused on building a theory or framework typically requires an unstructured or lightly structured interviews.

## 1.3 Structure of the Study

This study is divided into six chapters. First chapter is introduction, which focuses on the trends and current issues in the modularity research. Also, the objectives and research questions and methodology are presented in this chapter. The second chapter of the study represents a theoretical part which is divided into four sub chapters which cover a number of essential concepts such as what is modularity, modularity in services, mass customization and measurement frameworks. The literature research can be best summarized in Table 1. The categorization of literature into four groups allowed a better overview of related theories and greater support for the empirical part, especially in developing own measurement criteria. This chapter is concluded with a summary of key literature concepts. Chapter three gives a thorough description of the framework developed by Bask et al. (2011) and how it has been revised by incorporating own measurement criteria for modularity and customization. Chapter four concentrates on the empirical research and introduces the methodology of this study. It highlights why

semi- structured interviews were chosen as a way to collect data and gives an overview of an interview framework used for this study. Furthermore, empirical findings and interview results are presented. Fifth chapter takes a step further and provides discussion and analysis of the results presented in chapter four. This is followed by conclusions where main findings are presented, theoretical as well as managerial implications discussed and areas for future research identified. Theoretical implications are derived from the literature review and managerial implications are drawn from the interview results. Areas for future research are identified based on the theoretical and managerial implications as well as limitations of this study.

Table 2. Categorization of literature into four subject groups

| **Mass Customization Literature** | **Modularity Literature** |
|---|---|
| - Approached to mass customization: configurations and empirical validation ( Duray et al. 2000)<br>- Mass customization origins: mass or custom manufacturing ( Duray, 2002)<br>- Customizing Customization ( Lampel and Mintzberg, 1996)<br>- Should your firm adopt a mass customization strategy? ( Berman, 2002) | - A typology to unleash the potential of modularity ( Arnheiter and Harren, 2005)<br>- The Impact of Modular Production on the Dynamics of Supply Chain ( van Hoek and Weken, 1998)<br>- Matching Service strategies, business modules and modular business processes ( Bask et al. 2010)<br>- Modularity in developing business services by platform approach (Pekkarinen and Ulkuniemi, 2008) |
| **Measurement Literature** | **Service Management Literature** |
| - Service Architecture and Modularity (Voss and Hsuan, 2009)<br>- Measuring Modularity-based Manufacturing Practices and Their Impact on Mass Customization Capability: A Customer - Driven Perspective ( Tu et al. 2004)<br>- Managing Modularity of Product Architectures: Toward an Integrated Theory ( Mikkola and Grassmann, 2003)<br>- Capturing the Degree of Modularity Embedded in Product Architecture (Mikkola, 2006) | - The Service Economy: Standardization or Customization ( Sundbo, 2002)<br>- Modularization of Service Production and a Thesis of Convergence between service and manufacturing organization ( Sundbo, 1994)<br>- Emerging shared service organizations and the service-oriented enterprise ( Janssen and Joha, 2008)<br>- A framework for analyzing customer service orientations in manufacturing ( Bowen et al. 1989) |

## 1.4 Definitions

This paragraph briefly presents the key concepts that will be used throughout this paper. Among these are concepts such as *interfaces, customization, customized products, customer closeness, modularity, modular service, service module, service offering and service production* and more.

**Interfaces** are linkages shared among components and can be considered as "an elaboration of the physical architecture that comprises a minimal set of rules governing the arrangement, interconnections, and interdependence of the elements" (ESD, Architecture Committee, 2005)

**Customization** can be best described by identifying the point of customer involvement. The deeper the customer involvement goes in the production cycle, the higher the degree of customization Duray et al. (2000) and Duray (2002).

**Customized products** are those products that are designed, altered or changed to fit the specifications of an end-user (Duray, 2002).

**Customer closeness** is defined as the practice of keeping close contact with customers to communicate with customers effectively and to understand customers' individual needs (Tu et al. 2004)

**Modularity** can be defined as the degree to which the components of the system can be separated and recombined to create variety of configuration without losing its functionality (Schilling, 2000).

**Modular service** package according to Voss and Hsuan (2009) may be individually shaped by the customer or the service provider through combination of distinct service modules and components.

**Service module** can be seen as one or more service elements offering one service characteristic (Pekkarinen and Ulkuniemi, 2008).

**Service offering** represents the elements of the service visible to the customer. In the contents of this paper service offering describes the service characteristics visible to the customer along the two dimensions: modularity and customization (Bask et al. 2011).

**Service production** refers to the means of creating modular service and it is intra-organizational. In the contents of this paper process of creating modular service is described along the two dimensions: modularity and customisation (Bask et al. 2011).

**Product architecture** considered as an arrangement of product's functionality elements into physical building blocks, including mapping of functional elements into physical components and the specification of interfaces between interacting physical components (Ulrich, 1995).

# 2 LITERATURE REVIEW

## 2.1 Relevant Literature, Concepts and Theories

Before going any further into the essence of this study which is to provide measurement criteria for modularity and customization and illustrate its application to pure service industry through the framework developed by Bask et al. (2011) it is important to understand what is modularity and what is mass customization. This chapter aims to provide a thorough overview of literature that addresses both modularity and mass customization from a qualitative point of view and combine it with the measurement literature. Firstly, in this part of the study various definitions of modularity are examined, examples of modular products given and service modularity presented as a new field of study. Further on, the concept of mass customization is reviewed, four different archetypes are identified and division of industries based on the customization strategy presented. After examining literature on modularity and mass customization, theories and methods of measuring modularity and customization are given. This is followed by the summary of the main theoretical findings. Literature review on modularity, mass customization and measurement literature serve as basis for developing own measurement criteria and revising original framework of Bask et al. (2011).

### *2.1.1 Defining modularity*

The earliest writings on modularity appeared over decades ago and modularity has since become a basic theme in product design handbooks (Pine, 1993; Ulrich and Eppinger, 2008). However, according to Bask et al. (2010), a universal definition of modularity is still lacking, especially when used in the service context. Starr (1965) wrote about modular production as capacities to design and manufacture parts which can be combined in numerous ways. Baldwin and Clark (1999) define modularity as building a complex product or processes from smaller subsystems that can be designed independently. In the field of Operations Management modularity is mainly understood from the perspective of component combinability, meaning that by mixing and matching of components taken from a given set, different product configuration can be obtained (Salvador, 2007). Ulrich and Tung's (1991) and Ulrich's (1995) in turn define modularity as the relationship between a product's functional and physical structures. Ulrich and Tung (1991) define modularity from the physical goods point of view therefore it cannot be applied to services as such. Schilling (2000) on the other hand

emphasized the system approach to modularity and defines it as the degree to which the components of the system can be separated and recombined to create variety of configuration without losing its functionality. Services can be viewed as systems (Voss and Hsuan, 2009) therefore this definition can be applicable to physical goods as well as services. Whether modularity is similar for both physical goods and services is an important question and only a few authors have clearly expressed their point of view. For instance, Voss and Hsuan (2009) refer to goods focused definitions in their studies and posit that they also hold for services. In this paper definition provided by Schilling (2000) is used to define both product and service modularity. Below Table 3 summarizes definitions of modularity which were gathered from the literature review.

Table 3. Definitions of modularity

| Article | Definitions | Key Idea | Focus |
|---|---|---|---|
| Starr (1979) | The obtaining of the maximum variety of assemblies by combining a given number of parts | Component- re-combinability | Process |
| Ulrich and Tung (1995) | Similarity between physical and functional product architecture, minimization of incidental interaction between physical components | Standardization, inter-changeability | Product |
| Sanchez and Mahoney (1996) | Interdependent and closely coupled with modules but independent and loosely coupled across modules | Independence, loose coupling | Product, Process, Organization |
| Baldwin and Clark (1999) | Building a complex product or processes from smaller subsystems that can be designed independently | Standardization, inter-changeability | Product, Process |
| Mikkola and Gassmann (2003) | The combination effects of the ratio of the number of new and standard components with the degree of coupling and substitutability | Standard and new components, degree of coupling, substitutability | Product |
| Shilling (2000) | Product modules are specified, decoupled can be recombined and separated across modules | Separateness, loose coupling | Product |
| Pekkarinen and Ulkuniemi (2008) | Modular service is combined from one or several service modules. Modules can be service elements or processes. | Service modules re-combinability | Service |

### 2.1.2 *Types of modularity*

After reviewing literature on modularity three types of modularity (Figure 1) can be distinguished. These are product modularity, process or production modularity and organizational modularity (Bask et al., 2010, Pekkarinen and Ulkuniemi, 2008). These three types of modularity represent different levels of analysis from which modularity can viewed. However, Bask et al. (2010) has added service-related modularity as the fourth type of modularity, but it will be discussed separately later in this chapter. Here, as a starting point only three types of modularity will be discussed.

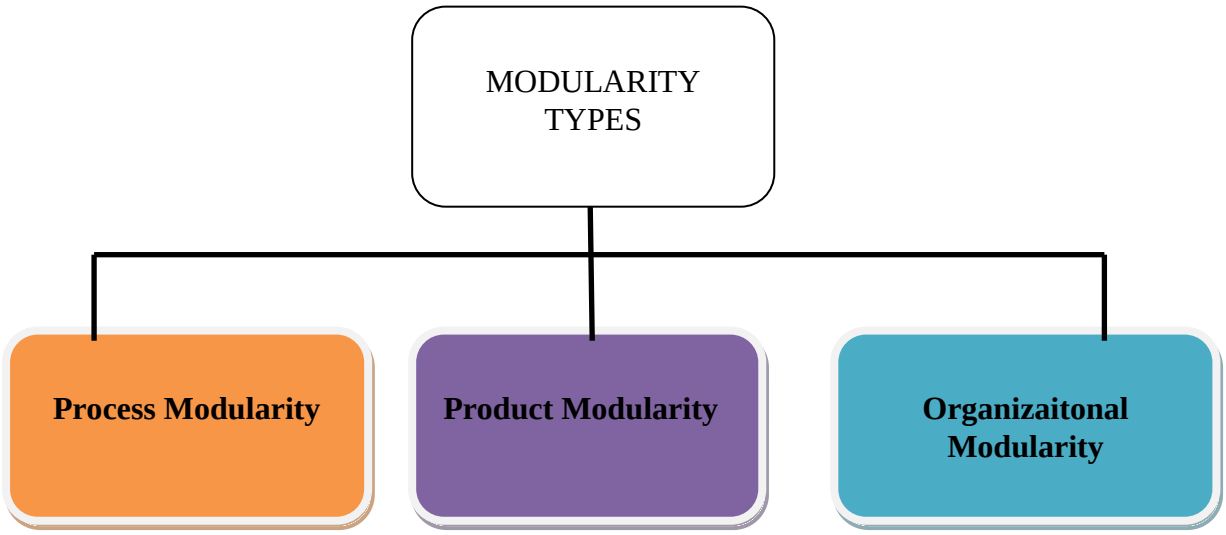


Figure 1. Different types of modularity

Product modularity is the most referred and matured type of modularity. The meaning of modules in products is easy to understand, since products are generally composed of separate components and subassemblies. Schilling (2000) argues that majority of products exhibit some degree of modularity. Product modularity is defined as is the use of standardized and interchangeable components or units to enable the configuration of wide variety of end product (Bask et al. 2009). Another concept closely related to product modularity 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 low interdependence among components is called loose coupling, which allows for mixing and matching of modular components within modular product architecture and provides potential for a large number of product variations with different functionalities and features (Sanchez and Mahoney, 1996).

Ulrich and Tung (1991) identified six types of product modularity which can be used separately or in combination to provide a customized end product. Their typology shows that modularity is multifaceted concept and illustrates that the final product can be built through various configurations. Figure 2 presents these six types of product modularity. Next, each type of product modularity will be explained in more detail.

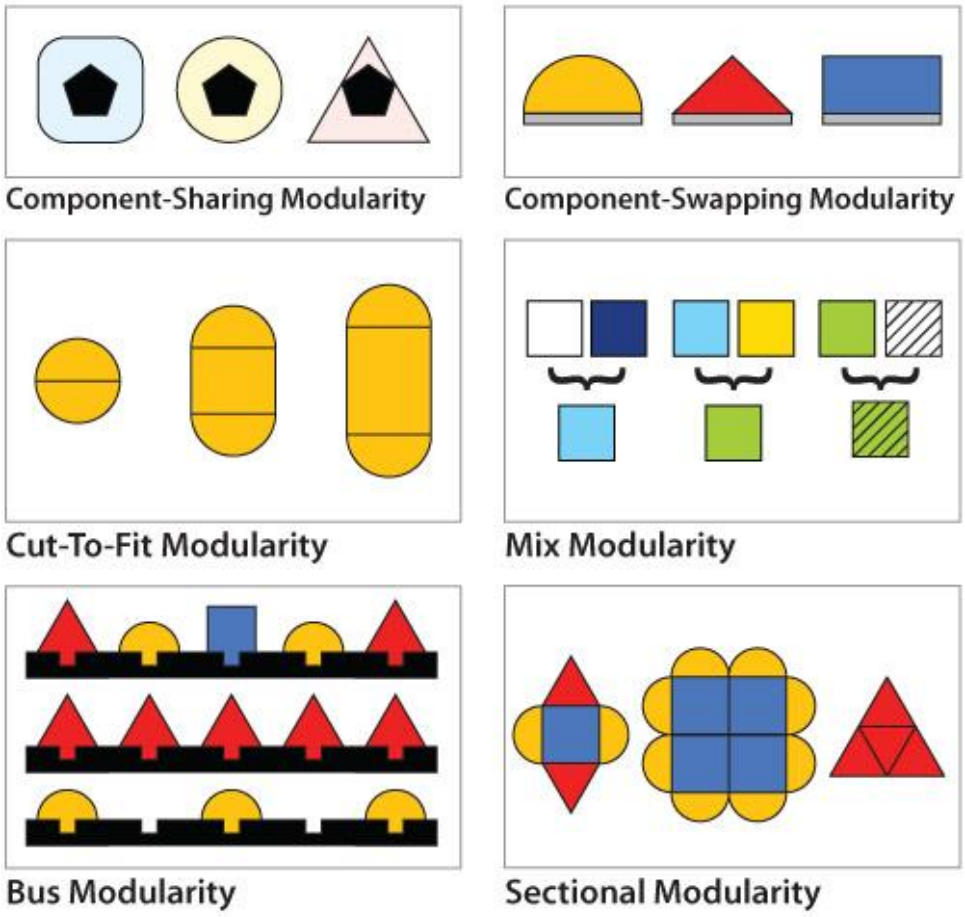


Figure 2. Product modularity types (Ulrich and Tung, 1991)

*Component sharing modularity* comprises of common components used in the design of a product. Products are uniquely designed around a base unit of common components. Therefore this type of modularity has also been called commonality sharing (Voss and Hsuan, 2009). It is not restricted to the same product family but common components can even be used across product families. A good exmaple of component sharing modularity is Elevators.

*Component swapping modulairty*, as the name suggests allows to switch options on a standard product. Modules are selected from a list of options to be added to a base product. Component sharing and component swapping are close types of modularity. In

the latter different components are paired to the same product while in the component sharing different products use the same component (Ulrich and Tung, 1991). As opposed to component sharing, components swapping can be seen as a convenient meanst to customize products and services. For example if a company providing a standardized product wants to benefit from component swapping modualrity, it has to find the most customizable part of the standard product or service and separate it into an inderchangebale components. A good example is a personal computer, where you have a common base and customizable components from which you can choose  for example, memory, camera, bluetooth etc.

Next is *cut-to-fit modularity* wich alters the dimentions of a module before combining it with other modules. Often used where products have unique dimentions, such as length, width or height. This is the most useful for products whose customer value focuses considerably on a varibale component and its suitability to customer's wants and needs ( Pine, 1993). For example, eyeglasses and Levi's jeans.

*Mix modularity* is similar to component swaping modularity but can be distinguishd by the fact that when combined, the modules lose their unique identity. In this type of modualrity the configuration rarely can be dissolved back to modular level. If a company want to utilize mix modualrity it has to shift to process-to-order operation and then reduce the batch size to one, meaing that the product is completed after the customer's choice ( Pine, 1993). For example, coffee vending machine and house paint are good examples of mix modualrity.

*Bus modularity* includes common bus to which other components can be attached through the same type of interface ( Ulrich and Tung, 1991). The term bus comes from electric and computer field where a bus or platform is a coomon module. A bus can be somehting abstract or hidden that is why it is quite challening to percieve. For example the infrustructure of CNN can be a bus ( Pine, 1993). A bus is an eanbler or product or service but it does not provide value to the customer without the attached modules.

Last but cetrainly not least is *section modularity*. Section modularity is similar to component swapping modulairty but focuses more on arrenging standard modules in a unique pattern.Sectional modularity enables the greatest degree of vatiety and customization but is also the most difficult to conduct ( Pine, 1993).  Good example of section modularity in a product is Lego. It consists of standardized components that can be rearranged in different ways which gives ability to create wide variety of designs starting from cars to castles and even cities. In services, amusement park can be a good

example, where services in the park may be selected or skipped and consumed in any order as well as repeated numerous times during the customer visit.

Process modularity in turn is a relatively new concept. In the literature mostly the focus has been on product and organizational types of modularity. However, Feitzinger and Lee (1997) give a good definition of process modularity and suggest that it is based on three principles:

1) *Process standardization*: breaking down the process into standard sub-processes that produce standard based units and customization sub- process that further customize the base units.

2) *Process re-sequencing:* reorder the sub- processes so that the standard sub-processes occur first while customization sub- processes occur last.

3) *Process postponement:* postponing customization sub process until a customer order is received

Modularity in production and processes is sometimes seen as an inevitable result of increased product modularity (Bask et al., 2010). This is because what seems to define product modularity also applies to production modularity (i.e. loose coupling, mix and match, standard interfaces). Process modularity works in a similar manner in both goods and services. According to Bask et al. (2010) the interfaces between sub-processes can be soft for example when referring to human interaction and hard for example when using technology.

In context of organizations Schilling and Steensma (2001) have pointed out that organizational systems are becoming increasingly modular. This is particularly evident with the increased outsourcing of various functions and using of organizational components that lie outside of the company. Modular organization is a system of modular processes with low coordination (Sanchez and Mahoney, 1996). This means that the organization is formed by the group of weakly linked subsystems. Schilling and Steensma (2001) studied the adoption of modular organizational forms at the industry level. Their study included contract manufacturing (quickly adding temporary manufacturing capacity modules by contract), alternative work arrangements (employing workers on a short-term contract basis), and alliances (accessing critical capabilities the company lacks in-house through partnership with other firms) as ways of creating modularity in an organization. In addition, Hoogeweegen et al. (1999) introduced the modular network design (MND) concept to explain how computer

information technology helps virtual organizations to effectively reallocate production tasks and resources among modular virtual teams to cut costs and throughput time. In the next sub-chapter examples will be given of how modularity has been used and applied by various companies in practice.

### *2.1.3 Application of modularity*

The potential benefits most commonly associated with modularity are that modular design serves as a basis for customization, product postponements and outsourcing (Voss and Hsuan, 2009). Modularity however, is not always the best means of meeting customer demand and achieving the optimal return policy. For example, in case of heterogeneous input and demand the modular system is superior, while in the case of heterogeneous input but homogeneous demand, the non- modular system is more cost efficient (Schilling, 2000). If there is variety in the needs of the customer but input is homogeneous modularity can produce scale flexibility but may not increase the scope of possible service configuration (Schilling, 2000). Therefore, modularity is not a panacea but it can bring significant benefits if applied in the proper context.

Many companies have found that modularity has the potential to revolutionize their entire operation. The computer industry has been the leader in successful application of modularity principles. Software developers such as Oracle and SAP deliver a wide selection of software modules that make it easier for companies to create custom application (Marshall, 1996). In the automobile industry, Ford and General Motors for example have introduced modular assembly lines and modular cars to improve the flexibility of production process (Pine, 1993). However, the drawback is that sometimes customers can perceive sets of modularized products/services as being overly similar. This was the case in 1970, when General Motors was heavily criticized for sharing too many components among models, making them look too much alike (Pine, 1993) Therefore when using modularity it is essential that companies remember to take into account what customers find most personal about a product or service and incorporate it into their final design.

Modularity can be also witnessed outside of computer and automobile industry. It can also be observed in the everyday consumer purchases. For example, in order to make bed consumers need to buy mattresses, pillows, linens and other components from one or different stores. All the parts fit together because manufacturers produce them according to standard sizes and rules. In the end consumers are able to mix and match

various sizes, patters, materials and textures of these parts to achieve personalized variations of the bed ornament. Similarly, O´Grady (1999) distinguished between hard and soft modules. Hard modules have a physical appearance, whereas soft modules have a limited physical appearance such as software, financial products or insurance policies. Many products consist of mixture of soft and hard modules. For example, television consists of series of integrated hard modules, like picture tube and soft modules like software used to change channels. Furthermore, modularity is very common in products that are comprised of modules with a short life span and need to be replaced frequently. This type of modularity is called limited life modularity and is widely applied nowadays (Arnheiner and Harren, 2005). For example, toner cartridges for the printer need to be replaced when the die runs out in the toner. Many computer printer retailers even collect and return depleted cartridges to the manufacturer for recycling and reuse. In Table 4 you can see some more examples of products with modular design.

Table 4. Examples of products with modular designs (Sanchez and Mahoney, 1996)

| Products | Form of modular product design |
|---|---|
| **Aircraft** | Common wing, nose and tail components allow several models to be leveraged by using numbers of fuselage models to create aircraft of different lengths and passenger/freight capacities (Sanchez and Mahoney, 1996). |
| **Automobiles** | Ford is converting its auto and truck engines to modular engine designs with high levels of common modular parts (Sanchez and Mahoney, 1996). |
| **Consumer electronics** | Over 160 variations of the Sony Walkman were leveraged by mixing and matching modular components in a few basic modular product designs (Sanchez and Mahoney, 1996). |
| **Household appliances** | General Electric leverages several models of dishwashers by installing different modular doors and controls on common assemblies of enclosures, motors and wiring harness (Sanchez and Sudharshan, 1993) |
| **Personal computers** | Personal computers often consist largely of modular components like hard disk drives, screen displays and memory chips coupled with some distinctive components like a microprocessor chip and enclosure (Langlois and Robertson, 1992) |
| **Software** | Software designers attain modularity through loose coupling. The objective is often to minimize coupling – to make modules as independent as possible. For example separating *action* (what the module does) from the *logic* (how the model accomplishes the action) is approach to software engineering that has been deployed by NASA and GTE, among others (Sanchez and Mahoney, 1996). |
| **Power tools** | Black and Decker designed its entire line of power tools in the 1980s to incorporate a high degree of common modular components (Sanchez and Mahoney, 1996). |

In addition to products a wide range of services are also being modularized, most notably in the financial service industry (Baldwin and Clark, 1999; Pekkarinen and Ulkuniemi, 2008). Financial services are purely intangible, having no hard surfaces, no difficult shapes, no electrical pins or wires. For example, managing portfolio of securities can be broken down to different steps such as selection of assets, keeping of records, transferring of ownership, reporting statues and sending out statements which can be performed by separate suppliers (Baldwin and Clark, 1999). In the next section modularity will be described in more detail in the context of services.

### *2.1.4 Modularity in services*

Even though many authors acknowledge that modularity exists in both physical goods and services, implementation of the goods–focused concepts into services is difficult to carry out due to generally observed differences between these two types of offerings. Therefore, the application of modularity in services will likely be influenced by some characteristics that distinguish services from products. Services in general can be defined as production activities that cannot be stored and thus must be produced at the moment of consumption. This means that the customer is involved in the production process and is a co-producer of the service together with the company providing the service. Owing to this process character of many services the service product and service process are two intertwined dimensions in final service offering (Van Der Aa and Elfring, 2002). Another characteristic of services is the central role of people. As services come into existence in close interaction between producers and customers modular service packages will involve both technical and human factors (Meyer and De Tore, 2001; Voss and Hsuan, 2009).

An important aspect of modularity both in products and services is the notion of interfaces (Baldwin and Clark, 1999; Voss and Hsuan, 2009). Interfaces in general describe how two parts in a modular system mutually interact (Salvador, 2007). In modular products interfaces are typically standardized and manage the connections and interdependencies across various types of physical components that comprise the final product. In modular services, interfaces are generally seen as supporting the flow and movement of both clients and information from one object involved in service provision to the next (Pekkarinen and Ulkuniemi, 2008; Voss and Hsuan, 2009).

According to (Pekkarinen and Ulkuniemi, 2008) a final modular service will be combined from one or several service modules. The modules can be service elements or processes. A service module as described previously is understood as one or several service elements offering one service characteristic. Below you can see (Figure 3) representing a modular service with two service elements and one interface. Service element is considered as the smallest units into which services can be divided. Interface keeps the two service modules together by providing common rules that govern the interdependencies between the two.

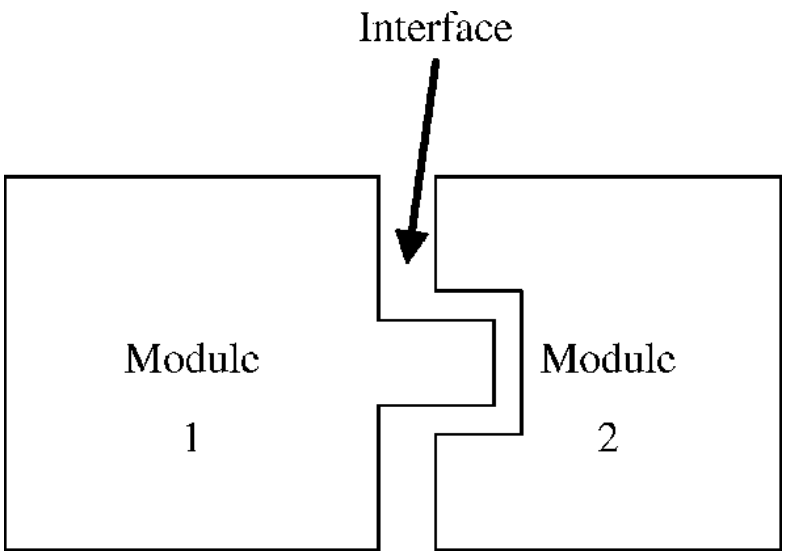


Figure 3. A modular service with two service elements and one interface (Pekkarinen and Ulkuniemi, 2008)

A good example of a modular service that a company can offer is the designing of software architecture. For instance, coding can be seen as one part of the process module and it is completed separately in India, while interface design is another part of the process module and is developed in Finland. Despite these two process modules being completed by separate units and in different locations the interface supports the flow of information between the two units and keeps it interdependent.

When talking about modularity in services another important aspect that needs to be considered is the level of standardisation. The level of standardization (Lampel and Mintzberg, 1996) will vary according to service provider's strategies. Certain services need to be highly customized to meet the specific needs of the customer, whereas other services can be offered as standard. Moreover, modularity in service production requires some degree of modularity in organization to enable the use of core capabilities of a

service producer. Generally speaking modularization serves three purposes (Baldwin and Clark, 1999), which are listed below:

- Modularity makes complexity manageable
- Modularity enables parallel work and improvement
- Modularity creates adaptively to deal with uncertainty

Modularization in services makes it possible to integrate and disintegrate potential new business components efficiently and effectively, either by sharing modular components internally, or by outsourcing modular components to an external supplier. To adapt to changing environment, new partners, business services and software modules can be plugged or removed. One way is to share two or more modules internally to create a single module that can provide the same service more efficiently or then have a completely new service as a result of the integration and synergy. For example, in early days of airline industry not many companies were willing to offer much more than a possibility of booking plane tickets online. Nowadays many companies have managed to combine two service components such as purchasing of plane tickets and making car rental reservation in one module therefore providing a new online service for a customer. Second alternative is to insource or create a new module internally by integrating new partners or modules through acquisition. For example, acquiring a 3$^{rd}$ party logistics service provider to enhance logistics capabilities of the firm. Last but not least is to outsource modules to external supplier by removing or selling them. For example many companies nowadays outsource IT services to India. Table 5 summarizes other services that use modularity in their design in different ways.

Table 5. Examples of services with modular design

| Services | Form of modular service design |
|---|---|
| **Vacation Tours** | Gateway Vacations purchases various components of tours such as airline seats, hotel rooms and entertainment options in bulk. Then customers and agents personally design the tour package that meets personal needs. Gateway Vacations uses information systems to mix and match various components and provide prices ranges ( Pine, 1993) |
| **Financial services** | Managing portfolio of securities can be broken down to different steps such as selection of assets, keeping of records, transferring of ownership, reporting statues and sending out statements which can be performed by separate suppliers (Baldwin and Clark, 1999) |
| **Healthcare** | Health care services can be divided into standard and customized. Standard services are offered to everyone and serve as the base for further diagnosis (e.g. blood tests, blood pressure, x-ray). Personalized treatment is provided based on the results obtained from the standard tests. |
| **Cruise Ship** | Each ship has an architecture consisting of various guest services such as swimming pools, restaurants, night clubs and cabins. Furthermore, services are associated with the running of the ship, its interface with shore visits, etc. A customized holiday package consisting of components from each of these services is combined for or by each guest (Voss and Hsuan, 2009) |

### *2.1.5 Mass customization*

The concept of mass customization can be best summarized in few words as providing custom products and services with mass production efficiency (Duray, 2002). However, the practice of mass customization does not particularly fit the conventional principles of manufacturing methods. For example quite often companies either chose to produce customized, tailored made products or mass-produced standardised products. As a result, mass customization presents sort of paradox by combining customization and mass production, offering unique products in a mass-produced, low cost, high volume production way. While discussed in the literature for more than a decade, mass customization has only recently been introduced to a larger extent.

Today there are several well-known mass producers that have benefited from the application of mass customization such as, Toyota, Hertz and Dell. The recent example of mass customization which is very interesting is a London based manufacturer of women's shoes called Selve (www.selve.co.uk). It enables customers to create their own shoes by choosing from a variety of materials and designs, on top of a true custom fit,

based on a 3D scan of the women's feet. Trained consultants provide advice in the company stores and the online shop offers re-orders. All shoes are made-to-order in Italy and delivered in about three weeks. Similar approach of mass customization has been implemented by other shoe makers such as Nike and Left foot (Piller, 2002). In addition, information itself is the one of the most easily customized standard products. Once collected in the database, information can be accessed by anyone. It is a completely standardized, mass produced commodity, but one with tremendous potential for economies of scope: everyone who accesses the information can do something at least slightly different with it (Pine, 1993). This is especially true nowadays with the improved capabilities of computers and telecommunications

Fixson (2006) highlights the difference between variety and customization, by stating that variety offers customers multiple options, while product customization offers customers exactly the product he/she wants. Therefore, offering great variety is not the same as offering a customized product. For example, when the customer comes to buy a washing powder in the store, there is a great variety of products available in the shelf offering liquid powders, sensed powders, powders for sensitive skin etc. However, what the customer sees on the shelf is variety of products not a customized product made specifically for his/her needs. Ulrich (1995) defines variety as the diversity of products that the production system provides to the marketplace. According to Ulrich (1995) variety can only be meaningful to customers if the functionality of the product varies in some way.

Another concept closely associated with customization is modularity, which has been already discussed in previous chapters. A number of authors suggest that modularity is the key to achieving mass customization. Pine (1993) identified five fundamental methods for achieving mass customization, which are: (1) customize service and standard products (2) created customizable products (3) provide point of delivery customization (4) provide quick response and (5) modularize components. These five steps need to be carried out in order for a company to move from mass production to mass customization. Therefore, it can be seen that modularity is essential for realizing mass customization. Baldwin and Clark (1999) also describe modularity as a means to partition production to allow economies of scale and scope.

Lampel and Mintzberg (1996) where among the pioneers to argue that customization and standardization do not define alternative strategies but rather represent the two extremes of a continuum of real-world strategies. Such continuum shows that while

some industries favour customization and some favour standardization, others can mix and match these two strategies in their products (from commodities to unique), processes (from standard to customized) and customer transactions (from generic to personalized). There five mass customization strategies can be seen in Figure 4.

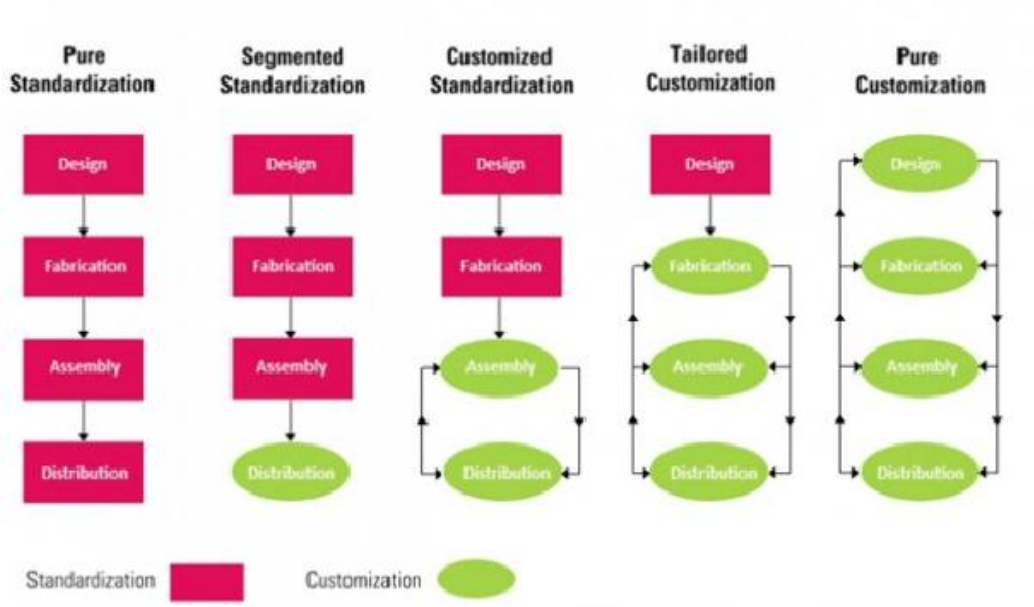


Figure 4. A continuum of strategies (Lampel and Mintzberg, 1996)

*Pure Standardization* is a strategy that uses dominant design that is targeted to the broad group of people, produced on the large scale and then distributed commonly to all. Under such strategy there is no distinction between different customers. The buyer has to adapt to the companies offering or then switch to another product. The buyer has no influence over the design, production or distribution of the product. Typical example of such strategy is the Ford's Model T car, with its slogan –"any colour so long as it is black".

*Segmented Standardization* resembles a strategy where companies respond to the needs of different clusters of buyers, but each cluster remains aggregated. Therefore the products offered are standardized within a narrow range of features. A basic design is modified and multiplied to cover various product dimensions but not at the request of individual buyers. Segmented standardization increases choices available to the customer without increasing their direct influence over design of production decisions. At most the tendency to customize would be at the delivery stage. A good example is

designer lamps that offer almost limitless variety of products but not at the customer's request.

*Customized Standardization* implies that the products are made to order from standardized components. The assembly is thus customized, while the fabrication is not. Each customer gets own configuration but constrained by the range of available components. This is quite often constructed around a central standard base, like for example like in the automobile or hamburger business. This strategy comes closest to the modularization concept.

*Tailored Customization* means that the company first presents a product prototype to a potential buyer and then adapts or tailors it to his/her individual needs and wishes. Here customization starts from the fabrication stage however the design remains standard. For example, a traditional men's tailor will show their client standard fabrics and cuts that can later be adapted to the client. The client can later come back for more fitting and tailoring (more customization).

*Pure Customization* as the name suggests takes customer wishes into consideration already at the design process itself. Here the product is truly made to order. For example, Olympic Games represent a good example of this strategy. Here all stages from design to distribution are largely customized. The relationship between the project executer and the client resembles a partnership where both sides are deeply involved in each other's decision making.

Having described five strategies for customization it would be worthwhile to extend this topic a little bit further and present another classification of customization but by industry. This would give a more practical insight into customization and present its application beyond conventional manufacturing to other kinds of operating processes such as services. Below you can see Table 6 summarizing the industries by customization adopted from Lampel and Mintzberg (1996).

Table 6. Industries by customization (Lampel and Mintzberg, 1996)

| Industry | Process Strategies | Product Strategies | Transaction Strategies |
|---|---|---|---|
| **Mass** | Standardization | Standardization | Standardization |
| **Thin** | Customization | Customization | Customization |
| **Catalog** | Segmented Standardization | Segmented Standardization | Standardization |
| **Menu** | Customized Standardization | Customized Standardization | Customization |
| **Tailoring** | Tailored Customization | Tailored Customization | Customization |
| **Routing** | Customized Standardization | Customization | Standardization |
| **Agent** | Tailored Customization | Tailored Customization | Standardization |
| **Bulk** | Standardization | Standardization | Customization |

*Mass industries* are the most known as they produce commodity goods such as diapers, petroleum etc. These products do not require complex production processes but rather rely on highly mechanized, inflexible, standardized production. Mass advertising is often combined with mass distribution to target the customers. *Thin industries* are the opposite of mass industries where customization is the key, as for example in the production of computers. Products in this industry are unique and require very large, complex and considerably cooperative buyer and seller efforts. Buyers are closely involved in the design of the product and generally expect a high commitment to after-sales service. In the *catalog industry*, companies tend to organize their products and distributions on the basis of catalogs, common examples are books, toys and pharmaceutical products. The buyer has a wide selection of choices, but the products themselves are not unique.

*Menu industries* represent products such as printed circuit boards and financial services, where buyers have a menu of choices from which they can select features for their final product. This strategy involves negotiations and relationship building between the seller and the buyer. According to Lampel and Mintzberg (1996), this customized standardization tends to be the preferred strategy among companies. *Tailoring industries* rely heavily on the individualization factor for instance industries such as residential housing and mainframe computers, use standardized core design and adapt it to individual customer needs. Customers have a considerable input mostly when it comes to peripheral design changes, price, delivery conditions and after-sale services. *Routing*

*industries* such as data transmission and delivery services, offer a mixture of standardization and customization. They accept their customers' orders in a generic way but then route them individually. For example, a customer of the post office writes an address on the letter and drops it at the mailbox. The transaction is completely impersonal but such standardized interface produces a rather customized service, as no two letters take the same route on the same day.

*Agent industries* can be best described as offering professional services such as health care and auditing. Characteristics of this industry would be explained in more detail here as it is closest to the pure service industry. The transaction tends to be very generic or standardized between the seller and the customer, mostly governed by standard contracts and specified by professional or technical codes of conduct. For example, we do not generally bargain over prices with our doctor. The provider of the services is normally far more knowledgeable than the customer. These professional activities tend to be craft like in nature, tailoring highly developed sets of professional skills to specific customers' requirements. Therefore, processes as well as the services themselves are best described as tailored customization. For example, in health care a drug prescription for chickenpox is based on standardized process adapted to particular patient's condition (age, severity, allergies etc.).

Last but not least are the *bulk industries* as the name suggests refers to the metal and coal producers of large volumes of standardized products that are sold in bulk to customers. The production facilities are automated and inflexible, however sellers and customers' negotiate size of orders, delivery conditions and prices.

Duray et al. (2000) and Duray (2002) have taken a similar approach as Lampel and Mintzberg (1996) and developed a framework for four mass customization types by bringing together customer involvement and modularity dimensions. They argue that the level of customer involvement plays a critical role in determining the degree of uniqueness of the product and the type of customization. For example, if customers are involved in the early design stages of the production cycle a product is highly customized. On the other hand if customer preferences are included only at the final assembly stages the degree of customization will not be as high. Therefore, the point of customer involvement provides a quite good practical indicator of the relative degree of product or service customization. These four types of mass customization can be seen in Figure 5.

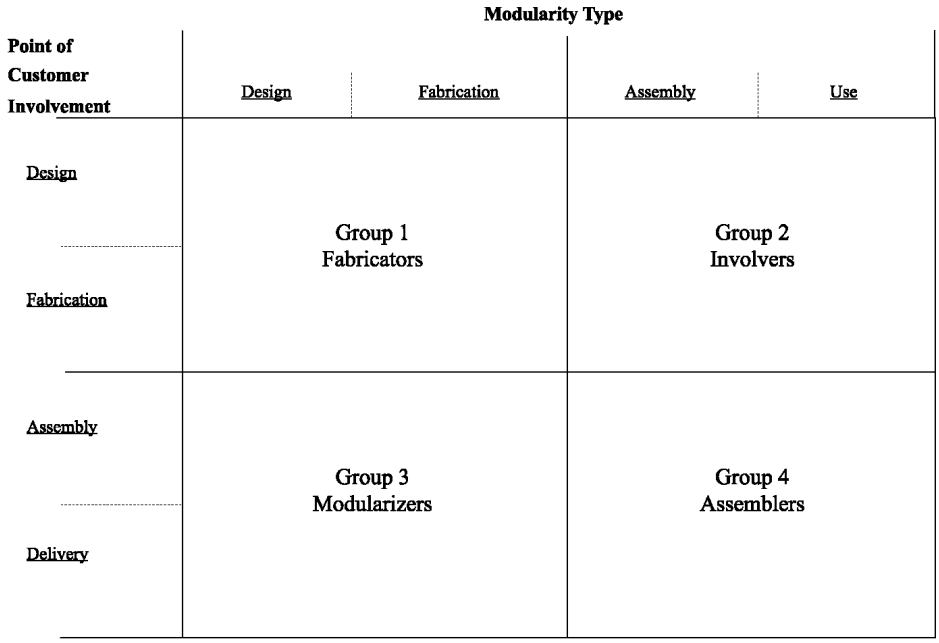


Figure 5. Four mass customization archetypes (Duray, 2002)

*Fabricators* comprise both of customer involvement and modularity during the design and fabrication stage of the production. Fabricators involve customers early on in the production process, delivering unique designs. Fabricators closely resemble a pure customization strategy. *Involvers,* as the name suggests incorporate customer involvement in product design during the design and fabrication stage but use modularity during the assembly and delivery stage. In this type of customization customers are involved early in the process although no new models are fabricated for the customer. Customer has a greater sense of ownership of the product design even though no customized components are fabricated. The type of mass customizers that most closely resemble standard producers would be assemblers.

*Assemblers*, include both customer involvement and modularity in the assembly and use stages. Mass customization is achieved by using modular components to present wide range of choices for the customer. The range of choices available by assemblers is quite large compared to mass producers, therefore customers perceive the product to be more customized. Last but not least are modularizers, which involve customer during the assembly and delivery stages but integrate modularity earlier in the production process in the design and fabrications stages.

After thorough review of customization literature, it appears that customer involvement in the production process does play a key role. Duray et al. (2000), Duray (2002) and Lampel and Mintzberg (1996) have used it as the corner stone in their research on mass customization. Therefore, this study uses customer involvement as a primary criterion to measure the degree of customization from the service production and service offering point of view. Overall, Duray et al. (2000) and Duray (2002) suggest and demonstrate broader configuration of mass customization. Although both high and low performers were found among all mass customization types, better business performance was seen among the types that used standard modules and employed modularity in the later stages of the production cycle. This indicates that there is a clear move towards modularity.

Even though all of the above literature has contributed significantly to our current understanding of modularity and customization, it offers limited insight into how the companies measure the degree of modularity and customization. Therefore, it is crucial to find studies that not only support modularity and customization from the qualitative point of view but also that focus on measuring modularity and customization. In the next paragraph, such studies will be presented shortly.

### *2.1.6 Measurement literature*

Many studies on modularity are qualitative and exploratory in nature. Although few quantitative studies can be found they quite often apply optimization models and address mostly manufacturing issues. However, it is important to take both qualitative and quantitative perspectives on modularity into account prior to developing own measurement criteria and applying it in the context of services. Authors that have in one way or another contributed to the research of modularity from the measurement point of view are Mikkola (2006), Voss and Hsuan (2009) and Tu at el. (2004). Mikkola (2006) proposed a measurement for modular product architecture and later in a joint study with Christopher Voss (Voss and Hsuan, 2009) have applied similar measurement but to modular service architecture. In their research Voss and Hsuan (2009) were able to measure degree of modularity in the service architecture through a modularity function, which is based on the following criteria: uniqueness of the service, degree of coupling and replicability factor. Tu et al. (2004) in turn, developed an instrument to measure modularity-based manufacturing practices based on the variables that are comprised of items inherent to dynamic teaming, product modularity and process modularity. In this chapter each of the above mentioned measurement criteria will be presented and discussed in more detail as to highlight what criteria has been given thus far. Later on measurement literature will be given in context of customization and what could be used as possible measurement criteria.

One of the pioneering researches in the field of measuring modularity is the study conducted by Mikkola (2006), which integrates various perspectives on product architecture modularity into a framework and proposes a way to measure the degree of modularity in product architecture. The characteristics of modular product architecture can be found in Appendix 3. The basic units of analysis of product architecture according to Mikkola are *components* and *interfaces*. Standard components capture mixing-and matching dimensions, while new to the firm components capture performance and the outsourcing strategy dimension of the modular product architecture. In addition, the extent to which components can be customized to fit firm's manufacturing process also influence the degree of modularity in product architecture. Mikkola combines several characteristics of modular product architecture to formulate the following key elements of product architecture modularity: components (standard and new to the firm), interfaces (standardization and specification), degree of coupling

and substitutability. Figure 5 presents theoretical framework of modularity in product architecture by incorporating these five measurement elements.

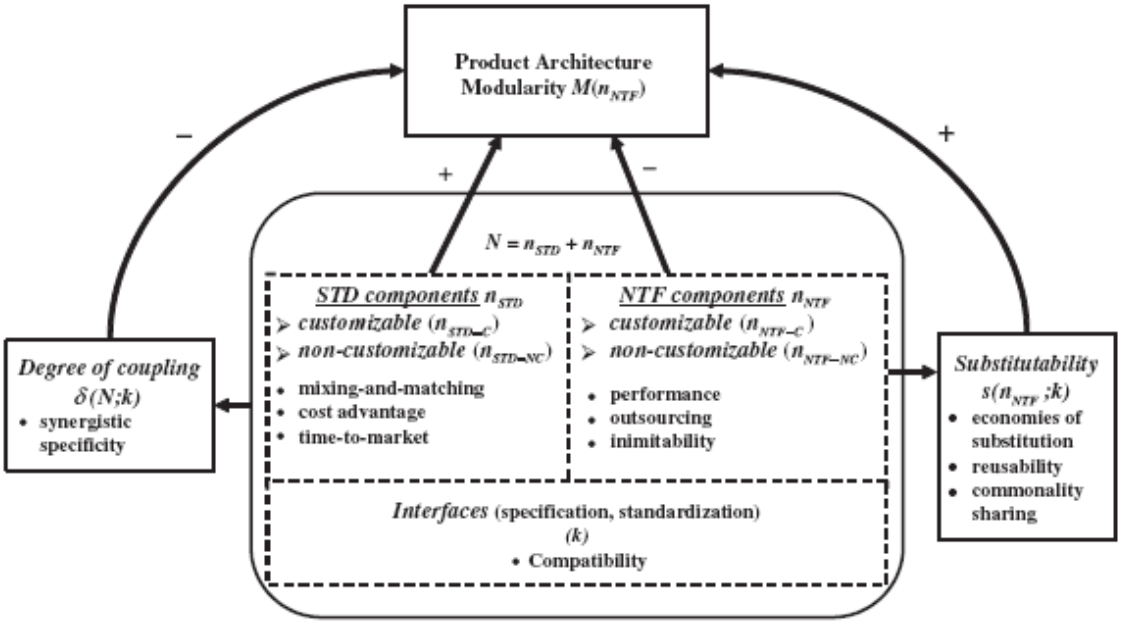


Figure 6. Theoretical framework of modularity in product architecture (Mikkola, 2006)

*Standard Components* in product refer to components available in a firm's library of qualified components or components used in firms previous or existing architectural design. Customization of standard components can be carried out, if the interface specifications of such components are standardized across the industry. For example components like capacitors, resistors and transistors are delivered to the production sites in standardized batches. The components are then cut by machines according to design specifications. On the other hand *new to the firm components* are the components that have been recently introduced to the company. These components are difficult to imitate by competitors, which can be a source of competitive advantage for a company. New to the firm components can be customizable or non-customizable. Customizable new to the firm components are the new components that have to be customized for particular applications such as new materials, new innovations etc. For example, stamped sheet-metal parts in coffee makers are custom fabricated by or for the manufacturer (Ulrich and Pearson, 1998). Non-customizable new to the firm components are components that are product specific but designed from scratch and can't be customized. Such components typically add value by either integrating different technologies into a new

component or by improving the performance of the existing component. For example, a windshield-wiper controller was a new component designed specifically for Jeeps (Mikkola, 2006). New to the firm component can be designed and manufactured in house, outsourced or co-developed with another firm.

*Interfaces* in product architectures are linkages shared among components, modules and subsystems. Interfaces define the rules for interaction across all components comprising product architectures. The degree to which interfaces become standardized and specified defines the compatibility between components, hence the degree of modularity. *Degree of coupling* refers to how tightly the components are put together in the system. The way in which the components are linked to each other creates a certain degree of coupling. Critical components which depend on many other components for functionality imply a high degree of coupling. For example, in computers microprocessors are critical components because they interact directly with a number of components, ranging from 56 to 200 interfaces (Mikkola, 2006). Therefore, product architecture with a high degree of coupling exhibit a high synergistic specificity, because the strong interdependence between components hinders recombination, separability and substitution of components, hence preventing the architecture from becoming modular ( Schilling, 2000). On the other hand product architectures with low degree of coupling include components that are relatively independent of each other, allowing for greater modularity.

*Substitutability* is another crucial element for measuring modularity in product architectures. It refers to the extent to which components can be reused or shared across different product designs. Sanchez (1999) suggests that reusability of common components within and across product lines can reduce costs by increasing buyer power for common components, by reducing component variety and by reducing costs of product support. Another aspect of substitutability is component sharing or using the same component version across multiple products. Many firms view component sharing as a way to offer a high variety in the market place while retaining low variety in the operations.

Based on the above summarized criteria the mathematical model, termed the modularization functions is applied to measure the key elements and their effect on the degree of modularity in the product architecture:

$$M(n_{NTF}) = e^{-n_{NTF}^2/2N\delta},$$

Mikkola (2006) in her research illustrates the application of modularization function by giving examples of two different product architectures: Jeep's windshield-wiper controllers and Schindler elevators. Although the application of modularization function to two sets of product architectures provides rather preliminary findings on how product architecture's degree of modularity can be measured, it can still be used as a powerful measurement tool. Furthermore, Voss and Hsuan (2009) take this idea of measuring modular product architecture further and apply the same elements to introduce a mathematical model for analyzing the degree of modularity in service architecture. These variables include: *standard services, unique services, degree of coupling and replicability factor.* Each of these variables will be briefly described here and later the service modularity function presented.

Standard services are plentiful in the industry and they provide a foundation for the shared services. *Standard services* are typical for the multisite services such as fast food and retail. The purpose of these services is to achieve agility, meaning that the company would be able to respond more rapidly and effectively to the changing market demands. *Unique services* on the other hand refer to the service elements that are unique within the company and are difficult to copy in the short term by competitors. For example, Cameron Macintosh Ltd. was among the first to realize the power of mass replication of uniqueness in the stage of shows, and they have successfully replicated shows such as Phantom of the Opera and Lés Misérables across multiple countries and multiple languages (Voss and Hsuan, 2009). This is particularly evident in firms in which knowledge and information sharing is tightly controlled. Consulting can be also added to this category of firms as it is very much knowledge intensive and offers knowledge-based, professional advisory services.

The degree of coupling measures the tightness of service architecture and it is independent of service, standard or unique. In a loosely coupled system information shared among the service elements takes place effortlessly, meaning that there are quite few linkages per service element. Last but not least replicability provides an indication of how easily a service can be reproduced. Here we are talking about the replicability of unique services, as these are the sources of competitive advantage. Taking all of the above elements into account Voss and Hsuan (2009) have developed a service modularity function that can measure the degree of modularity in service architecture. The function is illustrated below:

$$SMF(u) = e^{-u^2/2Nf}.$$

Voss and Hsuan (2009) have applied and tested the above function in the context of sea cruise services. Their findings give a good insight on how SMF can be used in decision making when a cruise company for example needs to design a service system for its cruise liners. Similar logic can be applied to other service industries such as consulting industry and elements comprising SMF can be used as independent metrics or as a combination of measurement criterion.

Tu et al. (2004) offer another approach to measuring modularity from the manufacturing practices point of view. They have developed an instrument that measures modularity-based manufacturing practices by firstly examining literature on modularity in manufacturing, mass customization and customer closeness. Next, they propose measurement items for modularity-based manufacturing practices, which are represented by three dimensions comprising altogether 20 items: Product Modularity (seven items), Process Modularity (six items) and Dynamic Teaming (seven items). These items are summarized in Appendix 4. This study represents one of the first and maybe even the only large scale empirical effort that has been made to integrate the scattered literature on modularity. It provides a good starting point for the future research on measurement of modularity and the role of modularity practices. The measurement items which were used to build the modularity-based manufacturing practices can also become a set of useful tools for further reference and practical assessment of modularity primarily in manufacturing, but also in other areas such as services as process modularity and dynamic teaming are important aspects in service modularity as well. Table 7 summarizes the measurement criteria which were found by reviewing existing literature on measuring modularity.

Table 7. Summary of measurement criteria for modularity from the literature review

| Author | Measurement Criteria | Focus |
|---|---|---|
| Voss and Hsuan (2009) | • Standard services<br>• Unique services<br>• Degree of coupling<br>• Replicability factor | Service |
| Tu et al. (2004) | • Our products use modularized design<br>• Our products share common modules<br>• Product modules can be reassembled into different forms<br>• Our production process is designed as adjustable modules<br>• Production process modules can be adjusted for changing production needs<br>• Our production process can be adjusted by adding new process modules<br>• Production teams can be re-organized in response to product/process change<br>• Production team members can be re-assigned to different teams<br>• Production team members can be re-assigned to different tasks | Product, Process and Organization |
| Mikkola (2006) | • Standard Components<br>• NTF Components<br>• Substitutability<br>• Interfaces<br>• Degree of Coupling | Product |

Having described measurement literature on modularity, customization will be addressed next. As has been previously discussed in Chapter 2 level of customer involvement plays an important role in determining the degree of uniqueness of the product and hence type of customization (Duray, 2002). For instance, if customers are involved in the early design stages of the production cycle a product is highly customized. On the other hand if customer preferences are included only at the final assembly stages the degree of customization will not be as high. Therefore, the point of customer involvement provides a good practical indicator of the relative degree of customization. This theory can also be used to identify companies that do not produce mass customized products. For example, companies that do not involve customer in the design process or do not use modularity cant not be considered as mass customizers.

Without some kind of customer involvement in the design process, a product cannot be considered customized. Taking all this into account, Duray (2002) develops a configuration model for classifying mass customizers based on customer involvement in design and product modularity. This theory has been validated by using both secondary and primary data and both case studies and surveys. Duray (2002) tested the relationship between mass customization and products produced by comparing the product mix and identifying it as standardized or customized. Producers with less than 50 per cent of their products customized were considered as standard product producers, while those companies with greater than 50 per cent customized products represented custom product producers.

Pine and Gilmore (1997) have identified four customization levels based mostly on empirical observation: collaborative (*dialogue with customers*), adaptive (*standard products can be altered by customer during use*), cosmetic (*standard products are packaged specifically for each customer*) and transparent (*products are adapted to individual needs*). Each of these levels will be shortly described in greater detail. Collaborative customizers approach suggests conducting a dialogue with individual customers to help them articulate their needs, to identify the precise offerings and customise the products. This approach is most appropriate to use when customers cannot easily choose what they want or when they have to choose from a wide-range of options. This type of situation resembles very well the service offerings that many service industries produce such as consulting.

The adaptive customizers approach implies than an organization offers a standard but customizable product that is designed so that customers can alter it themselves. This approach is best suitable to business where customers want the product to perform different ways on different occasions. The cosmetic customizers approach suggests that a standard product is presented differently to different customers. Rather than being customized the product with this approach is displayed differently and its characteristics are advertised in different ways. Last but not least is transparent customizer approach implies that organization should provide individual customer with unique products and services, without letting them know exactly how the products have been customized. This approach is suitable when customers specific needs are predictable or can easily be deduced. In another study, Pine (1993) suggests five stages of modular production, customized services (*standard products are tailor by people in marketing and delivery before they reach customers*), embedded customization (*standard products can be*

*altered by customers during use)*, point-of-delivery customization ( *additional custom work can be done at the point of sale*) providing quick response (*short time delivery of products*), and modular production (standard *components can be configured in a wide variety of products and services*). The combination of these frameworks is presented in Table 8.

Table 8. Summary of measurement criteria for customization from literature review

| Author | Measurement Criteria | Focus |
|---|---|---|
| Duray (2002) | • Customer involvement | Level of customization |
| Pine and Gilmore (1997) | • Dialogue with customers<br>• Standard products can be altered by customer during use<br>• Standard products are packaged specifically for each customer<br>• Products are adapted to individual needs | Approach of Customization |
| Pine (1993) | • Standard products are tailored by people in marketing and delivery before they reach customers<br>• Additional custom work can be done at the point of sale)Modular production<br>• Short time delivery of products<br>• Standard components can be configured in a wide variety of products and services | Stages of Customization |

The literature review reveals that there are few quantitative metrics available to measure modularity and customization, and those that are present have been developed quite recently. This is especially true in terms of measuring customization, as most of the studies are qualitative and descriptive in nature. Therefore, in this study the aim is to understand what measurements have been given and what could be used for developing own measurement criteria for evaluating companies on two dimensions: customization and modularity. In the next chapter summary of the literature review will be presented in order to highlight the key concepts and theoretical framework.

## 2.2 Summary of the Literature Review

Even though modularity as a concept has appeared in the literature over decades ago, it still lacks a unified definition. Starr (1965) defines modular production as capacities to design and manufacture parts which can be combined in numerous ways. Baldwin and Clark (1999) define modularity as building a complex product or processes from smaller subsystems that can be designed independently. In the field of Operations Management modularity is mainly understood from the perspective of component combinability, meaning that by mixing and matching of components taken from a given set, different product configuration can be obtained (Salvador, 2007). Modularity can also be distinguished into three types: product modularity, process modularity and organizational modularity (Bask et al., 2010; Pekkarinen and Ulkuniemi, 2008). Product modularity is the most commonly studied area of modularity. Ulrich and Tung (1991) have identified six different types of product modularity which can be used separately or in combination to provide customised end product. These are: *component-sharing modularity, component-swapping modularity, cut-to-fit modularity, mix modularity, bus modularity and sectional modularity.*

Regardless of the point of analysis, whether one is looking at modularity from product, process or organization point of view modularity has the potential to revolutionize companies operations. Often cited example is computer industry which has been the leader in successful application of modularity principles. Software developers such as Oracle and SAP deliver a wide selection of software modules that make it easier for companies to create custom application (Marshall, 1996). In the automobile industry, Ford and General Motors for example have introduced modular assembly lines and modular cars to improve the flexibility of production process (Pine, 1993). In addition to products a wide range of services are also being modularized. According to Pekkarinen and Ulkuniemi (2008) a modular service will be combined from one or several service modules. These modules can be service elements or processes. Interfaces keep the two or more service modules together by providing common rules that govern the interdependencies. A good way to see service modularity in practice is to look at travel agencies.

Mass customization is another concept that has been extensively studied in the literature and that goes hand in hand with modularity. Unlike modularity, mass customization has a rather universal definition of providing custom products and services with mass production efficiency (Duray, 2002). It is important though to understand the difference

between variety and customization. Fixson (2006) states that variety offers customers multiple options, while customization offers customers exactly the product he/she wants. Ulrich (1995) defines variety as the diversity of products that the production system can provides to the marketplace. However, variety can only become meaningful to customers if the functionality of the product varies in some way (Ulrich, 1995). Lampel and Mintzberg (1996) propose another way to measure customization based on the level of customer involvement. If customer is involved in the early stage of the production process a product is highly customizes, if the customer is involved at later stages of the production process the degree of customization is lower. Duray (2002) has developed a framework for four mass customization types by bringing together customer involvement and modularity dimensions. These four mass customization types are: *fabricators, involvers, modularizers and assemblers*.

In order to have a uniform understanding of modularity and customization it is necessary to review studies that support modularity and customization from not only qualitative point of view but also from the quantitative point of view. Authors that have greatly contributed to the research of modularity from the measurement point of view are Mikkola (2006), Voss and Hsuan (2009), and Tu at el. (2004). Mikkola (2006) in her study proposed a measurement for modular product architecture and later in a joint study with Christopher Voss (Voss and Hsuan, 2009) have applied similar measurement tool but to a modular service architecture. In their research Voss and Hsuan (2009) were able to measure degree of modularity based on the following criteria: *uniqueness of the service, degree of coupling and replicability factor*. Tu et al. (2004) offer another approach to measuring modularity but from the manufacturing practices perspective. They have developed an instrument to measure modularity-based manufacturing practices based on the variables such as *dynamic teaming, product modularity and process modularity*. Looking at customization from the measurement point of view it can be measured by identifying the customer involvement point as proposed by (Duray, 2002) and/or as Pine and Gilmore (1997) has suggested through a dialogue and adapting product/service to customer needs.

Despite quite scarce amount of literature available on modularity and mass customization altogether, literature that has been reviewed in this chapter offers a strong base for developing a solid understanding of both concepts and its measurement practices.

# 3 FRAMEWORK DESCRIPTION

Framework developed by Bask et al. (2011) serves as the foundation for this research. As was previously described this framework will be taken and applied in a different context (pure service industry) to examine if the same logic prevails or not. To accomplish this, measurement system is introduced into the initial framework based on the modularity and customization criteria, which is measured along the scale from 1 to 5. However, before going any further into the empirical part of this paper it is important to describe the origins of this framework and how it can be interpreted along the two dimensions: modularity and customization.

This framework of combining modularity and customization originates from the need to provide a more comprehensive means for analyzing product and service models. Therefore, Bask et al. (2011) developed a framework that portrays the degrees of customization and modularity separately, leading to service models combinations other than simply mass customization but also standardization and hybrid approached. The framework includes three perspectives from which services can be analyzed: service offering perspective, service production perspective and service production network perspective. For this study only two perspectives were chosen: service offering and service production. The framework has been constructed on the basis of literature review on modularity and customization. Using examples from automotive industry, Bask et al. (2011) provides four possible combinations of service modularity and customization. The objective of this study is to present different positions within the framework through descriptive and easy to understand examples rather than through full – case studies. Figure 8 illustrates the framework.

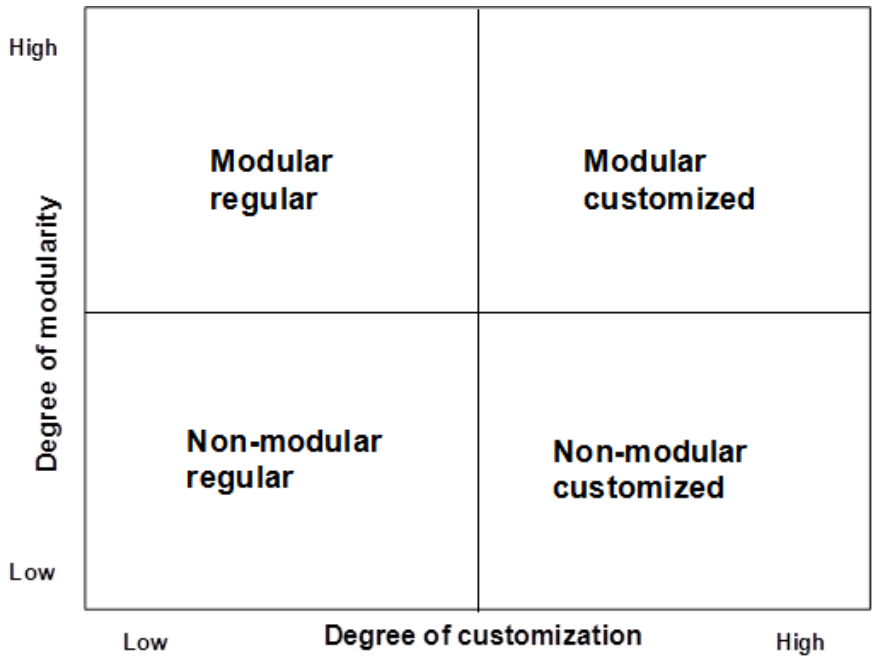


Figure 7. A general framework combining service modularity and customization (Bask et al., 2011)

In the framework, the measure of customization level for the service offering is the profundity of the customization experience for the customer Bask et al. (2011). In service production the measure is the deepness of customer involvement. The measure of modularity in the service offering is the product variants offered with different modules and service levels, and in the service production perspective the use of modularity principles in production.

Four extreme categories have been identified by Bask et al. (2011) when the degree of modularity and customization are combined. They are as follows: *non-modular regular*, *modular regular, modular customized* (mass customization) and *non-modular customized* as presented in the Figure 3. Regular stands for a predetermined and standardized element in the service while customized for a more customer specific element in a service. In the paragraph that follows each of the four dimensions will be described in more detail first when looking from the service offering point of view ( see Figure 8) and then from the service production (see Figure 9). Examples from automotive industry will be provided to better illustrate each of the four dimensions.

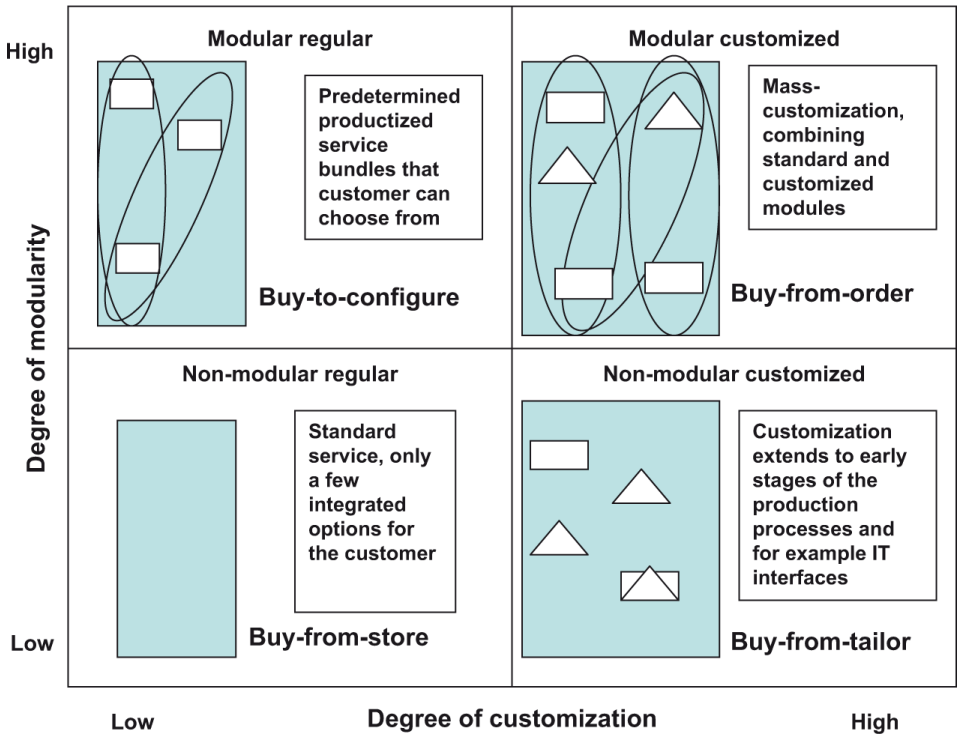


Figure 8. Combining modularity and customization in service offering (Bask et al., 2011)

If a service offering is *non-modular regular* there are only a few predetermined alternative products, services or their combinations offered and the customer does not influence their specifications. The customer can only choose from several alternatives. In the automotive industry non-modular regular service offering represents the traditional car production, in which cars were made according to the make-to-stock principle. The best known example is Ford's Model T, which is offered firstly offered in one colour (black) and later more options become available but still relatively few models and colour options were available for customers.

Alternatively, if the service is *modular regular* it consists of standard modules for the customer to choose from that are suitable for their needs. In this type of service the customer service lead time is short meaning that assembly can be done closer to the customer interface. A good example is the Smart car. The offering is built from larger standards, predetermined modules chosen by customer including coloured plastic body. Customization is performed at the assembly level and the level of customization is medium.

The next category is *modular customized*, which offers a large number of options for customer to choose from. The variety of offers is achieved through the use of both standard and customized modules that can be mixed and matched to meet individual

customer needs and preferences. Volvo car is a good example of a modular customized offering. Volvo offers more than one car variants. The five models produced on the basis of one production platform are available in fourteen colours, nice engines, five transmission alternatives as well as twenty-two types of interior trim and nine wheel variants (Bask et al., 2011). The customer can choose from many predetermined options and is involved in the early stages of production.

Last but not least, is the *non-modular customized* service offering which results in a fully customized service or product that is made according to customer requirements through highly integrated production process where customer involvement extends all the way to the design stages of the process. A good example of such service offering is Formula One car. It is tailor made from the beginning of production and such car can be described as an integrated product as opposed to modular one (Mikkola and Gassmann, 2003).

Having described the model from the service offering point of view now the description of the same model will be presented while looking from the service production perspective. Modularity in the production process reflects the way in which service is provided by the manufacturing operations and plants. *Non-modular regular* service production process involves low level of modularity in production and a low level of customization. This type of production process typically produces standard products, services or combination of both according to the make-to-stock principle. There is no customer involvement in production and the order penetration point is at the stock or place of sale. For example, Model - T and Nano offer few variants which have predetermined features and manufactured according to forecasted demand. On the contrary, *modular regular* service production is offered according to the assemble-to-order principle and customer preferences are integrated into the product or service at the assembly stage. The customization level is low or medium. Smart car's production flow is designed on the basis of this principle.

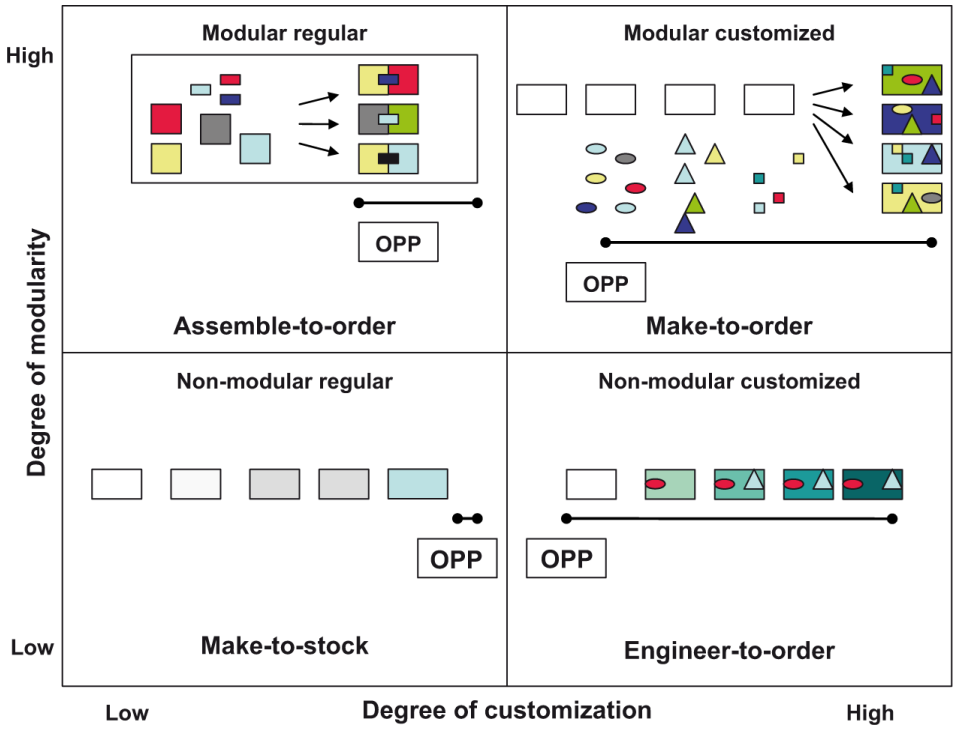


Figure 9. Combining modularity and customization from the service production perspective (Bask et al., 2011)

*Modular customized* service production configures products or services from customized and pre-determined modules. The production principle can be best described as make-to-order. Order penetration point takes place in earlier stages of production. This type of production process is very common to knowledge intensive business services such as legal consulting, which is based on both standard and customized modules. In the car industry, Volvo represents a good example of offering modular-customizes production.

Last but not least is *non-modular customized* service production which produces one of a kind products or services. The production process is highly customized with some presence of modularity. Customers are primarily involved in the design phase of production. This type of production is called engineer-to-order, which also resembles fabricators from the Duray (2002) framework which was described in Mass Customization subsection. Good example of such production strategy is the Formula One car that is one of a kind, having customer involved in the design and testing of the product and its components.

## 3.1 Framework Revised

Here a framework proposed by Bask et al. (2011) is revised by adding the scale and measurement criteria for modularity and customization (Figure 10). The revised framework is based on unifying literature on product and service modularity as well as several measurement studies to provide measurement criteria that takes into account various features of modularity and customization. This framework aims to help management understand the strategic and service design implications of modularity and customization. The measurement criteria for modularity can be seen in Table 8 and measurement criteria for customization can be seen in Table 9. The revised framework remains the same in terms of axis (modularity and customization), along which the companies are placed within the framework. However, modularity and customization are measured along preselected criteria, which are in turn ranked along the scale from low to high (1-5), depending to what extent one or the other criteria can be observed in the company during interview. Only measurement criteria that falls on the scale into the type 1, 3 and 5 is characterised with detailed descriptions. Thorough description of scale can be found in Appendix 2.

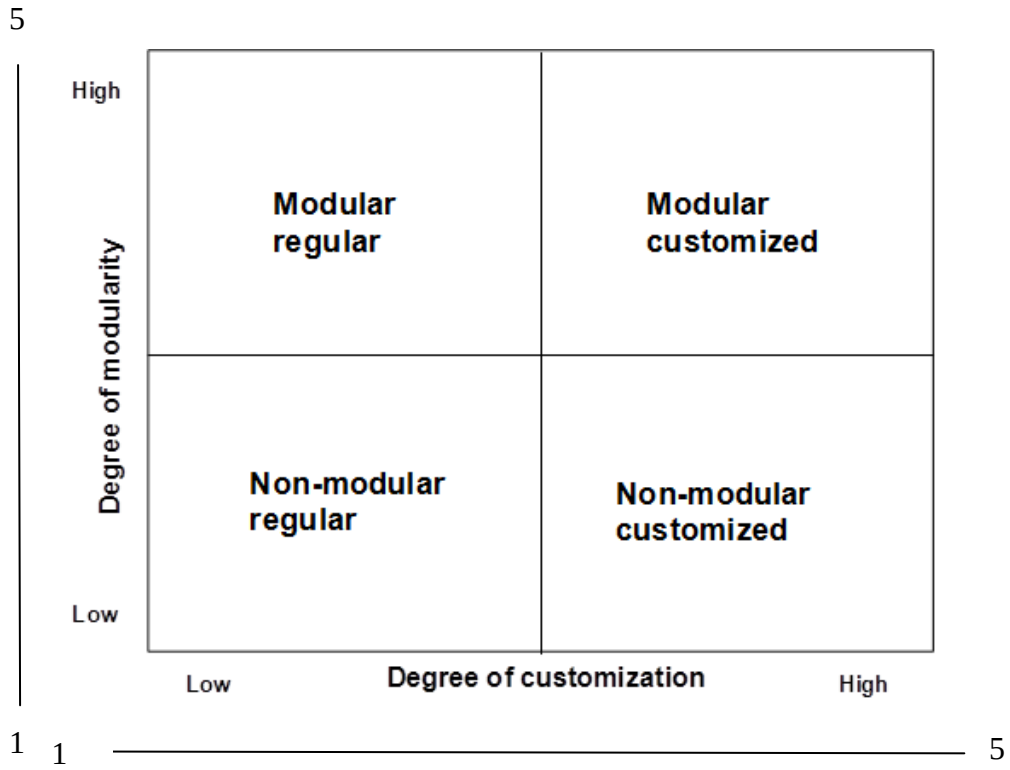


Figure 10. Revised framework for modularity and customization

The measurement criterion for this research is derived from the concepts, definitions and measurement elements that have been discussed in previous chapters. M1 is used to refer to modularity criteria number 1 and C1 is used to refer to customization criteria number 1. The same logic is applied to naming the rest of criteria. The measurement criterion for this research is derived from the concepts, definitions and measurement elements that have been discussed in previous chapters.

Mikkola (2006) in her study has identified several measurement criteria which were used to develop a measurement function. For this study some of these criteria were chosen such as *degree of coupling, interfaces and substitutability* to provide a good measurement of modularity in service offering and service production. These characteristics also reappeared in other scientific articles on modularity which makes it a good starting point. Additional measurement criteria have been adopted from the study conducted by Tu et al. (2004) particularly for defining criteria for measuring modularity in service production. Tu et al. (2004) has proposed a good set of criteria for measuring product modularity and process modularity (Appendix 4). For this study the following criteria have been adopted from the Tu et al. (2004) study: *service production process can be adjusted by adding new process modules; service production process can be broken down into standard sub processes and customized sub process; and service production modules can be easily rearranged during the production process.* Human factor is also vital of the success of modularity, especially in the service context. The management and employees must not only be aware of what modularity is and what it can achieve, but they also need to have the skills for its implementation. This has been measured by criteria such as *service production is facilitated by modularity of the organization (virtual teams, outsourcing, etc).*

When talking about customization criteria the greatest contribution came from the study of (Duray, 2002) which has used customer involvement as the main criteria for identifying the customization level. Therefore, majority of measurement criteria which have been developed for measuring customization in the service production reflect customer involvement in the production process. For instance: *customers can make modifications to their service offer quite late at the production process, during the service production process there is always a close collaboration between company and the end customer* and *customer can perform to a certain extent customization of the service offering.* In addition Pine and Gilmore (1997) have highlighted dialogue with the customer and adaptation of product to individual needs as important elements of

customized approach. Therefore, these two elements have been taken into account as well, for example, *customer requests are uniquely designed into the finished service and there is a continuous dialogue with the service provider and customer*. The rest of the measurement criterion was developed based on the thorough literature review of modularity and customization concepts as well as study on service modularity and customization by Bask et al. (2011).

Table 9. Modularity measurement criteria for service offering and service production

| Customer service offering point of view | Service production point of view |
|---|---|
| M1 – Customer service offering uses modularized design | M1 – Service production process can be adjusted by adding new process modules |
| M2 – Customer service offering includes service modules which are independent from one another ( degree of coupling) | M2 – Service production process can be broken down into standard sub processes and customized sub processes |
| M3 – Customer service offering comprises of the service modules that can be easily rearranged to suit the needs of the end user (mix and match) | M3 - Service production modules can be easily rearranged so that customization of sub processes can occur at any stage of production |
| M4 - Service components in the customer service offering are linked by standard interfaces | M4 - Service production is facilitated by modularity of the organization ( virtual teams, outsourcing, etc.) |

Table 10. Customization measurement criteria for service offering and production

| Customer service offering point of view | Service production point of view |
|---|---|
| C1 – Customer can perform to a certain extent customization of the service offering. | C1 – Customers can make modifications to their service offer quite late at the production process |
| C2 - There is a continuous dialogue with the service provider and customer | C2 - Customized services represent higher percentage of service basket |
| C3 – Various options of service modules are offered to the end customer | C3 – During the service production process there is always a close collaboration between company and the end customer |
| C4 – Continuous co-creation and co-design between the customer and service provider | C4 – Customer requests are uniquely designed into the finished service |

# 4 RESEARCH METHOD AND EMPIRICAL FINDINGS

## 4.1 Research Background

The objective of an empirical part of this research is to apply a measurement criteria, which was developed for this study and use it to assess the degree of modularity and customization of consulting companies that participated in this study.

Consulting industry has been chosen as a suitable context for a study of modularity and customization because service element is at the core of its business. Services always involve at least one customer contact and there is increasing demand to have them made according to customer needs and specifications and to be delivered at the right time and place. Majority of consulting services are produced according to the demand and they involve less physical aspect than manufactured products. However, the fact that consulting services do not contain much of physical elements makes modular service process to be less visible then for example in manufacturing or logistics industries.

Case study research methodology has been chosen as the principal research strategy for this study, as opposed to other research methods such as survey research or experimental research. Case studies can involve either single or multiple cases. For this study three case companies have been selected. There are several reasons why case study research methodology is preferred over other research methodologies. According to (Eisenhardt, 1989) case study research is considered as the most appropriate in situations where research and theory are still forming. Therefore, case studies are meaningful especially when there is limited prior knowledge or the existing knowledge seems inadequate (Eisenhardt, 1989). This is especially true for this study as service modularity and customization is a novice field of research which still lacks solid theoretical background and empirical contribution. Most of the research as was illustrated previously has focused on product and/or process modularity and product and/or process customization. Similarly, Voss et al. (2002) have highlighted that case research has been consistently one of the most powerful research strategies in operations management, particularly in the development of new theory. As the primary goal of this study is to revise the existing framework and propose a new measurement criterion, case study research has been chosen as a suitable research strategy for empirical part of this study.

A key success factor in an empirical study is the quality of respondents. Therefore for this study, respondents were chosen who had a detailed knowledge of their companies' service production and service offering processes plus an in-depth understanding of consulting industry. Interview participants occupied leading roles in their consultancies such as CEO, Managing Partner and Team Lead position. Hence, respondents had different professional backgrounds, came from different areas of consulting industry and company sizes. Three companies were interviewed for this study which came from IT consulting, management consulting and strategy consulting. The reason why different types of consultancies were chosen was to examine if the strategies differ or not in terms of modularity and customization if looking from different areas of expertise within the same industry. Due to the confidentiality factor the names of these three consultancies would not be disclosed in this research paper. Instead, the companies would be referred to as *A (*strategy consulting), *B (*management consulting) *and C (*IT consulting). The data has been collected through face-to-face semi-structured interviews and questions were sent prior to an interview to familiarize the respondents with the study area.

For this research it was necessary to define whether service offering and/or service production was modularized and/or customized in one way or another. This was done by interviewing companies about their service offering characteristics and service development practices. One of the key questions in this study is if there is a tendency towards modularization in service offering and service production and if so could that be explained as a necessity caused by market developments or the specificities of the particular industry.

## 4.2 Data Collection and Analysis

For this study out of several methods of data collection (observations, questionnaires, focus groups etc.) interviews were chosen as means to collect data for empirical research. Interviews are a good way of gathering information in situations where you need to get good quality answers in a rather short period of time. During interviews, one is able to repeat the question when needed and ask for further explanations. Interviews allow interviewer to be in control of the situation and evaluate the interviewees' replies and modify the questions accordingly. In my opinion the biggest advantage of interviews is its flexibility and human interaction. Interviewees most of the time do not see the questions the interviewer is about to ask, which gives an opportunity to answer freely and objectively. Even if the interviewer has prepared questions in advance and sent them to the respondent, the interviewer can still change the order in which the questions are asked. In addition, close interaction with the interviewee during an interview makes it possible for additional questions to arise which would not have happened otherwise. According to Vuorela (2005) and Wengraf (2001) interviews can be quite different in nature and therefore it is crucial to identify what type of interview suits best your needs and expectations. Thus, in the next paragraph different types of interviews will be shortly described and compared.

The degree of "structuring" in the interview refers to the degree to which the questions made by the interviewer are prepared before the interview (Wengraf, 2001). By looking at the spectrum of interviewing from the point of view of the interviewer who is preparing the meeting, interviews can vary from being lightly structured to heavily structured to completely unstructured and to fully structured. There is an argument that if you move from model-building to model-testing in your research, you move from lightly structured to more heavily structured types of in-depth interviews (Wengraf, 2001). The research focused on building a theory or a framework of a particular reality typically requires an unstructured or lightly structured interview. On the other hand once the theory or framework has been built, it is then tested by more heavily structured or fully structured interviews. This idea is best summarized in Figure 11.

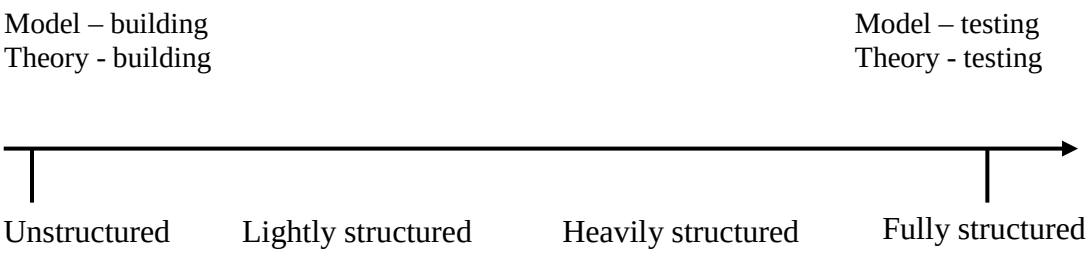


Figure 11. Spectrum from unstructured to fully structured interviewing (Wengraf, 2001)

Vuorela (2005) also divides interviews based on the amount of preliminary planning into three different types: open interviews *(unstructured),* theme interviews *(semi-structured)* questionnaires *(structured).*

According to Vuorela (2005) out of all the interview types, open interview represents a technique of interviewing that allows the most freedom. Normally, open questions are used in this type of interviewing, meaning that questions are not defined beforehand. Discussions can be seen as one form of open interviews. Such discussions can get very deep and the interviewer can ask questions based on the answers given by the interviewee. Therefore, final results from this type of interviewing are very informative and rich in content. In addition, such method allows the interviewer to get answers on questions, which one is not comfortable in asking directly. However, the disadvantage of this technique is that the analysis of information is time consuming and more difficult, compared to other types of interviews. Moreover, Eriksson (1986) pointed out that in order to succeed in open interviews the interviewer needs good social and communication skills.

Another type of interview is semi-structured interview, which represents a compromise between open interviews and structured interviews. This method comprises of well defined themes and interview topics but allows for certain degree of freedom. According to Eriksson (1986) structured interviews can be also semi-structured if the interviewer decides the sequence and questions in advance. Quite often semi-structured interviews take a form of an open discussion that consists of closed and open-ended questions.

Last but not least it is the structured interview, which is the most common method of interviewing according to Hirsijärvi and Hurme (2001). The interview consists of already predetermined questions. What distinguishes this method from a questionnaire is that in this method the interviewer asks the questions and records the interviewee's answers. The advantage of this method is that it is very easy and not as time-consuming

as for example open interviews. However, the biggest challenge of using this type of interviews is structuring the interview and preparing the right questions. Below you can see Table 11 which summarizes and compares the three methods.

Table 11. Comparison of interview types (Hirsjärvi and Hurme, 1995)

| | Structured interview | Semi-structured interview | Unstructured interview |
|---|---|---|---|
| **Form of questions** | Fixed | Recommended questions | Free |
| **Scope of questions** | Strongly defined | Broadly defined | Free |
| **Number of interviewees** | Large | Quite small | Small |
| **Cost per unit** | Quite small | Quite large | Quite large |
| **Amount of work required for analysis** | Quite small | Large | Large |
| **Concentration of the interviewer** | Can be small | Intense | Intense |
| **Information collected** | Superficial | Deep | Deep |

Based on the literature review on research methodology semi-structured interviews were chosen as means to collect data for this study. Semi-structured interviews give the possibility to keep the discussion flexible yet under control. Moreover, the results collected from semi-structured interviews are informative and deep in content, which is necessary to making further analysis of the results. Even though for this research an existing framework has been chosen, new measurement criteria has been developed and added to the framework. Therefore, in a sense a new framework has been proposed, which means a model building approach, which in turn according to Wengraf (2001), requires lightly structured interviews.

## 4.3 Empirical Findings

This chapter focuses on presenting the results obtained from the semi-structured interviews with the three consulting companies (Company A, Company B and Company C). First each of the companies will be analysed separately and later a join analysis will be given. As was mentioned previously each of the companies that participated in this study came from different consulting backgrounds and received the interview questions prior to the meeting. Interview discussions lasted between 45 minutes and one hour and took place at the respondents company's premises. Prior to interview, the participant was informed of the purpose and objectives of the study and how confidentiality of his or her statements would be handled. During the interviews participants were asked about issues related to what kind of services a company is offering at the moment (standard, unique or something in between), to what extent customer specifications are taken into account in developing services, can service modules be easily mixed and matched to create various services and how has the situation changed compared to 5 years ago (has the company moved towards customization, modularization or something in between). Interviews were audio-taped and transcribed for subsequent analysis. Interview questions can be found in Appendix 1.

Semi-statured interviews were organized in a way that would help analyse the responses directly along the measurement criteria which were developed and discussed earlier in this paper (see Chapter 3). First the respondents were asked questions about the modularity and customization of their services from the service offering point of view and later from the service production point of view. These questions were divided and formulated so that the answers given by the respondents would be measurable along the measurement criteria. For instance the first measurement criteria for measuring modularity from the service offering point of view is – *customer service offering uses modularized design*. In order to be able to see if that is the case respondents were asked additional sub-questions about what kind of services do they offer. For example do they offer standard services, do they offer customized services or something in between. In addition, they were asked to give examples of their services and tell which formed the largest part of their service portfolio. Similar approach was applied for retrieving answers to the rest of the questions supporting the measurement criteria. Altogether there are sixteen measurement criteria used for this study (eight measuring modularity and eight measuring customization). Each measurement criteria has two to three sub questions that help to test the respondents' validity of the answers.

Despite having pre-defined questions the interviews were not restricted to only these set of questions and there was no readymade sequence in which each of these questions had to be answered. Quite often during an interview the respondents automatically answered some of the questions without being directly asked. This really helped maintain a good flow of an interview and even on some occasions responses were informative beyond the scope of this study.

### *4.3.1 Results from Company A*

Company A was founded in 2006 and it specializes in strategic consulting. Its business model is based on utilizing skills, ambition and competencies of young professionals. Company A is a start-up company with revenue of less than 5 million euros. At the moment it employs around 10 people which are located locally in Finland. Its business services can be divided into two major categories which they call as sales concept and project methodology concept. According to the founder of the company sales concept means getting clients interested in their services, while methodology concept means how to execute the project.

***Respondent A:*** *"Before starting any project we have sales concept. This basically means the analysis of the industry, for example if talking about Rovio Entertainment Ltd and Gaming Industry we would first look for companies and opportunities and then we would see where could be interesting opportunities for us as well as forthcoming challenges and we would go to discuss with the potential client if there could be opportunities for both of us".*

According to Company A, even though in theory the methodology concept is made out of standardized modules, in practice every project still requires individual approach and tailoring. Respondent A mentioned that they have never came across of having two similar projects, or a practice of using some bits and pieces of information from one project to support another project. Everything these young professionals do is done from scratch and in compliance with the clients unique needs and wishes. For example, when respondent A was asked if the client can pick and choose feature from the pre-defined list, the reply was:

***Respondent A:*** *"No, because everything is custom made, we negotiate and agree on everything together. There is no such thing as having a list with options from which the client can choose, we prefer to see each project as one of a kind with specific requirements and as previously mentioned individual approach".*

Company A extensively monitors changes in their clients' needs and it tries to do it more often nowadays. According to respondent A this is one of the most critical phases throughout the entire process, after the project execution itself. When asked what kind of methods are used at the moment to track changing client's needs respondent A replied:

***Respondent A:*** *"We have key account management, so we have one person who is in charge of keeping contact with the client, we have various databases with all the projects we have done and the challenges we have identified. At the moment we are looking for some kind of newsletter. That is really important for us".*

Based on the above responses and few additional questions, it becomes clear that modularity as such is not applied to the customer service offering. Company A does not have standard modules which can be mixed and matched to provide various services, but it rather uses modules which are different and cannot be reused or shared among other projects. Therefore, the interfaces between these modules are very specific, which results in a very tailor made customer service offering. However, in order to understand if Company A utilizes modularity in its service production process, questions regarding organizational structure, dynamic teaming and production process have been asked. First question was aimed to understanding where does Company A positioned in terms of its service production on the scale from one of a kind production to fully standardized production.

***Respondent A:*** *"If looking at the scale, I would say our service production mostly corresponds with one of a kind production. For example, when we start a project, we don't have standard modules which we use for all of the projects and then modify them slightly. Our service production process looks more like sitting down with the client, designing and formulating together the possible solution or outcome and then deciding what is the best way to achieve this outcome and in the very end we think about how should we present and deliver our final service to the client. As you can see there are a lot of steps that need to be performed but as the projects vary in terms of scope and problem the methodology concept needs to be different as well".*

Furthermore Company A does not use capabilities and services of external partners most of the work is done in-house. The very few services that are being outsourced are of secondary importance to the company and for example comprise of graphical and video design. Mostly the teams in which the projects are carried out are comprised on average of three people with different competencies and backgrounds. However, normally such teams work from the client's premises, therefore there are few occasions when different tasks are preformed from different locations. Respondent A has also expressed that technology is very important for the company and its business. Company A uses knowledge management systems and it almost daily looks for new tools and software that would help their business and their clients business. According to respondent A

importance of technology has definitely increased especially with the rise of internet technology.

Last but not least it was important to know if the strategy of company A has changed since 2006, has it moved towards more customization or servitization or vice versa. Respondent A concluded that customized approach has always been at the core of their business, therefore strategy as such has not changed. However, when asked if modularity is something that the company would be willing to utilize in the future for instance in its service production process, respondent A has replied as follows:

***Respondent A:*** "*No, status concepts and project methodology are more illustrative and better concepts for us."*

Overall, Company A is a strategy consultancy which adapts a rather customized approach to its service offering and production. Based on the interview responses, it is evident that customer needs and wishes are taken into conisation throughout the entire process, from the beginning to the very end of the project. As was stated by respondent A *"the aim is to have as close and deep contact with the client as possible. Our aim is to do one big project and stay in contact with smaller tasks and then do another bigger project when is needed"*. Comparison with the other two companies (B and C) and measurement scores would be described later in this chapter.

### *4.3.2 Results from Company B*

Company B specializes in management consulting. It is also a niche player with less than 50 employees, but it has been able to generate a very good reputation in the Finnish market. Its largest client is a big international company, for whom they have completed until now 33 projects. Company B's main focus areas of management consulting include the following : 1) concentrate on challenges of senior management 2) aim at delivering results not just reports 3) challenge status quo and inject new thinking 4) assist management in decision making though facts and insights 5) support organizations in implementation and 6) build organization capabilities. When asked about modularity company B has been by far the most knowledgeable out of the three companies that were interviewed. Respondent B defined modularity as a way to prepare a meal:

***Respondent B:*** *"We don't have products, we don't have ready answers, so nothing we do is sort of predefined completely. But of course the ingredients that we use are somewhat modular. So it is like preparing a meal, where you don't have the exact recipe that you eat every time but rather that you have certain ingredients that you mix and match to come up with a new dish"*

Company B provides five different types of services. First type is *strategy*, which means everything related to running the strategy process, supporting strategy work by doing for example additional analysis such strategic due diligence to support decisions on acquisitions. Second type is *sales and marketing*, which includes all the work done at the customer front, for example how to steer sales, how to allocate the marketing sourcing. Another type of services is *operations*, which means everything that is related to sourcing to production to supply chain and logistics. Fourth type is *finance and control* which is about how to manage the clients company, how to steer the company with numbers, providing performance measurement and even various incentives. Last but not least is *structure and organization* which simply means how the client company are structured. If looking at the sales by service area in 2001-2010 strong focus has been on finance and control mostly due to the background of the founding partners. However, recently company B has managed to have a well balanced portfolio of services.

According to respondent B even though they can list each project they have within any of these service areas, many projects include more than one of this service areas. The most typical case is integration or merger project where company B brings two companies together. The integration project includes in one way or another all of these

service elements (i.e. strategy, sales and marketing, operations, finance and control, structure and organization).

When talking about services, it was evident that company B uses some components from previous projects to find solution or provide customized service to different clients. It is able to re-use components that have been used or developed before for different projects and this creates an added value to the company and to the client.

***Respondent B****:" I would not call them standard. We try to use what has been done before, every good concept we have. We have applied concepts from one industry to another, which is adding a lot of value. For example, in Finland what we did in the paper industry, was the concept we developed on how to select right product customer combination for paper machine. The same concept was taken to mobile operator to select right clients and to create new products for mobile phones that allowed maximizing a cash flow. So, new concepts are kind of ingredients, yes we can put chilli into chocolate it is not too bad, it is actually quite good".*

If placed on the scale from standard to hybrid to customized services, the average of services that company B is offering to its clients would be hybrid. However, some projects by nature are more standard. For example if the company B decided to do a sourcing development project it would typically include a lot of similar elements despite of the industry, despite of the exact challenge or problem at hand. It would include standard steps such as defining the categories for spending, preparing a baseline for how much to spent money on each category, analysing how many vendors there are, which vendors are strategic , which are just in case etc. Therefore, some projects have 80% of standard content, while some projects have 20% of standard content. In general however, on average company B offers hybrid services. According to respondent B company B does not customize things that do not add value to customize. And it does not simplify things for the sake of simplifying things too much.

Looking at modularity from the organizational point of view, company B strongly believes in team work and that best results are achieved by working together. Therefore, it tries to find the right dynamics between working together and thinking independently. It does not optimize things in a way that somebody within a project is focusing only one task and only that task alone. Instead it tries to build its own assets, which means developing a lucrative package of capabilities for its employees. This also implies that employees can easily switch between tasks and perform multiple functions within the project.

In addition, company B has projects where a lot of people are involved from different parts of the world. And in order to facilitate a smooth execution of such projects it uses extensively various technologies especially video conferencing. Moreover, this consultancy uses external partners when it does not have the knowledge or competencies in certain areas. For example it has used advertising agencies and IT companies as external partners in a number of projects. Company B realises that by nature they are a rather small player and they cannot compete by having everything done in house. Therefore they prefer to utilize the best there are experts in different areas. When company B decides to use external partners it still remains the main contractor for the client. Furthermore, company B has outsourced a team of three people to India, who are providing business intelligence services. This team is comprised of local professionals, who are located in India and complete assignments in India.

When asked if customers are demanding greater variety nowadays respondent B has replied positively to this question. According to his observation and 15 years of experience in the consulting industry, it seems that in the earlier years more products or standardized services were sold. This was mainly because clients were not capable of buying something more complicated. It was easy to buy readymade products as clients could not define well what they were looking for and on the other hand consultants could not understand what the client would need. However, over the years this situation has improved. Consultancies have more variety to offer, there are lot of consultants that offer tailor made services, although there are still those that sell standardized service products. Also, clients have learned that there is a difference of buying readymade solutions and buying perfectly fitting solutions.

***Respondent B:*** "*Although not everybody is buying tailor made suite some and many people still do, just to make sure that it fits. So I think that variety has increased based on the supply but also based on the more intelligence in demand side".*

Compared to a couple of years ago, company B has definitely moved towards modularization. Respondent B mentioned that there has been a time when they were not using any of the old slides from any of the previous projects. Every time they would start a project from a clean slate. But with time, they realized that it was not reasonable and they started to utilize more information from finished projects. Company B has even built so called intellectual capital storage, which is a system where one can search for needed information in the database of finished projects. However, respondent B did highlight that:

***Respondent B:*** *"We will not go to the extreme where we always think that it is close enough, let's sell this".*

Therefore, company B has learned how to re-use information from its projects and store it in a database, where with the authorised access consultants can search for standard or specific information. Overall, when looking from the customer offering and production point of view, company B offers its clients customized service through the use of modularity. Company B has been able to use the same components to create variety of services by mixing and matching various ingredients but still keeping in mind customer needs and wants. By using modular blocks of various sizes that are connected by standard interface, company B has been able to achieve efficiency and provide good customer experience.

***Respondent B:*** "*If modularity becomes the only thing in your strategy, then you go too far, you become a product company. But if you don't have it at all you are missing in terms of efficiency. There must be some modularity. If I put my LEGO's on the table, although I have done different projects, still the LEGO pieces I have are not completely different from LEGO pieces of my colleague. We are still talking about the same components or ingredients".*

When looking at the customization aspect of services that company B offers, it is valid to say that customers have fairly a lot to say when it comes to what type of project they want. According to respondent B, they always try to create a project that includes the right things, such as appropriate scope, realistic staffing from company's side as well as clients. However, if there are some parts of the project that can be performed better and cheaper by other consultancies or other specialized firms, clients are always advised to use their services. Throughout the project client has the possibility to stop the whole project, and/or stop one stream of the project and/or re-scope the project. Company B does not try to maximize every project by adding a lot of things that do not bring value to the customer, but it is rather focused on creating a long lasting relationship with its client.

***Respondent B***: "*We were at our client's Christmas party where the CEO of the company has been congratulating his staff, that they have one year behind without consultants. And somebody raised hand and said that company B has been here and the CEO responded that company B is not a consultant".*

### *4.3.3 Results from Company C*

Company C is an international consulting company that specializes mainly in IT consulting. It has more then 400 000 employees across the globe and it has been very successful in offering high end technology consulting services to its clients. In addition to IT services, company C also offers business services, outsourcing services and trainings.

When asked about what type of services on average company C offers if looking on the scale from standard, to hybrid and to customized services, respondent C replied that as a consultancy there is always a level of customization in all of their offerings. However the level of customization can vary, therefore some projects are unique while others are standard. Unique projects within the organization are referred to as one of kind projects. Such projects normally involve company C research team joining a project as well as research team from the client's company. An example of one of a kind project that company C has performed is the development of the interface for the restaurant chain Amica. Amica has never been involved in such project and company C did not have off the shelf solutions to offer to its client but instead they created a joint system around it. A typical standard service that company C offers is benchmarking.

***Respondent C****: "I guess we would have 9 out of 10 standard and 1 out of 10, something that we created for the customer from scratch. So, let's say that in general maybe 60% of services that we offer have standard components and 40% have customized components".*

Normally client can modify or adjust his offering at two stages throughout the service offering process: at the sales and delivery stages. The sales stage means the stage where offering is being initiated and the delivery stage means how the final outcome of the offering is being presented and distributed to the client. Company C does not provide a list of features that the client can choose from as such, however it does provide additional options to its client where possible.

***Respondent C:*** *"If we do a proposal we might say ok, we will do this study in Sweden and Finland and then optionally we can also do it in Russia. And then in a way customer gets to decide eventually if he wants it to be done in Russia, so that is kind of additional list that is provided"*

According to respondent C technology has been gaining more importance in contributing to the development and offering of customer service. This is especially true for utilizing information management, analytics and optimization software to predict and model different types of data. According to respondent C previously a lot of people in the company C were relying on Excel or some rather basic tools and now people are using more profound tools and technology to support analysis. Company C also re-uses components or information from previous projects to support on-going projects. It never starts a project completely from scratch unless nothing similar has been done before. As respondent C highlighted:

***Respondent C:*** *"So, in a way this comes back to an idea of six LEGO bricks being re-used and 4 being created".*

This means that company C uses standard components as a base for all of its projects and then it adds different features to the project to make it meet various needs of the customer. Such modifications are normally done at the end of the service production process. When looking at modularity from the organizational level perspective, company C has a very extensive partner network. Even though it has a lot of staff in payroll, it uses partners for specific skills, those could be technical skills or it could be certain providers of specific services. Respondent C mentioned off-shoring and near-shoring as the two examples of such services.

***Respondent C:*** *"I think maybe most relevant to your question is our delivery model of not outsourcing but off-shoring and near-shoring. We have a very integrated delivery model which includes near-shoring from certain locations in Europe and then from off-shoring locations around the world. We call this "follow the sun" methodology where there is always some place open providing services".*

Company C is also extensively utilizes teams rather than individuals performing separate projects. Rotations across different functions are very common and are aimed to helping the employees develop a set of skills that can be utilized not only within the company but also in the future if the employee decides to move towards new challenges outside of the company. Therefore, in company C consultants can perform different tasks within the same project or the same task across different projects. According to respondent C, company C has been using modularity in its service offering and service production for quite some time therefore it is not a new phenomenon in its industry. However, respondent C did mention that in other service industries such as maintenance modularity is definitely a new way of thinking.

When looking at the customization aspect of service offerings and production that respondent C emphasised the importance of understanding and communicating with the client at the beginning and at the end of the project. After the completion of every project whether it is a standard or unique project consultants evaluate and review performance of the project and the satisfaction of the customer. These information is then stored in the databases as different types of report stories. In addition, when asked about the possible trend of offering more customized services now or in the future compared to couple of years ago, respondent C pointed out:

***Respondent C:*** *"I see that a trend could be visible in a sense that some element of the service should be standardized, but no there is no major shift in terms of the change of how much we customize and how much we don't".*

## 4.4 Summary of Results and Comparison

In the previous chapter interview results from the three case companies (A, B and C) have been presented and his chapter is focused on summarizing those results based on the scores obtained from the measurement criteria. Firstly scores on modularity and customization criteria will be presented by looking from the service offering perspective (Table 12) and later scores for modularity and customization will be presented by looking from the service production point of view (Table 13). Thorough description of the scale used to assign scores to the respondents' answers can be found in Appendix 2. After reviewing these scores, each case company would be placed within the framework developed by Bask et al. (2011) according to the level of customization and modularity in its service offering and service production. This would be discussed in more detail in Chapter 5.

Company A has scored the lowest on modularity compared to the other two consulting companies. The main reason for such low scores was the absence of modularity as such in the customer service offering. All the service offerings that company A makes are custom made. Therefore, the modules which are created are unique and tightly coupled making it very difficult for them to be re-used for multiple projects. Company B has scored the highest in terms of modularity. Company B uses standard components that can be easily mixed and matched to provide various solutions to its clients. It understands the benefits that modularity offers and it utilizes it extensively in its service offering. Clients can easily remove, add or re-design certain features though out the project. Company C has scored relatively high in terms of modularity in its service offerings as well. It utilizes both standard and customized modules to design its service offerings.

In terms of customization all three companies take clients' needs and wishes into consideration when offering their services. Company A and company B allow customers to make modifications at any point in time and there is always an on-going cooperation between the client and the consultant. Both company A and company B have high level of customization in their service offering. However, company C allows its clients to make modifications at certain points of the project and the communication between the two parties is at its most during those times. Therefore, company C has slightly less customization in its service offering. In addition, customer cannot fully modify their service by themselves, majority of modifications are done by the company.

Table 12. Results on modularity and customization from service offering perspective

| Measurement Criteria | Company A | Company B | Company C |
|---|---|---|---|
| **MODULARITY** | | | |
| M1 Customer service offering uses modularized design | 1 | 5 | 5 |
| M2 Customer service offering includes service modules which are independent from one another ( degree of coupling) | 1 | 5 | 5 |
| M3 Customer service offering comprises of the service modules that can be easily rearranged to suit the needs of the end user (mix and match) | 1 | 5 | 4 |
| M4 Service components in the customer service offering are linked by standard interfaces | 2 | 4 | 5 |
| **CUSTOMIZATION** | | | |
| C1 Customer can perform to a certain extent customization of the service offering. | 5 | 5 | 4 |
| C2 There is a continuous dialogue with the service provider and customer**.** | 5 | 5 | 4 |
| C3 Various options of service modules are offered to the end customer | 4 | 4 | 4 |
| C4 Continuous co-creation and co-design between the customer and service provider | 5 | 5 | 4 |

Looking from the service production point of view scores for modularity remained more or less the same for all the three consulting companies compared to the service offering perspective. Company A has low modularity in the service production because the production process is highly integrated and it is hard to see it as a subsystem of standard and customized components. Components in the production system cannot be easily re-arranged as they are governed by specific interfaces and all the process are carried out in-house. On the other hand company B and company C break down their production process into standard and customized sub processes. Boundaries can be easily defined between the service modules allowing for disintegration and performing of different modules in different locations and teams. External partners and outsourcing services are extensively utilized in the service development process. Such flexibility makes it possible to re-arrange and re-combine different components in the production process. Therefore, company B and company C both have high level of modularity in their service production process.

Level of customization has not changed much by looking at the scores from the service production perspective (Table 13). Company A produces mostly customized services therefore customized services form the biggest proportion of its service basket.

Customers can make changes to their service offering throughout the entire process and there is an on-going dialogue between the two parties. Customer satisfaction is very important to the company therefore it is constantly looking for new ways to be closer to their clients (e.g. distribution of newsletters). Company B shares the same customization characteristics as company A, however on average it produces hybrid services rather than customized. Despite producing hybrid services customer requests are still uniquely designed into the finished services. Last but not least company C has the least customization incorporated into its service production. Company C relies heavily on standardized processes therefore customization is possible only at the begging and at the end of the production process. Collaboration with the client is also limited to those two project phases. Moreover, as has been previously mentioned customized modules form smaller portion of the service offering, as majority is based on the standard modules. However, having said that, company C does produce services which are highly customized but those represent only 1 out of 10 projects.

Table 13. Results on modularity and customization from service production perspective

| Measurement Criteria | Company A | Company B | Company C |
|---|---|---|---|
| **MODULARITY** | | | |
| M1 There are easily identified boundaries between service modules within the production process | 1 | 5 | 5 |
| M2 Service production process can be broken down into standard sub processes and customized sub-processes | 1 | 5 | 5 |
| M3 Service production modules can be easily rearranged during the production process | 1 | 5 | 5 |
| M4 Service production is facilitated by the modularity of organization ( e.g. outsourcing) | 2 | 5 | 5 |
| **CUSTOMIZATION** | | | |
| C1 Customers can make modifications to their service offer quite late at the production process | 4 | 4 | 4 |
| C2 Customized services represent higher percentage of service basket | 5 | 4 | 3 |
| C3 During the service production process there is always a close collaboration between company and the end customer | 5 | 5 | 3 |
| C4 Customer requests are uniquely designed into the finished service | 5 | 5 | 5 |

Modularity helps companies combine rationality and cost saving by focusing on the needs of the individual customers. Services are standardized but in modules which can be combined individually by the single customer. Company becomes more systematized but still with a certain flexibility and decentralization. Overall it is valid to say that the service production process influences the service offering and vice versa. Having examined the three consulting companies it can be seen that if the company uses modularity in its service production process, then modularity is also visible to a certain extent in the customer service offering.

## 4.5 Main Findings and Discussion

According to the scores obtained from the measurement criteria on customization and modularity each of the participating companies will be now placed within revised framework. The objective is to see if the companies fall into one category within the revised framework or not. This would help us understand more the trends and strategies that consulting companies use and whether modularity is one of them or not.

Based on the responses received from the candidates and the measurement criteria scores, quite a clear distinction can be made between company A and the other two consultancies (company B and company C). Company A is a start-up company that specializes in strategy consulting. Company A does not offer standardized services or hybrid services, majority of services are purely customized services. This means that each service is comprised of specific modules which can't be easily rearranged to form various service offerings, but rather offer one of a kind solution. Therefore, all the projects that company A performs are unique and require individual approach. Customers can make modifications and adjustments to their offering throughout the entire project process and there is always a close collaboration between the client and the consultant. In addition customer can perform customization of their service offering by themselves as they are closely involved in the service creation. Therefore, when looking from the service offering and production points of view both contain a very high level of customization and none of modularization. Company A has always centred on offering customized services to its clients therefore it does not see modularity as a concept that it would be using in the future. Taking all the above into account company A falls into the non-modular customized quadrant in the framework in terms of service offering and service production ( Figure 14) and ( Figure 15).

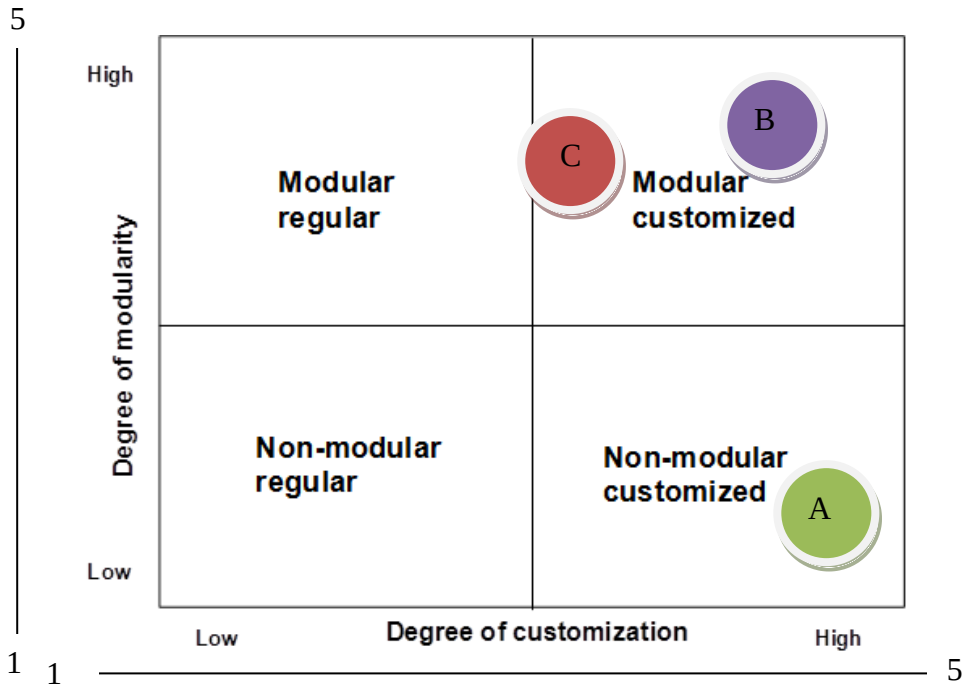


Figure 12. Companies placed within the revised framework form service offering perspective

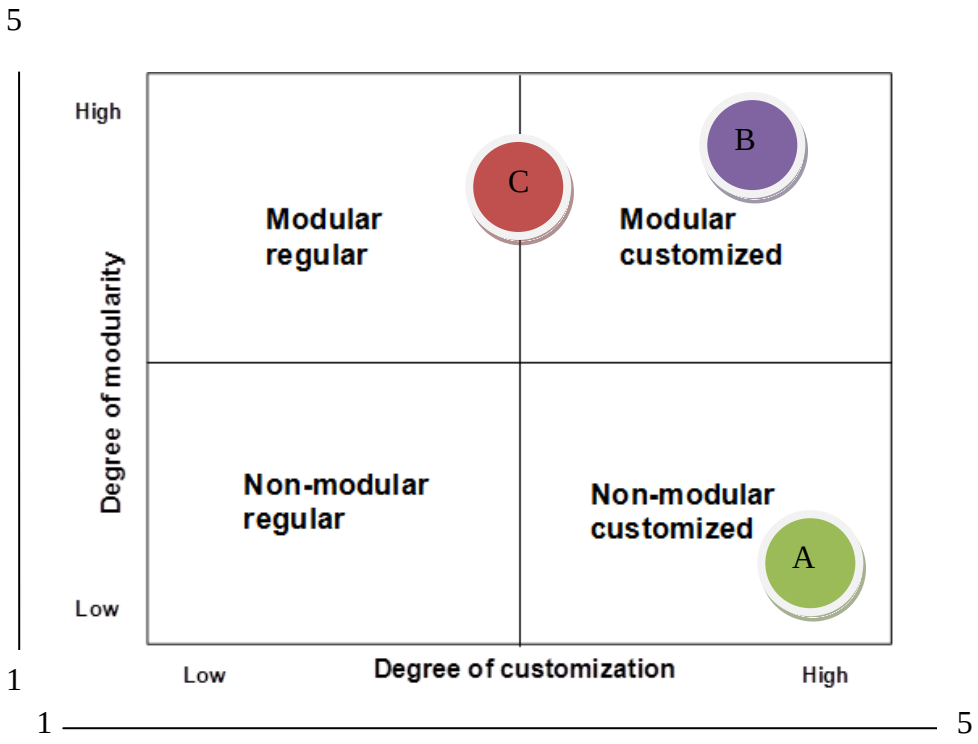


Figure 13. Companies placed within the revised framework form service production perspective

On the other hand company B and company C are familiar with modularity and use it to a certain extent in their service offering and service production process. Company B has been by far the most knowledgeable out of three companies about modularity. On average company B offers hybrid services which are comprised of both standard and customized elements, however it also offers occasionally services which are 80% customized or 80% standard. Over the years company B has moved towards modularization and learned to use components from previous projects to find alternative solutions and provide customized services to different clients. It has been able to create different outcomes by utilizing both standard and customized modules by mixing, switching or bundling them together. Customer is involved in the service production process from the very beginning and there is an on-going collaboration and co-creating between the two parties. Therefore company B has a high level of both customization and modularity in its service offering and service production and falls into the modular customized quadrant (Figure 14) and (Figure 15).

Last but not least company C has been also successful in utilizing modularity as part of its strategy. Company C adopts 60% of standard elements and 40% of customized elements in its customer service offering. It provides the possibility for customers to make changes to its offering but only at the beginning and end of the project. In addition, company C offers variety to its customers by offering options which can be incorporated into the standard processes. The only time when customer receives a completely customized service offering that is specific to its needs is when the project is one of a kind. Normally out of every 10 projects one is one of a kind. According to respondent C modularity is utilized to its fullest in the service production phase rather than offering, where the standard components form a base to which additional features are added in order to make service offering more customized. Overall, company C has relatively high level of modularity in the service production process and service offering and medium level of customization (as the customer is involved only at certain stages of the production process) in service production process and service offering. In the service production process, company C is even more skewed towards modular regular quadrant as the customer involvement in the service production is more restricted.

Neither of the interviewed companies falls into the non – modular regular quadrant. One explanation could be that it in consulting industry even if the company is selling a product, it would still be to some extent customized and not completely standard. For

example, pre and after sales service that is offered to the customers might vary depending on the product purchased and consultants' skills.

As can be seen all the three companies fall into different quadrants of the revised framework. According to the results such difference in the level of customization and modularity can be attributed to the companies coming from different areas of expertise. It appears that companies adapt different strategic approaches depending on the market conditions and their working environment. For instance, for strategic consultancies it makes more sense to incorporate a greater degree of customization and very little or none of modularity as majority of projects are very case specific. On the other hand in management consulting high level of customization and modularity results in a perfect match. It is fair to say that modularity is not used everywhere but is certainly a concept that has been utilized successfully by some consultancies. This by no means implies that modularity is the success factor and without it many companies are doomed to failure. It means that depending on your area of expertise and industry specifics modularity might be/not be the best solution.

Overall, if looking at the results obtained the measurement criterion for modularity and customization has been well defined and sub-questions helped to test the answers given by the respondents. Initially a scale from 1 – 3 has been used with detailed descriptions in three levels. However, this proved to be difficult to implement in practice, as there was no such clear distinction between the answers and it was hard to allocate responses based on only three options. Therefore, the scale has been re-defined to larger scale from 1-3 to 1-5, leaving the descriptions in three levels but giving more flexibility to move along the scale. This allowed to position companies more precisely in the revised framework along the measurement criteria.

## 4.6 Evolution of Strategies

As can be seen company A, company B and company C if compared to each other are positioned differently within the revised framework when looking from the service offering and service production point of view. One of the objectives of this study is to see if the strategies have changed over time and if there are certain strategies that companies wish to implement in several years. Out of the three respondents, only respondent B mentioned that their strategy has changed compared to couple of years ago. Company B has moved away from traditional customization strategy to offering and producing more modular and customized services. As has been stated before

company B has introduced modularity into its practices by utilizing standard components from previous projects and re-using and re-combining them to come up with new solutions. Customers are involved at an early stage of the project design until the project is successfully executed and even offered personalized after sales services. Company B is very successful with its current strategy and will continue offering and producing services based on the modular-customized strategy. Respondent A and respondent C replied that their strategy has not changed over the past few years and that there will not be any drastic changes occurring in the near future. However, both respondent A and respondent C highlighted that if looking at consulting industry in general they anticipate more companies to use modularity in their practices. The shift in strategy for company B is illustrated in Figure 14.

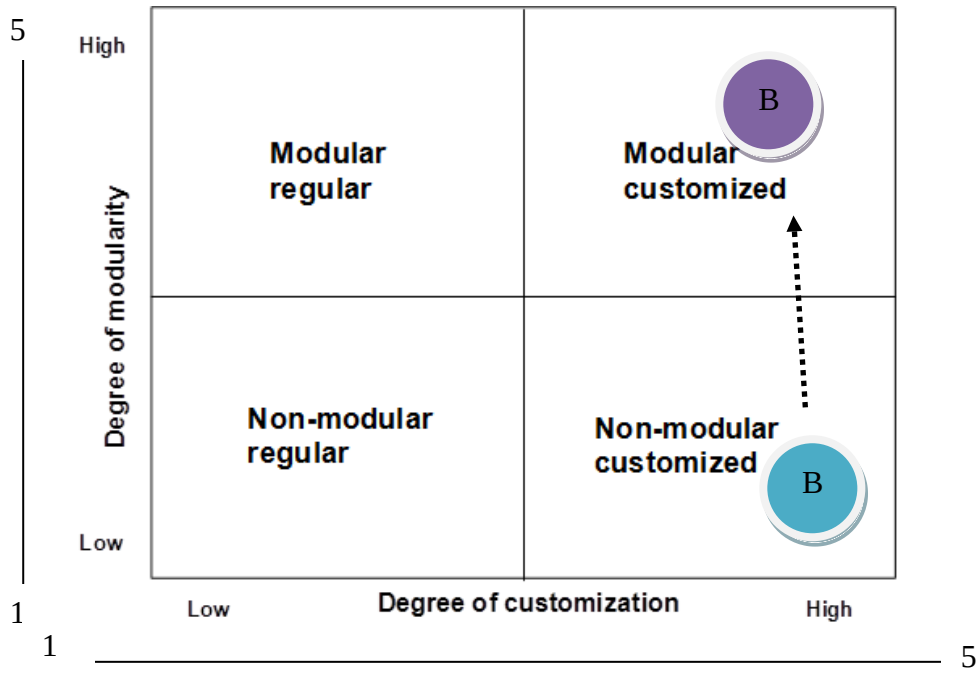


Figure 14. Evolution of *company B* service offering and service production strategy

Duray (2002) in her study discussed a progress path of how to move from one quadrant to the other along the modularity and mass customization dimensions of her framework. For instance, standard producers can move towards offering more customized services by involving customers in the later stages of their production process. On the other hand, customized producers can move towards offering more customized services by involving customer in the earlier stages of the production process. We can apply the same logic to the revised framework proposed in this study as the measurement criterion for customization and modularity is very similar to what Duray (2002) has used in her

study. For example if company A decides to move from the non-modular customized strategy to modular regular strategy it would have to incorporate both customer involvement and modularity in the end of its service offering and service production stages such as assembly, delivery and use stages. In modular-regular strategy modular components are introduced and used to provide wide range of choices to the customer. The same logic can be used for studying the evaluation from one strategy to another of any company.

# 5 CONCLUSION

The purpose of this study was to provide a more systematic point of analysis of modularity and customization in the pure service industry. This has been achieved by revising the framework for modularity and customization proposed by Bask et al. (2011) and incorporating measurement criteria for customization and modularity along with a proper measurement scale (1-5). A measurement criterion for modularity and customization was developed based on the existing qualitative and quantitative literature, while scale was used to position the companies within the revised framework according to low or high degree of modularity and customization.

Case study has been chosen as the principal research strategy for an empirical part. Three consulting companies from different areas within the consulting industry (IT consulting, Management Consulting and Strategy Consulting) were selected as case companies. Semi-structured interviews were used as the primary method to collect data and questions were pre-defined beforehand. Based on the responses provided by the company representatives, companies were evaluated along the measurement criteria and ranked on the scale from low to high. According to these results each of the companies were placed within the revised framework.

This study reveals that modularity is not a novice concept within the service industry. Two out of three companies were familiar with it and used it extensively in its service offering and production. According to the results position of the companies within the revised framework did not change significantly if looking from the service offering or service production perspective. Company A is placed into the non-modular quadrant of the framework, company B is placed into the modular-customized quadrant and company C is placed somewhere in between modular regular and modular-customized quadrants. Hence, each of the interviewed company is located in different quadrants within the framework which shows that despite being in the same service industry strategies differ. A possible explanation might be that in fact these three companies are representative of the specifics of their area of expertise within consulting industry. Therefore, based on the interview results and positioning within the revised framework a tendency towards mass customization and modularity can be seen in IT consulting and management consulting. In order to see if this is a valid argument to be generalized further empirical analysis and testing should be conducted with a larger sample of companies from these three different consulting backgrounds (IT, management and strategy).

## 5.1 Theoretical Contribution

Most of the research that has been done previously on customization or modularity focused on the manufacturing industry rather than service industry (Ulrich and Tung 1991; Bask et al., 2010; Schilling, 2000; Pine 1993; Duray et al., 2000; and Duray, 2002). This study on the other hand addresses modularity and customization in the context of pure services that are comprised not only of physical attributes but also organizational structures, human interactions and information flows between the parties involved in the service development and offering. Moreover, having revised the framework that was put forward by Bask et al. (2011) by developing and adding the measurement instrument with a well-defined scale allows the framework to be more integrated and cohesive. This in turn makes it more theoretically justified as it is no longer based solely on qualitative assumptions but also quantitative metrics and thorough literature review on modularity. Furthermore, such theoretical framework contributes greatly to various fields of research such as mass customization, modularity, service management and service operations management. Based on the results obtained it is fair to say that the revised framework is applicable in the service context and it can also be used in evaluating product producers such as manufacturing companies.

## 5.2 Managerial Implications

As has been previously mentioned the main outcome of this research is the revised framework on customization and modularity that has been applied within the service industry context. Companies can utilize such framework internally to evaluate their own strategy or/and benchmark against their competition in the market. Knowing the trends in the market and analysing itself internally through the above presented framework managers can identify areas for improvement. Moreover, having such tool in place helps to not only evaluate where the company is now but also where it wants to go. For instance, if the company is at the moment located in the modular regular quadrant and it wishes to move towards modular customized it would need to not only offer greater variety through pre-determined options but also incorporate customer requests into the design of the finished service. On the other hand if the company is located in a non-modular customized quadrant and it wants to take a giant leap towards modular-customized it would need to introduce standard and customized sub processes into its service production that would allow it to share components and come up with personalized solutions. In addition, this framework can be used to evaluate if the

strategy has changed or evolved over the past years. Company can do this by evaluating itself along the measurement criteria and storing the results in the database. After a period of time results can be compared and placed within the framework to see if any shifts have been taking place or not. Overall, this framework gives a pretty good overview of different strategies related to the degree of customization and modularity that can be appropriate for different types of business environments.

## 5.3 Limitations

This study is based on a thorough literature review of modularity and mass customization and it takes the first step towards providing results for measuring modularity and customization it the service industry context. However, there are a few limitations that can be identified and used as topics for future research.

This study is limited in scope. It is based on three case studies with three different consulting companies, which is not sufficient to generalize on the big scale. Therefore, it requires further testing and analysis by interviewing larger sample of companies from the same industry. Another challenge is related to semantics. Unfortunately only few managers in service industry use the language of modularity. Modularity still remains very much associated and identified with manufacturing and production industry. Therefore, there is a need to provide a thorough explanation and definition of modularity as a concept in service setting, in order to minimize the risk of misunderstanding and misinterpretation while conducting interviews.

This study does not claim that the best strategy for offering and developing consulting services is by means of modular customization (high degree of customization and high degree of modularity). On the contrary, modular customized strategy may not be an appropriate strategy for all service providers. Last but not least services differ in terms of characteristics and attributes from physical goods, which means that in services the modules may mix together or can be difficult to observe where the module ends and another one starts. This characteristic of services and service modules can bring extra challenges in identifying the exact elements involved in the service production and offering.

## 5.4 Suggestions for Further Research

In the previous subchapter limitations have been described, however they provide a good basis for further research suggestions. In order to validate the results of the revised framework it is necessary to conduct a more thorough study within the consulting industry. One of the arguments has been that strategies differ in terms of customization and modularity as a result of industry specifications. Therefore, it is crucial to interview larger sample of consulting companies from different consulting backgrounds (IT, management and strategy) to examine if this is actually the case or if the results have shown such distinction purely by chance. In addition, this study is merely qualitative by nature, therefore there is a need to conduct quantitative studies to support and test this framework further.

Furthermore, research based on single respondent as representative of *company A* or *company B* or *company C* is subject to the possibility that a given respondent provides skewed perspective on the subject under analysis. Multiple respondents from the same company can be compared to assess the degree of agreement and thereby evaluate the reliability of the single respondent.

Services can feature high or low human involvement. They can be information systems based or physically based, they may be B2B or B2C. This study contributes to only a small fraction of service industry which is based on the high human involvement and B2B service offerings. Therefore, it is important to conduct similar studies in other service industries in order to generate a deeper empirical understanding of different service architectures.

Furthermore, the framework proposed by Bask et al. (2011) has been revised by looking from both service offering and service production perspective. However in their initial study Bask et al. (2011) has identified a third perspective which is called service production network. Networks are essential part of any product or service organization and they can be as well either regular or customized in nature. Therefore, measurement criteria can be developed for measuring modularity and customization by looking from the service production network to give even more integrated point of analysis.

## 6 REFERENCES


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.

Baldwin, C.Y and Clark, K.B. (1999) "Design rules the power of modularity ", *Massachusetts Institute of Technology, 415p.*

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., Tinnilä, M and Rajahonka, M. (2010)" Matching service strategies, business models and modular business processes", *Business Process Management Journal,* Vol.16 No.1, pp. 153-180.

Bask, A., Lipponen, M., Rajahonka, M and Tinnilä, M. (2011) "Framework for modularity and customization: service perspective" *Journal of Business & Industrial Marketing,* Vol. 26, No. 5, pp. 306-319.

Berman. B. (2002) "Should your firm adopt a mass customization strategy" *Business Horizons*, July-August, pp. 51-60.

Da Silveira, G., Borenstein, D and Fogliatto, F.S. (2001) "Mass Customization: Literature review and research directions" *International Journal of Production Economics*, Vol. 72, pp. 1-13.

de Blok, C., Luijkx, K., Meijboom, B and Schlos, J. (2010) "Modular care and service packages for independently living elderly", *International Journal of Operations & Production Management,* Vol.30 No.1, pp. 75-9.

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., Miligan, G.W., and Berry, W. (2000) "Approaches to mass customization: configuration and empirical validation" *Journal of Operations Management*, Vol. 18, pp. 605-625.

Eisenhardt, K.M. (1989) "Building Theories from Case Study Research" *Academy of Management Review*, Vol. 14, No.4, pp. 532-550.

Eriksson, P. (1986) “Kysely ja haastatetelu – ohjeita empiirisen tutkimusaineiston hankinnosta aine – ja syventävien opintajen seminaarilaisille. Tampere: Tampereen yliopisto.

Feitzinger. E. and Hau L.Lee. (1997) “Mass customization at Hewlett-Packard: The Power of Postponement”, *Harvard Business Review*, January – February pp.116-121.

Fisher, M.., Ramadas, K., and Ulrich,K. (1999)“ Component sharing in the management of product variety: A study of automotive braking systems” *Journal of Management Science,* Vol.45, No.3, pp. 297-315.

Fixson, S.K. (2006) “Modularity and Commonality Research: Past Developments and Future Opportunities”, *MIT Sloan School of Management,* pp 1- 54.

Hirsjärvi, S., and Hurme, H. (2001) “ Tuutkimushaastattelu – Teemahastattelun teoria ja käyntö”. Helsinki: Yliopistopaino.

Hoogeweegen, M. R., Teunissen, W. J. M., Vervest, P. H. M., and Wagenaar, R. W. (1999) “Modular network design: Using information and communication technology to allocate production tasks in a virtual organization”, *Decision Sciences,* Vol. 30, No 4,pp. 1073-1103.

Galvin, P. (1999) “Product modularity, information structures and the diffusion of innovation” *Int. J. Technology Management,* Vol.17, No.5, pp. 467 – 479.

Lampel, J and Mintzberg, H. (1996) “Customizing Customization” *Sloan Management Review* pp. 21-30.

Langlois, R.N. and Robertson, P.L. (1992) “Networks and innovation in a modular system: Lessons from microcomputer and stereo component industries” *Research Policy,* Vol. 21, No. 4, pp. 297-313.

Lau, A. K.W., Yam, R. C.M., Tang. E. (2009) “The complementary of internal integration and product modularity: An empirical study of their interaction effect on competitive capabilities” *Journal of Engineering and Technology Management,* pp. 305-326.

Maister, D. (2004) “The Advance Business: Essential Tools and Models for Managing Consulting” Pearson Prentice Hall, 2004.

Marshall, M. (1996) “Oracle goes modular.” *Communications Week*”, 631, 1-1

McCutcheon, D.M., and Meredith, J.R. (1993) “Conducting case study research in operations management*” Journal of Operations Management,* Vol. 11, pp. 239-256.

Menor, L.J., and Roth, A.V. (2007) “New service development competence in retail banking: Construct development and measurement validation” *Journal of Operations Management,* Vol.25 No. 4, pp. 825-846.

Meyer, M.H. and Detore, A. (2001) “Perspective: creating a platform-based approach for developing new services” *Journal of Product Innovation Management,* Vol. 18, No.3, pp.188-204.

Mikkola, J. H., and Grassman,O. (2003) “ Managing modularity of product architectures: Towards an integrated theory”, *IEE Transactions on Engineering Management,* Vol.50 No.2, pp. 204-218.

Mikkola, J.H. (2006) “Capturing the degree of modularity embedded in product architectures” *Journal of Product Innovation Management,* Vol.23 No.2, pp.128-146.

Orton, J.D. and Weick, K.E. (1990) “Loosely coupled systems: a reconceptualization” *Academy of Management Review,* Vol.15, No.2, pp. 203-223.

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

Piller, F.T. and Stotko, C.M. (2002) “Mass customization: four approaches to deliver customized products and services with mass production efficiency” *Engineering Management Conference,* Vol. 2, pp. 773-778.

Pine, B.J.I. (1993) “Mass customization: the new frontier in business competition”, Boston Massachusetts, *Harvard Business School Press, 333p.*

Pine, J. (1993) “Mass customizing products and services” *Planning Review* Vol. 21 No.4, pp. 6-13.

Pine, J. and Gilmore, J. (1997) “The four faces of mass customization” *Harvard Business Review,* Vol.75 No.1, pp. 91-101.

Salvador. F, Forza.C, and Rungtusanatham. M. (2002) "Modularity, product variety, production volume, and component sourcing: theorizing beyond generic prescriptions" *Journal of Operations Management,* Vol. 20, pp. 549 – 575.

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

Sanchez, R. (1999) "Modular Architectures in the Marketing Process" *Journal of Marketing,* Vol. 63, pp. 92-111 (Special Issue).

Sanchez, R. and Sudharshan, D. (1996) "Real-time market research: Learning-by-doing in the development of new products" *Marketing Intelligence and Planning,* Vol.11, No. 7, pp. 29-38.

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

Schilling, M. A., & Steensma, H. K. (2001) "The use of modular organizational forms: An industry-level analysis", *Academy of Management Journal"* Vol. 44, No.6 ppt. 1149-1168.

Starr, M.K. (1965) "Modular production – a new concept" *Harvard Business Review,* (November – December) pp. 131-142.

Sundbo, J. (1994) "Modularization of service production and a thesis of convergence between service and manufacturing organizations" *Scandinavian Journal of Management,* Vol. 10, No.3, pp. 245-266.

Sundbo, J. (2002) "The Service Economy: Standardization or Customization?" *The Service Industries Journal,* Vol.22, No.4, pp. 93-116.

Tu Q, Vonderembse M.A., Ragu-Nathan T.S., 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.

Ulrich, K and Tung, K. (1991) "Fundamentals of product modularity" Issues in Design Manufacturing/Integration, Vol. 39, pp. 73-77.

Ulrich, K.T. and Ellison, D. (1999) "Holistic customer requirements and the design-selected decision" *Journal of Management Science,* Vol. 45, No.5, pp. 641-658.

Ulrich, K.T. (1995) “The role of product architecture in the manufacturing firm”, *Research Policy,* Vol. 24, ppt. 419-440.

Ulrich, K.T. and Pearson, S. (1998) “Assessing the Importance of Design through Product Archeology” *Management Science*, Vol. 44, No. 3, pp. 352-369.

Van Der Aa, W. and Elfring, T. (2005) “ Realizing innovation in services” *Scandinavian Journal of Management,* Vol. 18, No. 2, pp. 155-171.

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.

Vuorela, S. ( 2005) “ Haastattelumenetelmä” Tamperen yliopisto.

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

Voss, C.A., Tsikriktsis, N. and Frohlich, M. (2002) “Case research in operations management” *International Journal of Operations & Production Management,* Vol. 22, No. 2, pp. 195-219.

Wengraf, T. (2001) “Qualitative Research Interviewing: Biographic narrative and semi-structured method” London, *SAGE Publications Ltd, 399p.*

Wilkinson, A., Dainty, A., and Neely., A.(2009) “Changing times and changing timescale: the servitization of manufacturing” *International Journal of Operations and Production Management,* Vol.29, No .5, pp. 1-6.

### Other Sources

Selve UK , www.selve.co.uk *retrieved on 15.04.2011*

Nike, www.store.nike.com retrieved *on 16.04.2011*

Left Foot, www.leftshoecompany.com/home *retrieved on 6.06.2011*

### Interviews

Company A, CEO, Helsinki, *15.08.2011*

Company B, Managing Partner, Helsinki, 24.08.2011

Company C, Business Strategy Consulting Team Leader, *8.9.2011*

## APPENDIX 1

### STRUCTURED INTERVIEW

#### **PART ONE**: DEMOGRAPHIC INFORMATION

***INSTRUCTIONS:*** Please provide the demographic information requested below on you and your company.

Name: _____

Company: _____

Title: _____

What is the primary business unit of your company?

_____

This questionnaire will ask you about the "business unit" with which you are most familiar. This may be entire company, a division, or some other business unit. Please give the name of the business unit for which you will be responding and its primary business:

_____

Please indicate the size of your company in terms of Revenue and number of Employees:

Revenue: _____<5m ____5-49m ____50-499m ___>500m Other_____

Number of Employees: ____<50 ___50-499 ___500-4999 ___>5000 Other_____

How long have you been with this business unit? _____

With this company? _____

**Understanding of concepts:**

***Modularity*** - the degree to which the components of the system can be separated and recombined to create variety of configuration without losing its functionality

***Customization*** - identifying the point of customer involvement. The deeper the customer involvement goes in the production cycle, the higher the degree of customization

## **PART TWO**: SERVICE CUSTOMIZATION AND MODULARITY

***INSTRUCTIONS:*** The following questions are about your business unit's/company's service offerings. This section is aimed at understanding the service offering from the **customer's point of view.** Please be prepared to provide examples.

1. What service products do you offer?
    - Do you offer standard services? If yes, how many?
    - Do you offer unique services? If yes how many?
    - Do you offer services that have both standard and customized components? If yes, how many and what do they look like? For instance, do they have more customized or standardized components?
2. To what extent does the level of pre and after sale services influence your customers in their decision to buy or continue using your services?
3. To what extent can your customers dictate the prices, conditions and features of your business units/company's service products?
4. Is competition in your industry based totally on product differentiation, totally on price competition or is it somewhere in between?
5. To what extent customer's specifications are used to alter the service package? What parts of the package are standard for everyone and which are customer specific?
6. Do you have products which are standard and do not vary according to customer needs?
7. How important is technology for delivering customized products?
    - Do you use standard systems, which are accessible to everybody?
    - Do you use systems which are very specific and few people can use?
    - Do you have standard interfaces between various systems that allows for easy integration?
8. Do you believe your business units/company's customers are demanding more variety or customization today than they did before? Why or why not? If so, how far do you think this trend will go?

## **PART THREE**: PROCESSES AND ORGANIZATION

***INSTRUCTIONS:*** The questions below are about your company's processes and organization. These questions ask you to indicate how your services are **developed and produced**. Please be prepared to provide examples.

1. Where does your business units/company's production process lie on the scale between one-of-a-kind production (where each final product is different from the next) and fully standardized mass production?

    - Do you have standard sub processes which serve as a base for all services production?
    - These sub processes are independent from one another and can be completed separately?
    - Do you have customized sub processes which are incorporated in the service development process based on the customer needs?
    - These sub process are independent from one another and can be completed separately?

2. How much more production flexibility (meaning the ability to change quickly between products, add/remove features, modify products) exists in your production?

    - Customers can make adjustments to the service from the very beginning or production process allows for customers to make modifications only at the later stages of production process?

3. If your business unit/company is providing more product variety and customization today, how is it being done?

4. If you are providing more variety and customization how has your business units/company's organization (outsourcing activities, partnerships, supplier relationships) is structured to provide such variety?

5. Teams within your business unit/company can be easily re-organized in response to service/process changes?

## APPENDIX 2

Table 15. Scale and measurement criteria for modularity from service offering perspective

| Scale | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **M1: Customer service offering uses modularized design** | Final service that is offered to the client is comprised of purely customized components. The service is tailor made and its components cannot be re-used for other service designs. | Final service that is offered to the client is comprised of modular components to some extend that can be used for other service designs but their presence is rather limited. | | The final service that is offered to the client is comprised of modular blocks and components that can be re-used for other service designs. | |
| **M2: Customer service offering includes service modules which are independent from one another ( degree of coupling)** | Service modules cannot be easily separated they are tightly coupled, preventing from making drastic changes to the service design. | Some service modules are loosely coupled allowing for slight modifications to be created to the system. | | Service modules are loosely couples resulting in a rather independent blocks which can be adjusted and performed in different locations. | |
| **M3: Customer service offering comprises of the service modules that can be easily rearranged to suit the needs of the end user (mix and match)** | Service modules within the service offering cannot be easily re-arranged. Each service offering has a predetermined set of service modules, which results in a very standard service package. | Service modules within the service offering can be re-arranged to some extent which limits the service offering to several predetermined choices | | Service modules within the service offering can be easily re-arranged to form various sets of service offerings that can be modified according to the customer requirements. Provides potential for large number of service variations. | |
| **M4: Service components in the customer service offering are linked by standard interfaces** | The interfaces between service components within the service offering are specific to each service module meaning that service components cannot be easily replaced leaving the service offering as one off rigid solution. | The interfaces are somewhat standard. Some components are standard and are linked by standard interfaces allowing to some flexibility with the service design. | | The interfaces between service modules are standard so that one service modules can be easily replaced by the other. | |

Table 16. Scale and measurement criteria for customization from service offering perspective

| Scale | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **C1: Customer can perform to a certain extent customization of the service offering.** | Closed customization. Only business unit can performs all service customization if there are any. | Semi-open customization. Customer can make certain changes by itself, but still majority of customization is performed by business unit. | | Open customization. Customer can perform any and all customization that can be performed in the service offering. | |
| **C2: There is a continuous dialogue with the service provider and customer** | Service provider and customer do not interact throughout the process, only at the point of sale and delivery. | Service provider and customer interact at the point of sale and delivery as well as occasionally throughout the process. | | Service provider and customer have an ongoing relationship where they meet each other on regular basis and follow up the process. | |
| **C3: Various options of service modules are offered to the end customer** | Service provider offers one or two options to the client. | Service provider offers more than five different options to choose from. | | Service provider offers extensive range of options for the customer depending on his need. | |
| **C4: Continuous co-creation and co-design between the customer and service provider** | Customer is involved only at the latest stage of service design. | Customer is involved at later stages of service design and can add or remove features at that point. | | Customer is involved in the design of the service from the very beginning and it resembles a close cooperation between the two parties. | |

Table 17. Scale and measurement criteria for modularity from service production perspective

| Scale | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **M1: Service production process can be adjusted by adding new process modules** | Service production process does not allow addition of new process modules, it is very standardized. | Service production process can be adjusted to some extent, but closer to the end of the production process. | | Service production process can be adjusted by adding new models throughout the whole production process. One of a kind production. | |
| **M2: Service production process can be broken down into standard sub processes and customized sub processes** | Each service is produced in a unique way therefore it cannot be broken down into standard sub processes; each sub process is one of a kind. | Service production involves some kind of standard sub process, normally those are non-strategic. | | Service production can be broken down to standard sub processes. Those modules can represent small or big blocks. | |
| **M3: Service production modules can be easily rearranged so that customization of sub processes can occur at any stage of production** | Service production modules cannot be easily rearranged, as the development follows a pre-defined sequence. | Service production modules can be re-arranged but only at the later stage of production. | | Service production modules can be re-arranged during any stage of production. | |
| **M4: Service production is facilitated by the modularity of the organization (the company is a modular organization, e.g. outsourcing, etc.)** | Company organization is not modular, all the process are executed in-house and in pre-defined teams in one location. | Company organization is to some extend modular, it uses third party services. | | Company organization is modular, it extensively uses outsourcing and virtual teams. | |

Table 18. Scale and measurement criteria for customization from service production perspective

| Scale | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **C1: Customers can make modifications to their service offer quite late at the production process** | Customers can't make modifications to their service offer. It would be considered as a separate project. | Customers can make modifications to their offer but to a certain extent( taking into account budget constraints and resources) | | Customers can make modifications quite late at the production process. | |
| **C2: Customized services represent higher percentage of service basket** | Standard services represent higher portion of the basket | Hybrid services represent highest portion of the basket | | Customize services represent highest portion of the basket | |
| **C3: During the service production process there is always a close collaboration between company and the end customer** | There is little collaboration between the service provider and client during the production process | There is cooperation between service provider and client but only at certain points of the production process | | There is an ongoing cooperation and collaboration between the service provider and client in the production process. | |
| **C4: Customer requests are uniquely designed into the finished service** | Customer requests are not taken into account when offering final service. Standard services are offered to everyone. | Customer requests are taken into account when offering final service but limited to certain pre-determined choices. | | Customer requests are taken into account when offering the service to 100%, there is no standard package for everyone. | |

## APPENDIX 3

**Table 1. Characteristics of Modular and Integral Product Architectures[a]**

| | Modular Product Architecture | Integral Product Architecture |
|---|---|---|
| Design Criteria | Commonality sharing | Maximum performance |
| Component Boundaries | Easy identification | Difficult identification |
| Redesign to Architecture | Without modification | With modification |
| Interfaces | Decoupled | Coupled |
| Outcome | Economies of scale | Craftsmanship |
| Product Variants | High | Low |
| Nature of Components | Standardized/generic | Unique/dedicated |
| Component Outsourcing | Easy | Difficult |
| Learning | Localized/Dispersed | Interactive |
| Synergistic Specificity | Low | High |
| Component Substitutability | High | Low |
| Component Recombinability | High | Low |
| Component Separability | High | Low |
| Nature of Innovation | Autonomous | Systemic |
| System Design Strategy | Decomposition | Integration |

[a]Adapted from Baldwin and Clark (1997), Chesbrough and Kusunoki (2001), Christensen and Rosenbloom (1995), Fine (1998), Garud and Kumaraswamy (1993, 1995), Henderson and Clark (1990), Hsuan (1999), Langlois and Robertson (1992), Muffatto (1999), Orton and Weick (1990), Pine (1993), Sanchez and Mahoney (1996), Sanderson and Uzumeri (1997), Schilling (2000), Tassey (2000), Ulrich (1995), Ulrich and Eppinger (1995).

Figure 19. Characteristics of modular and integral product architectures (Mikkola, 2006)

## APPENDIX 4

| Code names | Measurement items |
|---|---|
| *Product modularity (PM)* | |
| PM1 | Our products use modularized design |
| PM2 | Our products share common modules |
| PM3 | Our product features are designed around a standard base unit |
| PM4 | Product modules can be reassembled into different forms |
| PM5 | Product feature modules can be added to a standard base unit |
| *Process modularity (PRM)* | |
| PRM1 | Our production process is designed as adjustable modules |
| PRM2 | Our production process can be adjusted by adding new process modules |
| PRM3 | Production process modules can be adjusted for changing production needs |
| PRM4 | Our production process can be broken down into *standard sub-processes* that produce standard base units and *customization sub-processes* that further customize the base units |
| PRM5 | Production process modules can be re-arranged so that *customization sub-processes* occur last |
| *Dynamic teaming (DT)* | |
| DT1 | Production teams that can be re-organized are used in our plant |
| DT2 | Production teams can be re-organized in response to product/process changes |
| DT3 | Production teams can be re-assigned to different production tasks |
| DT4 | Production team members can be re-assigned to different teams |
| DT5 | Production team members are capable of working on different teams |

**Source:** Tu *et al.* (2004)

**Table AIII.**
Modularity-based manufacturing practices

Figure 20. Modularity-based manufacturing practices (Tu et al., 2004)