Mass customization as a solution for the Service Industry

A case study of mass customization for service organizations

UNIVERSITY OF TWENTE
School of Management and Governance

Author:
Maarten ter Harmsel
s1054465

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Supervisors:
dr. A.B.J.M. Wijnhoven University of Twente
dr. J. Veldman University of Twente

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Work title:	Mass customization as a solution for the Service Industry: *A case study of mass customization for service organizations.*
Name student:	Maarten (C.M.) ter Harmsel T: 06 - 17246328 E: c.m.terharmsel@student.utwente.nl
Student number:	1054465
Study:	Business Administration
Track:	Service Management
Faculty:	School of Management and Governance
University:	Universiteit Twente Postbus 217, 7500 AE Enschede I: www.utwente.nl / E: info@utwente.nl
1e supervisor UT:	Dr. A.B.J.M. Wijnhoven T: 053 - 489 3853 E: a.b.j.m.wijnhoven@utwente.nl
2e supervisor UT:	Dr. J. Veldman T: 053 - 489 5532/3480 E: j.veldman@utwente.nl
City:	Enschede/Rijssen
Date:	10 May 2012

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Preface

This thesis is the conclusion of the Master Business Administration I started in February 2010 at the University of Twente (UT). After finishing my bachelor in Economics and Law at the University of Utrecht I was looking for a more business-oriented specialization. By choosing the Service Management track at the University of Twente, in line with my preference for a career in service-oriented firms, I developed my knowledge and experience of the service industry by specific courses and in the end this master thesis.

This thesis would not have been possible without the support of my supervisors, dr. Fons Wijnhoven and dr. Jasper Veldman. They provided me with helpful subject-specific input and have assisted me patiently during this long process in times when my motivation dropped to a low level.

At last, but not least, my gratitude goes to all people that have contributed to this thesis in any way. Especially to my parents and my girlfriend, who supported me continuously during this exciting journey.

Abstract

This research integrates insights from the dominantly goods focused literature on mass customization with the increased importance of the service industry by fulfilling the need for a more systematic approach in the analysis of mass customization in a service setting. Over the last few years, limited research is conducted on mass customization applied to the service industry. We present a revised framework based on the work of Bask, Lipponen, Rajahonka & Tinnilä (2011), which allows for measuring mass customization on service offerings. Modularity and mass customization are presented as independent variables, based on an in-depth literature analysis and a case study analysis.

Results of this study show that this framework is suitable for the service industry setting. Different service offerings, being a service process at a bank, Software as a Service (SaaS) and the configuration of cars (Citroën DS-series) are scaled successfully along the developed revised 5x5 framework. By re-scaling the framework of Bask et al. (2011), this research diminishes the existing research gap of mass customized services, since the framework is no longer based solely on qualitative assumptions but also on quantitative variables. For managers this framework is a rather helpful tool to evaluate the strategic use of mass customization in offering their services to customers, and gives them great insights in the mass customization capability of their organization.

This research has a limited scope, since is focuses only on the service offerings perspective and the results are based on three case studies. Future research should therefore concentrate on the validation of the results we found for the revised framework, by expanding the sample of service offerings.

Keywords

customer co-design, mass customization, mass customized services, modularity, service industry, service offering

1. INTRODUCTION

This chapter introduces the reader to the basic terminology and concept of mass customization. A problem description and purpose section is provided, and the main scope of this research is translated into different research questions.

1.1 Background

The adage of Henry Ford does no longer apply anymore. Remember his famous statement: "*you can have any color car you want as long as it's black*" which is related to the start of the industrialization era in the twentieth century when Henry Ford and others transformed the system of craftsmanship into the system of mass production by a new way of producing goods. It was characterized by the smooth-running flow and operational efficiency of the assembly line, specialized machinery and worker tasks, which creates great economies of scale through standardized cars (B. J. Pine, 1993). Today however, this is no longer applicable to the automobile industry. Pine (1993, p. 7) introduces us to a "new frontier in business competition. In this frontier, a wealth of variety and customization is available to consumers and businesses through the flexibility and responsiveness of companies practicing this new system of management."

This new frontier is *mass customization*. "Within the manufacturing world, mass customization is about producing highly configured products with the efficiency of a mass-produced product" (Gardner, 2009, p. 3). Mass customization creates opportunities for organizations when they are able to produce affordable and reliable output (supply) which corresponds to the increasing demand for customized products of consumers that exactly fits to their specific needs (Papathanassiou, 2004). That tendency to increased individualization of demand results in a growing number of product variations, supported by flexible and agile production systems according to Piller and Kumar (2006a).

Hence, mass customization creates both benefits for customers and organizations. The possibility of creating modular components results in flexibility and variety for customers. Mass customization therefore can be characterized as a production system with a high degree of customer interaction. The need for this is summarized by McCarthy (2004) who gives five competitive factors that determines why a mass customization strategy should be adopted by an organization:

1. Customers and their expectations have shifted from a broad base of uniformity and sameness to a network of niche and heterogeneous market requirements;
2. Fashions and customer preferences shift literally overnight, and product life cycles have become significantly shorter;
3. Assemble to order and the construction of product families are strategies that offer options and differentiation, whilst maintaining performance in terms of cost, quality and delivery;
4. Understanding and satisfying specific customer expectations enables a company to achieve a better strategic fit with customers' long-term needs;
5. The ability to forecast and understand market opportunities is increased from the improved and frequent communication with customers.

These five factors explain that customer interaction is advantageous for organizations, since they collect information which improves the knowledge base of the organization (Pine II, Peppers, & Rogers, 1995).

Because mass customization has its origin in the manufacturing domain (producers creating and selling tangible goods), this domain dominates the research landscape on mass customization. Piller and Tseng (2010) mention this as the existence of a *research gap* in the existing base of literature on mass customization for the service industry. This is also described by the above-mentioned five competitive factors, where the word 'product' is used frequently and the word 'service' is completely absent. However, adopting a mass customization strategy could be also highly relevant for organizations in the service industry, according to Piller and Tseng (2010). Other authors also mention this need:

- The importance of the service industry is increasing over the years. The world has become a service economy, in which the contribution of the service industry to the economy is larger than the manufacturing industry (Metters & Marucheck, 2007). Based on the idea that virtually all economies are producing and exchanging more services than goods, increased attention is given to research that explains the distinguishing characteristics of services relative to manufactured goods (Vargo & Lusch, 2008).

- Research (De Koning, Does, & Bisgaard, 2008) shows that it makes sense for competing organizations in the service industry to improve their operational efficiency and effectiveness. This includes for instance quality improvement, cycle time reduction, productivity improvement, waste reduction, and the elimination of rework (De Koning, et al., 2008). Adopting a mass customization strategy can be seen as a specific method for these improvements in the service industry. Also Piller (2004) described the value of this flexible manufacturing technology for efficient production of products with a high grade of variety.

- Service organizations need to eliminate their operational inefficiencies to avoid competitive disadvantages and to stay in business (de Mast, 2006).

Mass customization is presented by this research as a means to achieve a competitive advantage for service organizations. Contributing to the research gap of mass customization for services, this research presents a framework that combines modularity and mass customization for the service industry. Next, we present a specific section on the research scope (1.2), we formulate the research questions (1.3) and the research purpose (1.4). In section 1.5 we elaborate on the context-specific research definitions, whereas in section 1.6 the research design is defined.

1.2 Research scope

Mass customization is often presented as a production method that is cost minimizing in combination with a high grade of customization for individual customers. According to Pine (1993) the best way of creating a wide range in product or service variances is producing modular components. Customization and modularization therefore seem to be closely related to each other. In this thesis we use the framework developed by Bask et al., (2011) which relates modularity and customization and shows the different stages of both variables. This

research explores their framework, and fulfills the need of an empirical-based framework that measures both modularity and customization for the service industry.

The framework is useful for service organizations and individual services considering that it is a critical measurement tool for the level of efficiently meeting the diversity of customer requests. Salvador, de Holan and Piller (2009) confirm this usefulness by emphasizing that an organization should not only adopt mass customization as a strategy for the efficient utilization of its operations, but rather the synchronization of all its organizational aspects along its customers' needs.

1.3 Research questions

In order to explore the framework of Bask et al. (2011) for mass customization in the service industry and elaborate on it, the main research question is formulated as following:

➔ *How can mass customization be analyzed in the service industry?*

As stated above, the main question does not give an answer on how service organizations can adopt mass customization, but to what extent they (can) apply mass customization.

This research question raises three sub-questions:

1) What are the main challenges for the successful application of mass customization at service organizations?

   In order to define the challenges of mass customization for service organizations, the literature is reviewed. This review will give an insight on the most important obstacles of mass customization for service organizations in general.

2) What is an effective framework to analyze the degree of mass customization for service organizations?

   From the literature, the framework of Bask et al. (2011) is elaborated in order to exploit the value of mass customization for service firms. This framework enables us to rate individual mass customized services on the degree of modularity and customization.

3) What is the result of implementing this revised framework?

   Case study analysis will be conducted to demonstrate that the presented framework is applicable for individual firms in the service industry. This research is limited to the implications of mass customization for the organization itself. Development of this framework gives service firms in general the possibility to respond to individual customer needs.

1.4 Research purpose

Because customers demand services that meet their increasingly diverse needs *mass customization* has been proposed as a solution to this challenge (Heiskala, Paloheimo, & Tiihonen, 2005). This research concludes on the successful implementation of mass

customization at service organizations by presenting an evaluation framework that guides these organizations in the right direction, whether their service offering matches customer needs (being heterogeneous) with modular, customized service offerings at mass production efficiency.
Next to this purpose, the developed framework can be used for future research on the relatively unexplored field of service mass customization, as indicated by Piller and Tseng (2010).

1.5 Research definitions

Because of the focus on services (rather than products) we present this relatively big section on the main research definitions. It gives great insight into the differences between the service and manufacturing industry, and shows the importance of a well defined definition of the word *service(s)*. Besides that, we give a description about customers being the most essential driver in service management.

1.5.1 Service organizations versus manufacturing organizations

De Mast (2006) describes three important differences between a manufacturing and service organization:

(1) Products in manufacturing organizations are highly *tangible*; services and especially the service delivery process are less so;
(2) Related to this, production flows are *transparent* in manufacturing and less transparent in services. The same holds for problems and irregularities;
(3) Finally, the customer is much less involved in the production process in the manufacturing domain than in services. The *interaction* with the customer determines the quality of the service.

These differences between service and manufacturing organizations causes us to spend attention to the discussion about how *tangibility*, *transparency*, and *interaction* should be measured. Despite of these differences, it still remains unclear how actually a service could be defined. As presented above, it is almost evident that service organizations are mainly producing intangible products and have more interaction with its customers relative to manufacturing organizations that are producing feasible products and have less customer contact (Reid, Luxton, & Mavondo, 2005). However, this does not alter the fact that some services can be seen as a product (e.g., a good) produced by service organizations (e.g., a credit card provided by a bank). This shows that it is difficult to apply the above mentioned differences. How can these differences in terminology be explained? For answering that question, better understanding of the word ‘service(s)’ is required.

1.5.2 Service(s)

The most obvious explanation is that there are two perspectives distinguished for the word service(s). On the one hand services can be seen as *products*, that includes both tangible goods and intangible services as units of output. Vargo and Lusch (2004) call this the goods-dominant (G-D) logic. On the other hand service is described as a *process*, which is the service-dominant (S-D) logic (Vargo & Lusch, 2004).

"The essence of G-D logic is that economic exchange is fundamentally concerned with units of output that are embedded with value during the manufacturing process. G-D logic uses principles developed to manage goods production for managing services production and delivery" (Vargo & Lusch, 2008, p. 255). This explains the difference between the G-D logic and the S-D logic, since the first "sees services as units of output, and the S-D logic sees services as a process – the application of competences (knowledge and skills) for the benefit of another party" (Vargo & Lusch, 2008, p. 256). This is in line with the definition of Kotler (1988, p. 477), who defined a service as "any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything."

For this research, the definition of a service is taken from the S-D logic mindset that sees *service as a process* in which "the locus of value creation moves from the producer to a collaborative process of co-creation between parties" (Vargo & Lusch, 2008, p. 256). The S-D logic is identified as an appropriate philosophical foundation for the development of service science (Maglio, Vargo, Caswell, & Spohrer, 2009) and using it as an organizational framework gives evidence for service organizations being service-providers. Therefore, *service* is defined as "the application of specialized competences (knowledge and skills), through deeds, processes, and performances for the benefit of another entity or the entity itself" (Lusch & Vargo, 2006, p. 283).

Hence, customer value in services is created by all the involved parties through intangible, dynamic resources that are capable of creating value through collaboration. "In S-D logic, goods are still important; however, service is superordinate" (Vargo & Lusch, 2008, p. 256). This means that customer orientation should be in the heart of any organization in the service industry. The characteristics of service management emphasizes this statement in the next section.

1.5.3 Service management

Gummesson (1994, p. 78) describes service management by presenting the service paradigm, being "an interest in the customer and the customer's interaction with the provider's personnel in delivering the service and creating value." The customer is an important actor, since "the customer is a partner and value creation is a balance between human input and technology, between cost and revenue, and between customer perceived quality and productivity. Process thinking is in the core of service delivery" (Gummesson, 1994, p. 78).

Grönroos (1994, p. 5) describes service management as "more a perspective than one discipline or one coherent area of its own. It is a perspective that gives firms that face service competition, i.e. that have to understand and manage service elements in their customer relationships in order to achieve a sustainable competitive advantage, more or less similar guidelines to the development of such separate areas as management, marketing, operations, organizational theory and human resources management as well as quality management including service quality management and Total Quality Management." Grönroos (1994) presents different definitions of service management, of which the definition of Albrecht represents a perfect description that includes the importance of customers in the service management perspective:

> *"Service management is a total organizational approach that makes quality of service, as perceived by the customer, the number one driving force for the operations of the business"* (Albrecht, 1988, p. 20).

This customer perspective proves the relevance of service management for service organizations and the interactive process that was described by the S-D logic. The essence of the service management perspective is summarized by Grönroos (1994), who defines five key areas:

(1) It is an *overall management perspective* which should guide decisions in all areas of management (not only provide management principles for a separate function such as customer service);
(2) It can be seen as *customer driven* or market driven (not driven by internal efficiency criteria);
(3) It is a *holistic perspective* which emphasizes the importance of intra-organizational, cross-functional collaboration (not specialization and the division of labor);
(4) It takes the *management of quality as an integral part* of service management (not a separate issue);
(5) It gives importance to the *internal development* of the personnel and reinforcement of its commitment to company goals and strategies are strategic prerequisites for success (not only administrative tasks).

These five characteristics make clear that focusing solely on economies of scale and cost reduction as guiding management principles for businesses in the service industry is challenged as obsolete and even potentially dangerous. "Service management as an overall management perspective gives high priority to the external efficiency of the firm, how customers perceive the quality of the core products and the total performance of a firm, instead of overemphasizing internal efficiency, economies of scale and cost reduction. This combines the overall management perspective of service management with its customer-driven and quality-oriented facets, employee-oriented concerns and its long-term perspective" (Grönroos, 1994, p. 9). Others agree on this by stating that "customer loyalty is the cornerstone of successful service management" (Heskett, Sasser, & Hart, 1990, p. 30).

Hence, services should be viewed as a process of customer co-creation that creates substantial customer value for each individual customer. In case of a service organizations, it is shown that services are not always tangible and process performance in services is usually not transparent. This could be seen as an impediment to apply business improvement methods like mass customization. In fact, the opposite is true. It has already been shown that *mass customization* could be used as a strategy for process improvement at organizations who like to take advantage of the fact that individual customers are different. The objective of mass customization is to turn customer heterogeneities into profit opportunities.[1] For organizations that manufacture tangible products mass customization has proven importance in order to stay in business and benefit from economies of scale. For example car producers are making use of it, since cars could be customized by the customer according to individual customers' personal needs. For them this means a lot of variety, whereas the producer can profit from mass production efficiency.

The above mentioned characteristics emphasize the grounded importance for organizations in the service industry to improve and develop customer oriented processes. Winkler & Schwaiger (2004) confirm this by stating that customer satisfaction has a positive long-run effect on organizations' revenues. Box 1.1 shows this by a reconstruction of the recent development in the banking industry.

[1] http://corporateinnovation.berkeley.edu/mcpc2011/theme.html

BOX 1.1 – TRENDS IN THE SERVICE INDUSTRY, ILLUSTRATED BY THE BANKING SECTOR

During the last years the service industry has undergone a major change in the way it operates and is managed. According to Fasnacht (2009, p. 8) as an example "banking has traditionally been a conservative industry and resistant to change. The stable industry structure, defined boundaries, clear business models, and identifiable players made change linear and predictable." However, the recent global financial crisis has changed this situation, in particular that specific moment of September 2008 when Lehman Brothers filed for bankruptcy. The banking industry now has "an ambiguous structure, blurred boundaries, new business models, and change in banking is unpredictable" (Fasnacht, 2009, p. 9).

Besides these changing business rules of banks, the change in customer behavior also forced other service organizations to adopt innovative sources of competitive advantage. Today, customers demand services that meet their increasingly diverse needs (Heiskala, et al., 2005; Papathanassiou, 2004). Caused by the economic relapse, distinctiveness to customers is arguably more and more important for service firms (de Man, 2010). For example, research performed by different consultancy firms confirms that customer centrality is the most important driver for banks in order to respond to increasing customer requirements. Figure 1 gives an overview of the implications on the major trends that Atos Consulting (2009), The Boston Consulting Group (BCG) (2004) and (2009), and Accenture (2009) describe in their business outlooks for the banking industry.

The shift towards customer centrality in the banking industry

	Trends for retail banks	*Implication for retail banks*
Atos Consulting		
	1) Shifting customer needs.	Customers get and expect more insight into products and conditions.
	2) Shifting customer loyalty.	Switching is easier for customers.
	3) Decrease in consumer confidence.	Due to the credit crisis, consumer confidence in the banking sector is at a low level.
The Boston Consulting Group		
	1) Customers will ask more and more customized products and services.	Customer focus is closely related to operational processes.
	2) Process automation and industrialization.	Provide centralized and uniform processes that benefit the customer experience.
Accenture		
	1) Transparency of banks in approaching customers.	Stops erosion of consumer confidence.
	2) Simplify the product offering while promoting customer-focused product initiatives.	Building strong relations with customers.
	3) Renewed customer focus.	Alleviate the complexity of products and services.

Source: Atos Consulting (2009), The Boston Consulting Group (2004, 2011), Accenture (2009).

Figure 1. Trending topics for retail banks according to consultancy firms.

The shared findings of these consultancy firms confirms that individual banks can only profit from the shift in customer behavior by a competitive advantage achieved through increased transparency, reduced complexity, and increased differentiation. This is explained as being the industrialization of the banking industry.

Industrialization is essentially a conversion of artisan methods to more efficient, cost effective, standardized and streamlined systems for the delivery of products and services (Levitt, 1976). A worldwide developed Accenture survey proves that the banking industry is subject to industrialization. In essence, industrialization of the banking industry means the following (Accenture, 2009):

1) Creating the ability to differentiate on the outside (the market), to increase revenues;
2) Simplification on the inside, with the aim of reducing costs and complexity;
3) Execution mastery, which prioritizes execution as a core capability.

To be more specific, industrialization means simplifying the bank's operating model on the inside, which reduces costs, whilst creating the ability to differentiate on the outside, in order to grow revenues. Accenture's survey explains simplification on the inside as the "componentization or standardization of products, processes and technology, and the use of these components to create modularized customer service platforms. These modularized platforms can cut across business and product silos. This reduces costs, but also creates the flexibility required to customize products and services for different customer segments" (Accenture, 2009, p. 5). That means more differentiation for customers. Figure 2 shows the three elements of industrialization in the banking industry.

Figure 2. Industrialization in banking comprises three core elements (Accenture, 2009).

According to these elements, industrialization in banking will lead to standardized operational platforms which ensure a consistent and uniform customer treatment on the one hand, and customized segmentation of products and services on the other. The survey indicates that in 2006 already 90% of the questioned banks were investing in

differentiation and simplification of the operating model. Nikolaidou, Anagnostopoulos and Tsalgatidou (2001, p. 65) emphasize the need of this by stating that "given the competitive nature of the banking industry, improving and revising business processes is required." Customers of financial institutions are increasingly getting used to the fact that they get a custom made range of services on demand. Therefore, increased operational efficiency results in a strong competitive advantage (BCG, 2004).

1.6 Research design

Since this research investigates a relatively unexplored research area (mass customization for services), we use as well theory in order to contribute to practice, as practical findings that contribute to the existing knowledge base. Design science research is an effective methodology that is useful for both this practical and theoretical element of this thesis.

According to Hevner, March, Park and Ram (2004), design science research is a research paradigm in which a designer answers question relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The different stages of design science are presented in figure 3, which gives a simple representation of the model.

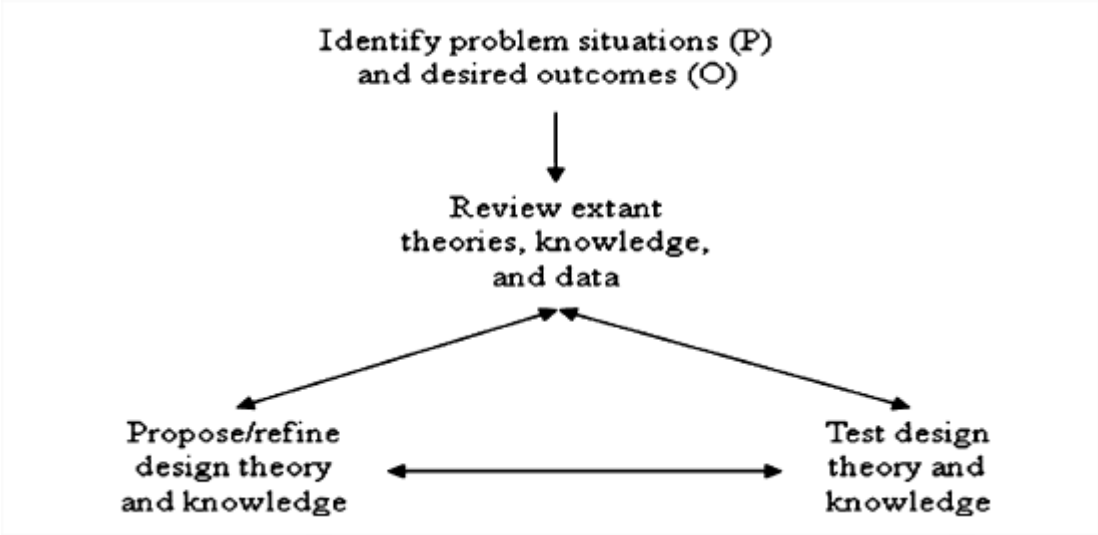

Figure 3. Design theory development (Carlsson, Henningsson, Hrastinski, & Keller, 2011).

First, during the problem identification stage it is necessary to establish the criteria for evaluating the expected outcome in order to verify that it meets the goals (Carlsson, et al., 2011). Klein, Jiang and Saunders (2006) suggest three criteria how design propositions can be evaluated:

1. Importance: meets the needs of practice by addressing a real world problem in a timely manner, and in such a way that it can act as the starting point for providing an eventual solution;
2. Accessibility: is understandable, readable, and focuses on results rather than the research process;

3. Suitability: is suitable for addressing the problem: complete, provides guidance and/or direction, and provides concrete recommendations.

In design science research, the problems as well as the problem situations have to be articulated and formulated by the researchers in such a way that they can be researched (Carlsson, et al., 2011).

Second, the review phase is where design theories should be enhanced by being grounded in previous research and knowledge. A design theory should be enhanced by continuously interacting with what is currently known, that is, grounding in extant theories. Reviews should be driven by a focus on outcomes and how outcomes can be produced (Carlsson, et al., 2011).

The third step is to specify from the extant theories what would work for the particular design that is created. "The transition from extant theories to design propositions requires a logical break-down of the extant theories, as well as an adaption of the design propositions to the context where the design is to be implemented" (Carlsson, et al., 2011, p. 119).

The last step is to test and verify the created knowledge in order to make clear whether it is a useful theory. "After having formulated an initial design theory, the next step is to test the design theory with empirical tests, which include the selection of appropriate data collection methods. In doing this, it can be examined whether the design theory may be used as support when trying to change reality. Based on the results, the outcome may be reflected on and the design theory may be refined. Through multiple studies one can accumulate supporting evidence iteratively and continuously move towards evidence saturation" (Carlsson, et al., 2011, p. 123).

Figure 4 identifies the existence of three design science research cycles that can be used in IS research projects:

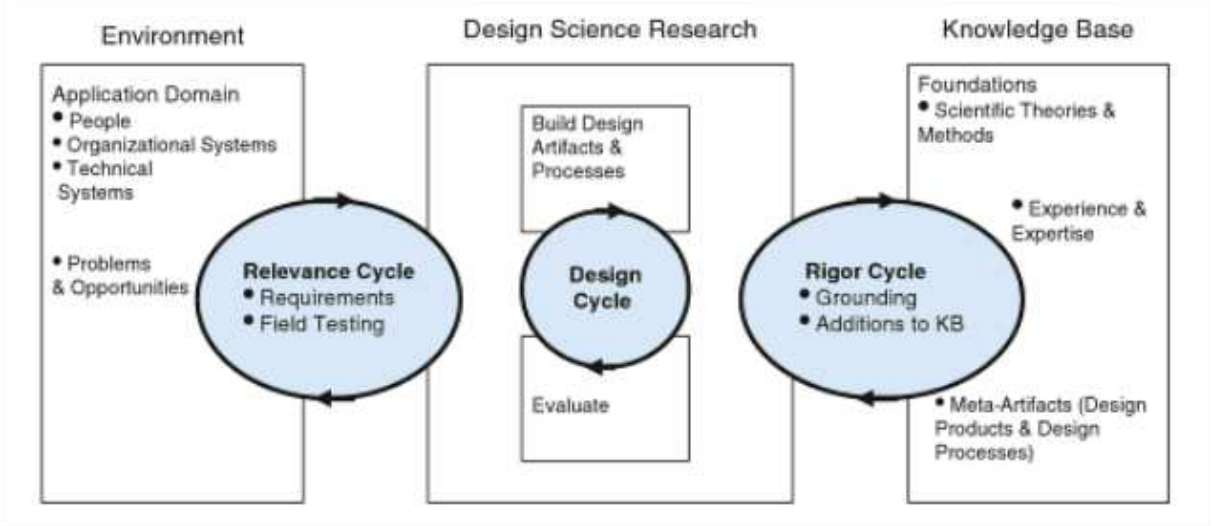

Figure 4 - Design science research cycles (A. Hevner & Chatterjee, 2010).

It presents the IS research framework found in Hevner et al., (2004) with overlaid research cycles. The *Relevance Cycle* bridges the contextual environment of the research project with the design science activities. In this thesis, the contextual environment are presented by several cases of service organizations or individual services, which are introduced in chapter

4. Here, the match is made with the built artifact, being the revised framework of Bask et al (2011).

The *Rigor Cycle* connects the design science activities with the knowledge base of scientific foundations, experience, and expertise that informs this research project. This is actually the existing knowledge on mass customization, presented in chapter 2, which is the grounding of this thesis.

The central *Design Cycle* iterates between the core activities of building and evaluating the design artifact and processes of this research project. This cycle tries to solve the challenges found in literature with a specific artifact for practice, in order to create a feedback loop for the knowledge base. Chapter 5 concludes on this cycle by defining its implications for the knowledge base and the environment.

"These three cycles must be present and clearly identifiable in a design science research project" (A. Hevner & Chatterjee, 2010, p. 16). In the end, design science research, as is this thesis' method, will contribute to as well the environment as to the knowledge base with artifacts that are grounded by the knowledge base and introduced in the environment.

This theoretical explanation does not explain in-depth how design science research – more specific: the design cycle – should be conducted. Therefore, the design science research methodology (DSRM) is introduced (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007), which incorporates principles, practices, and procedures required to carry out design science research (see figure 5). It is obvious that there are problems with applying mass customization to the service industry, and therefore this process model can be used to design a suitable solution framework.

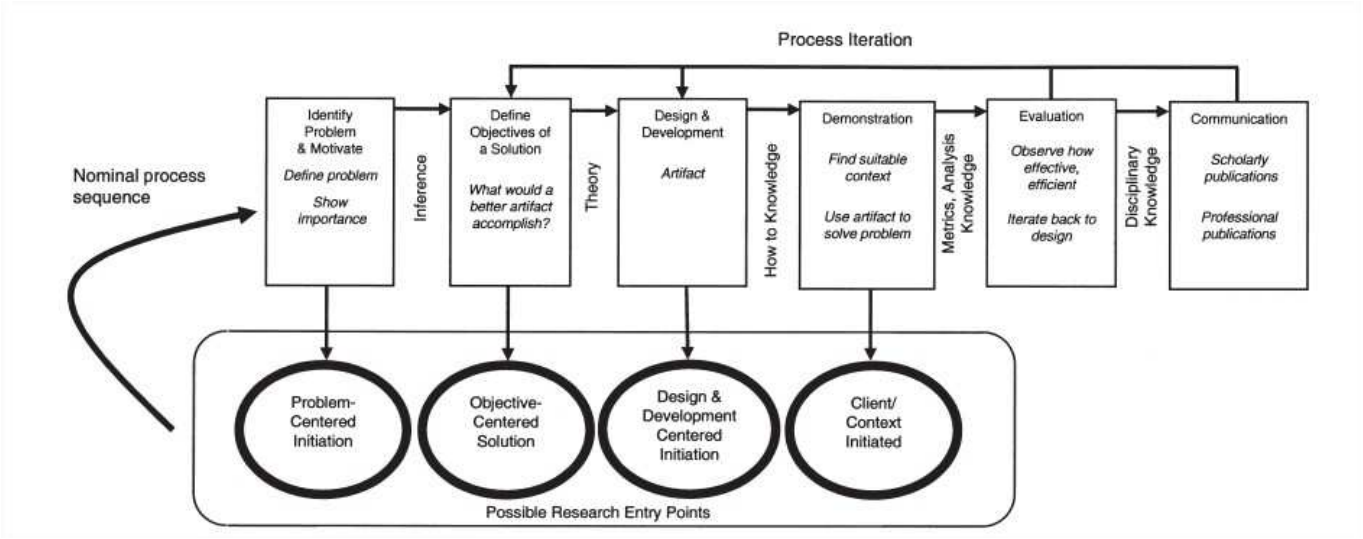

Figure 5 - DSRM Process Model (Peffers, et al., 2007).

The design science process includes six steps (Peffers, et al., 2007):

1. *Problem identification and motivation*. In this stage, the research problem is introduced and the value of finding a solution is justified. Chapter 1 already contributed to the identification of the problem, and chapter 2 adds the required knowledge of the state of the problem and the importance of its solution.

2. *Definition of the objectives for a solution*. From chapter 3 onwards, this thesis introduces the applicability of mass customization for service organizations. It elaborates on the objectives of the framework of Bask et al., (2011) and describes the objectives for an extended version of this framework. Solution.

3. *Design and development*. The latter part of chapter 3 presents the revised framework (the artifact). This is done by moving from objectives (stage 2) to design and development of the revised framework by using knowledge from theory. As a result of this stage, we come up with the intended solution.

4. *Demonstration*. This stage demonstrates the use of the revised framework (artifact) by applying it on multiple cases in chapter 4. It helps us to effectively use the artifact in order to solve the problem.

5. *Evaluation*. This stage observes and measures how well the artifact supports a solution to the main problem. This is done through the comparison of the objectives of the solution (stage 2) and the observed results from using the revised model for the case study analysis (demonstration, chapter 4).

6. *Communication*. Communication is done through this thesis, in which the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences is presented.

1.7 Structure of the rest of this thesis

The different phases of the design science method are crucial for a scientific approach of the concept of mass customization. Figure 6 gives a schematic overview about how this research uses the different stages as described above (see next page):

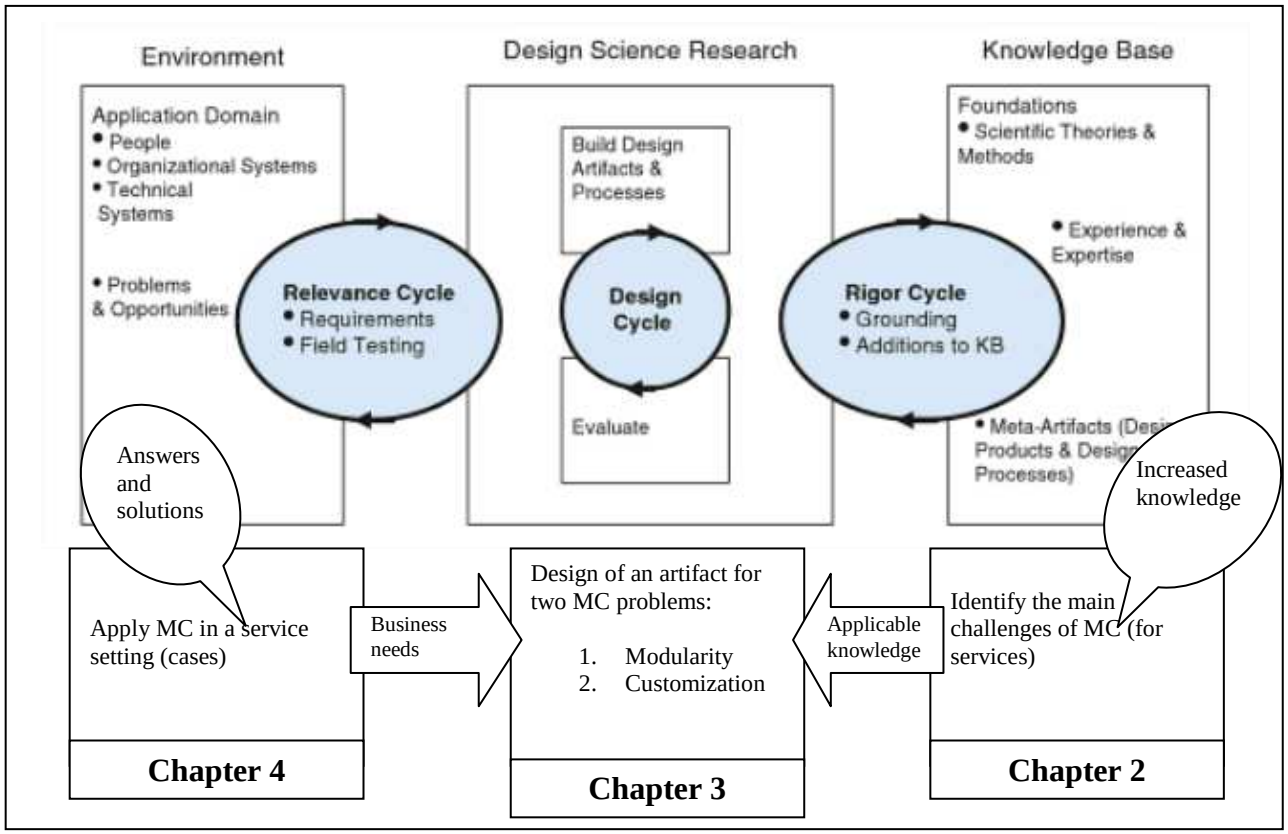

Figure 6 - Using DSRM in this research

Using the DSRM model from figure 6 gives great opportunities for the relatively unexplored field of framing mass customized services.

Chapter 2 first describes the available literature that is used for this research on the features and challenges of mass customization in general. It answers the first research sub question.

Chapter 3 explains the applicability of mass customization for service organizations, by giving a solution for the main challenges of mass customization by using the design science process model. The second sub question is answered in this chapter.

Chapter 4 presents the case studies that uses the described framework of chapter 3 in order to analyze the degree of modularity and customization in the service industry.

Finally, chapter 5 will conclude this thesis by answering the main research question, drawing conclusions and through giving its implications.

2 MASS CUSTOMIZATION EXPLAINED

This chapter explains the concept of mass customization. Its origins are presented, and definitions are provided. Then, application for the service industry is researched, which leads to a conclusion on the most relevant challenges for mass customized services. This explains why it is difficult for service organizations to develop a well-functioning mass customization strategy.

2.1 The genesis of mass customization

Before mass customization is related to service organizations, the general development of the concept is reviewed. Davis (1987) and Pine (1993) were the first researchers who studied the concepts of mass customization in depth. They described mass customization as a process by which firms apply technology and management methods to provide product variety and customization through flexibility and quick responsiveness (Davis, 1987; B. J. Pine, 1993). Mass customization is the ability to provide products tailored to individual customer needs on a large scale at, or close to, mass production efficiency using flexible processes (Da Silveira, Borenstein, & Fogliatto, 2001; Hart, 1995; Heiskala, et al., 2005; B. J. Pine, 1993).

Whereas in mass production low costs are achieved primarily through economies of scale, for mass customization this is achieved primarily through economies of scope. Although Davis and Pine made mass customization popular, the futurist Alvin Toffler already described in the 1970s the opportunities of modern flexible manufacturing technologies (Toffler, 1970). According to Toffler, “in a production system where switching costs are marginally small, high variety and individuality would come at almost no cost” (Piller & Kumar, 2006b). Piller and Kumar (2006b) however mention the role of the Internet as the enabler of matching the flexible manufacturing capabilities (envisioned by Toffler) with customer demands in sales efficiently. Hence, Internet lowered transaction costs and connected supply and demand for organizations and customers (Piller, Moeslein, & Stotko, 2004), and caused the breakthrough of mass customization.

Da Silveira et al. (2001) describe three ideas that justify the development of mass customization systems, which are based on the findings of Kotha (1995):

1. New flexible manufacturing and information technologies enable production systems to deliver higher variety at lower cost;
2. There is an increasing demand for product variety and customization. According to Kotler (1988, p. 11), “even segmented markets are now too broad, and do not permit developing niche strategies;”
3. The shortening of product life cycles and expanding industrial competition has led to the breakdown of many mass industries, increasing the need for production strategies focused on individual customers.

Hence, mass customization could be adopted by organizations as a strategy that provides them with a sustainable competitive advantage. The next section will exactly make clear how mass customization could be defined and how mass customization is characterized.

2.2 Definitions of mass customization

Davis (1987) was the first researcher that defined mass customization. He distinguished the difference between mass and customized markets by defining mass customization as "when the same number of customers can be reached as in mass markets of the industrial economy, and simultaneously they can be treated individually as in the customized markets of pre-industrial economies" (Davis, 1987, p. 169) Pine (1993) popularized this concept further and defined mass customization as organizations "providing enough variety in products and/or services so that customers find exactly what they want at a reasonable price" (Piller, 2004, p. 314) According to Tseng and Jiao (2001, p. 691) mass customization corresponds to "the technologies and systems to deliver goods and services that meet individual customers' needs with near mass production efficiency."

Piller and Müller (2004, p. 584) summarized those general definitions by explaining mass customization on the basis of three options: "Mass customization means the production of goods and services for a relatively large market, which meet exactly the needs of each individual customer with regard to product characteristics (*option 1 – differentiation option*), at costs roughly corresponding to those of standard mass-produced goods (*option 2 – cost option*). The information collected during the process of individualization serves to build up a lasting individual relationship with each customer (*option 3 – relationship option*)."

This definition shows immediately that mass customization is not a one-size-fits-all solution for matching all customer demands with a personalized product or service since there is always room for choice left. Pine (1998) made a remark to place mass customization into perspective by explaining it as a creator of unlimited demand: "customers don't want choice. They want exactly what they want."

This means that there can be measurable levels of mass customization defined, which is described in the literature as different concepts of mass customization. That makes clear that a one-size-fit all implementation of mass customization is difficult to provide. For instance, Gilmore and Pine (1997) define four different areas of mass customization. These four have different approaches in the realization of customization.

1. *Collaborative customization*. In this approach, firms conduct a dialogue with individual customers to determine the precise product offering that best serves the customers' needs. The information from this dialogue is used to specify and manufacture a product that suits the individual customer.
2. *Adaptive customization*. In this approach, firms produce a standardized product which can be customized by the customer.
3. *Transparent customization*. In this approach, customers are not informed about the fact that products are customized for them. Though, firms provide individual customers with unique products.
4. *Cosmetic customization*. This approach has an artificial nature, since standardized products are presented to different customers in unique ways.

In some cases a single approach is sufficient for serving customers best. More often, managers will need a mix of some or all of the four approaches to serve individual customers (Gilmore & Pine II, 1997).

Wijnhoven (2011) introduces this as distinct classes of information process models. Collaborative and adaptive customization can be classed as a *value shop*, which "consist of interactions between a client (problem owner) and service provider. A value shop is a process for abstract information goods" (Wijnhoven, 2011, p. 85). Transparent and cosmetic customization could be classified in terms of information process models as a *value chain*, which are "the time-related concepts of start and finish, and sequences of increased value, i.e., processes that can be decomposed into activities" (Wijnhoven, 2011, p. 85). Value chain models can be used for low abstract information goods.

Duray et al. (2000) succeeded in the merge of customer involvement and modularity. "Bringing these concepts together, mass customization can be defined as building products to customer specifications using modular components to achieve economies of scale" (Duray, et al., 2000, p. 611). As a result, four mass customization archetypes are proposed, see figure 7 on the next page.

1) *Fabricators*: implement as well customer involvement as modularity in the design and fabrication stage of the production cycle. Fabricators deliver distinctive designs and uniqueness, since customers are involved early in the production process;
2) *Involvers*: combines customer involvement in the design and fabrication stage, but utilize modularity during the assembly and use stage. Customers participate again in the process from the beginning, but no new modules are fabricated during this interaction;
3) *Modularizers*: includes customized modularity from the design and fabrication stage, but involves the customer at the assembly and use stage.
4) *Assemblers*: includes both customer involvement and modularity in the assembly and use stage. This offers mass customization due to the utilization of modularity which creates a great variety of choices for customers.

Based on these archetypes, it is possible to distinguish manufacturers that are mass customizers and those that are not by determining whether they involve the customer in the design process, and they employ modularity to the customer.

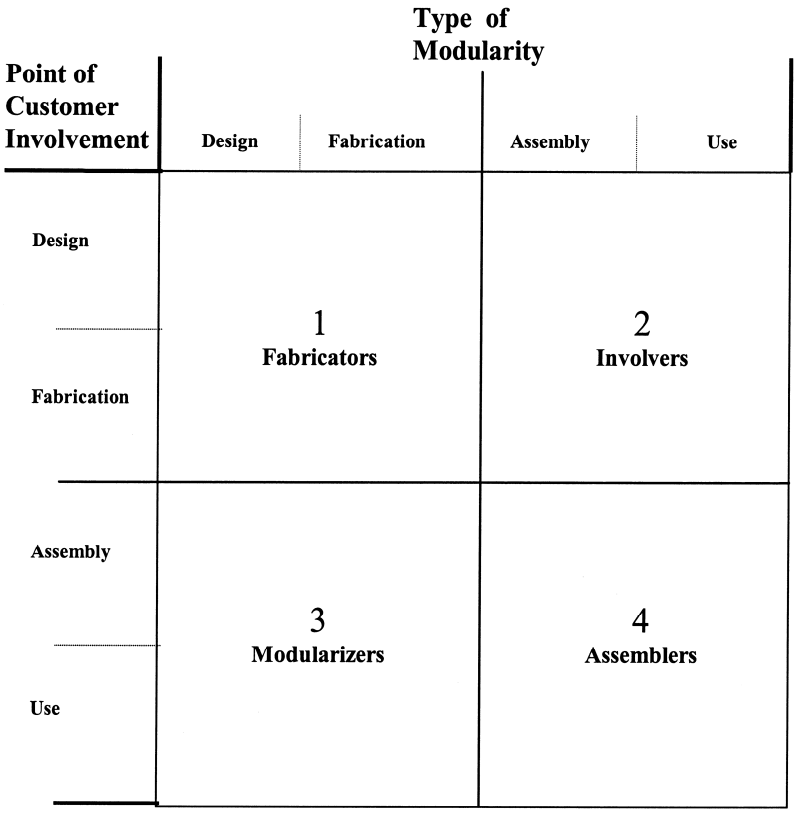

Figure 7 - Matrix grouping of mass customization configurations (Duray, et al., 2000).

The applicability of mass customization for services however, is not treated yet. Since it is clear how mass customization has been grounded and developed, and how the concept is defined, we switch to the more specific implications for service organizations.

2.3 Mass customization for the service industry

Regarding the features of mass customization described above, it is shown that mass customization is largely focused on the manufacturing domain, for the production of customized goods. However, there is also evidence from the literature that mass customization adds a lot of value to the provision of services. For instance, Salvador et al. (2009) poses that "mass customization is not some exotic approach with limited application possibility. It is a strategic mechanism that is applicable to most businesses. The key is to view it basically as a *process* for aligning an organization with its customers' needs." This actually means that service organization should be able to adopt mass customization in order to meet the needs of individual customers. The fact is that this holds true, as long as "it is appropriately understood and deployed" (Salvador, et al., 2009, p. 76). Therefore, this section compares the differences between mass customization of goods, relative to services. Doing this allows us to determine the most important aspects of mass customized services that need to be revised in the framework of Bask et al. (2011). For that, it is important to review as well the service supplier as the customers point of view, since both have respectively influence on the degree modularity and the desired level of customization.

2.3.1 Mass customization of goods relative to service mass customization

The value of mass customization for service organizations can be explained by providing the differences between mass customized goods and services.

Different authors describe the essence of the difference between goods and services. Zeithaml et al. (1985, p. 35) state that "services differ from goods in their intangibility, heterogeneity, perishability, and inseparability of production and consumption." Besides this, "service transactions do not result in change of ownership" (Cowell, 1988, p. 300).

According to Piller and Tseng (2010), a major difference between them is the fact that services are provided to the customer along a process in which the customer is directly involved (similar to value shops). These two authors stress customer integration as one of the main differences between mass customization for goods and services. Figure 8 summarizes the general differences between them.

Mass customization of Goods	VERSUS	**Service Mass Customization**
• Configuration primarily based on human-to-machine interaction • Configuration rules and choice menu are hard-coded into the "machine" ⇩ • Configuration settings cannot be flexibly adapted		• Customer integrated into the service delivery process • Heterogeneity of the service outcome • Often to be deliverd personally ⇩ • Configuration is an ongoing process with direct involvement of the customer • Prior fixed configuration settings are limited

Figure 8. Differences of mass customization for goods and services (Piller & Tseng, 2010).

As visible from figure 8, customers are an integral part of the production process for service organizations. Kaplan and Haenlein (2006, p. 173) mention an opportunity and a challenge for this direct integration of the customer in the service delivery process. "On the one hand the company has a continuous contact with the customer, which is a benefit for the customization of the service delivery. On the other hand, the integration of the customer implies an inherent heterogeneity of the process' outcome, which makes it difficult to maintain standardized service modules."

2.3.2 Benefits and challenges of mass customization for *suppliers*

Heiskala et al. (2005) analyzed the benefits and challenges of mass customization from the viewpoint of the supplier and the customer. Based on a case study, they analyzed the relevance of each benefit and challenge in services compared with mass customized goods.

Below, a summary of supplier **benefits** is given in figure 9. This research chapter provides also the benefits, although the area of interest are the challenges.

Benefit	Relevant in services?
Reduction in inventory	*No*; Services are perishable and therefore not storable
Reduction in product model obsolescence; fashion risk	*No*; Services are perishable, therefore discounts to move aging products from stock are not an issue.
More accurate customer information	*Yes*
Customer participation in design: satisfaction, effort spent and switching cost	*Yes*; Although mass service customers participate in specification more than MP goods customers as it is.
Potential for premium pricing	*Yes*

Figure 9 - Supplier benefits from mass customization (Heiskala, et al., 2005).

From their research they show the most cited benefit of mass customization as being *reduction in inventories*. Since services are not storable, this benefit is not relevant in services. *More accurate customer information* is a benefit that seems relevant for service organizations, as mass customization often involves a continuous dialogue with customers and the information reflects actual customer information (Piller, et al., 2004). Next to this, premium pricing is proven to be feasible in mass-customized services (Sundbo, 2002). This is an important feature of mass customization.

There are also **challenges** for suppliers, which are presented in figure 10.

Challenge	Relevant in services?
Elicitation: complexity, increased information, ensuring validity, first time right	*Yes*; Intangibility of services may highlight the difficulties. Simultaneity of production and consumption: errors cannot be necessarily notices before delivery, as in goods.
Difficulties in achieving the required production process flexibility	*Yes*; But maybe to a lesser extent, human workers allow for flexibility.
Finding balance of increased customization and customer value	*Yes*
Increase in information flows and information transferred (product & customer)	*Yes*; Maybe even a bigger issue in services where knowledge at customer interface is often tacit and information needs to flow between persons to a larger extent than in manufacturing

Figure 10 - Supplier challenges from mass customization (Heiskala, et al., 2005).

A major challenge is the difficulty of *customer needs elicitation* for services (Piller, et al., 2004). Elicitation is complex, because the information involved increases. Communicating the value of a service to the customer is emphasized by the intangibility of the service offering (Matthyssens & Vandenbempt, 1998). Actually, it seems that all supplier challenges from mass customized goods are also applicable to mass customized services. Especially the information intensity is a huge challenge for mass customization of services to overcome.

2.3.3 Benefits and challenges of mass customization for *customers*

According to Heiskala et al. (2005), mass customization *benefits* for customers have not attracted much attention in literature. Two benefits are mentioned, which are also relevant for service offerings:

1. Improved fit between product and customer needs (Kotha, 1995);
2. Enjoyable participation in design and specification of the product (Franke & Piller, 2004).

Challenges for customers are more easily found, figure 11 summarizes the main findings.

Challenge	Relevant in services?
Increased price of products	*Yes*
Time and effort spent in design, specification	*No*; Due to perishability, service customers may be more accustomed to spend effort in specification
Waiting for the finished product	*No*; Services are perishable and produced after purchase as it is.
Complexity of design, specification.	*Yes*; Intangibility may even highlight complexity. Customers and/or customer service staff having trouble with understanding the service contract options.

Figure 11 - Customer challenges from mass customization (Heiskala et al., 2005)

Increased prices are obviously relevant for mass customization of services. This means more expensive service provision for customers. Also waiting time and effort spent on the product could be a challenge for customers, but Heiskala et al. (2005, p. 212) argues that "customers, being more involved in the production process, may be more accustomed to state their preferences, and wait for the delivery of the specified service. The argued added customer value from mass customization should compensate for these customer sacrifices." *Complexity of mass customized services design* is the main challenge found, which is particularly caused by the inherent intangibility of services.

It seems that there are obstacles for service firms that like to implement mass customization as a strategy in order to obtain operational efficiency. Piller and Tseng (2010) describe this as the conflicting goals of mass customization: "on the one hand to satisfy divergent needs of customers and on the other to accomplish efficiency comparable to volume production without the economies of scale."

Piller and Tseng (2010) mention the following challenges of successful mass customization for goods and services:

1. *Speed and lead time:* mass produced goods are readily available from off the shelf and customers expect this short lead time from customized products.
2. *Customers' needs:* customers often do not know exactly what they want. Customers can order such explicit customized goods that it is not economic to produce.
3. *Economies of scale:* customization leads to small quantities and higher varieties, which makes it difficult to reach the necessary scale of economy.
4. *Value:* Offering choices may not automatically be of value to customers. The offered product variety should match the customers' perceived value of the product.
5. *Complexity:* High variety and small quantities can drive additional costs, that could defeat the efficiency goal of mass customization.

Companies that like to adapt to a system of mass customization should find an integrated way to address these challenges. Next to the five challenges of Piller and Tseng (2010), Haas and Kunz (2010) address two specific challenges to mass customization for services:

1. *Customer integration* in the production process. Customers of service firms are not simply consuming the outcome of the production process, but are an integral part of it. Hence, service costs could easily explode, resulting from fulfilling every wish a customer has. To overcome this problem, the understanding of customers' customization needs is required. A well thought through design of the service can ease the decision making process and prevent this from happening;
2. *Intangibility* of the service offer. The intangible nature of services relatively increases the complexity of the configuration process. Imagination of the service is difficult for the customer and communicating the advantage of a new offer is more difficult for the service organization. Empathy and deep understanding of consumers' customization needs is key for creating a superior service experience.

Based on those two challenges, Haas and Kunz (2010, p. 610) describe the key challenge of mass customization for service organizations as "translating customer needs into customization concepts and guidelines."

2.3.4 Summary of challenges for service organizations

Since this chapter tries to find an answer on the first research sub-question (*what are the main challenges for the successful application of mass customization at service organizations?*), it is useful to provide an overview of the challenges found and described in this chapter on applying mass customization at service organizations so far. Table 1 concludes on the main challenges that prevent mass customization from being successful in the service industry. The findings are categorized by author(s), some double challenges are double.

Summary of Mass Customization challenges for services	
Main challenges of successful MC for services (Heiskala et al., 2005)	
1) Supplier challenges	Elicitation, complexity, increased information; Difficulties in achieving the required production process flexibility; Finding balance of increased customization and customer value;

	Increase in information flows.
2) Customer challenges	Increased price; Complexity of design, specification is difficult to understand
Main challenges of successful MC for services (Piller & Tseng, 2010) / (Haas & Kunz, 2010)	
3) Speed and lead time:	Customers expect short lead time from customized products or services = supplier challenge
4) Customers' needs:	Customers can order such explicit customized goods or services that it is not economic to produce = supplier challenge
5) Economies of scale:	Customization leads to small quantities and higher varieties = supplier challenge
6) Value:	Offering choices may not automatically be of value to customers = supplier challenge
7) Complexity:	High variety and small quantities can drive additional costs = supplier challenge
8) Customer integration:	Service customers are an integral part of the production process = supplier challenge
9) Intangibility:	Intangible nature of services relatively increases the complexity of the configuration process = supplier/customer challenge

Table 1. Mass customization defined from literature

2.4 Concluding remark

The first sub-question (*what are the main challenges for the successful application of mass customization at service organizations?*) can be answered from the findings out of the knowledge base. The complex nature of mass customization creates different problem areas as mentioned in table 1. Combining these findings with the complex nature of the service industry makes it difficult to implement a one-size-fits-all solution of mass customization. From the literature, it is shown that there are more supplier challenges than customer challenges. In order to benefit from service mass customization, service suppliers have to verify whether their service offering(s) are suitable for the application of mass customization. Organizations who are able to overcome (most of) these challenges can benefit from the increased demand for customized services.

3 THE APPLICABILITY OF MASS CUSTOMIZATION FOR SERVICE ORGANIZATIONS

This chapter introduces the most important variables service mass customization. In this chapter these variables are elaborated, and we work towards the development of our revised framework is developed for the verification of a service organizations' mass customization capability. That framework is used in chapter 4, for the application on multiple cases; services or service organizations will be assessed against the framework.

3.1 Mass customization: variables

Piller and Kumar (2006b) describe three crucial components of mass customization, which are essential for every mass customization strategy. In order to develop a proper mass customization solution for service organizations, these three principles should be described first:

1. *Modularity*
   Modular product and process structures are an essential part of every mass customization strategy (Duray, et al., 2000; Gilmore & Pine II, 1997; Kumar, 2004). Piller and Kumar (2006b) show that mass customization demands compromise, because only those mass customization options that are consistent with the capabilities of the processes, and the given product architecture are being offered: "A mass customization system is characterized by a low production cost per unit, normally associated with mass production. To reach this objective, a mass customization system has a finite solution space. All processes are performed within a fixed product and process architecture characterized by flexible and responsive but stable processes. The processes are designed to yield output limited to a fixed range of specifications, represented by a consequent modular product design. Each module serves one or more well-defined functions of the product and is available in several options that deliver a different performance level for the functions it is intended to serve."

2. *On-demand manufacturing*
   Final assembly of the prefabricated modules only takes place after an order is placed (Piller & Kumar, 2006b). "The resulting cost-saving potentials are predominantly based on the better access to knowledge about the needs and demands of the customer base" (Salvador & Forza, 2004, p. 279). Mass customization thus leads to knowledge about the customer, which could lead to significant cost reductions, "like the elimination of distribution inventory, less product returns, reduced obsolescence or antiquated-fashion risks, mitigated product liability risks, and reduced cost of staffing to deal with post-sales product failures, complaints, liabilities, and loss of reputation" (Piller & Kumar, 2006b, p. 131).

3. *Customer co-design process*
   From a strategic management perspective, mass customization could be seen as an differentiation strategy (Piller & Kumar, 2006b). Chamberlin (1962) described customization as an economic theory, stating that the intent of offering customized goods and services is to attain increased revenue by the ability to charge premium prices derived from the added value of a solution meeting the specific needs of a customer (Piller & Müller, 2004). Piller and Kumar (2006b) state that each mass

customization business starts with a co-design process between the manufacturer and the individual customer, conducted with a dedicated system for customer co-design, known as configurator, user toolkit, or co-design-platform. These guide the user through the configuration process.

These three principles are also mentioned by Salvador et al. (2009). They approach this as three fundamental capabilities that a business requires in order to implement mass customization. According to Salvador et al. (2009), these fundamental capabilities are:

1. The ability to reuse or recombine existing organizational and value-chain resources (like modularity);
2. The ability to identify the product attributes along which customer needs diverge (like on-demand manufacturing);
3. The ability to help customers identify or build solutions to their own needs (like customer co-design).

In order to make these three variables (modularity, on-demand manufacturing, and customer co-design) work for mass customization at service organizations, a more in-depth analysis of each variable is needed. Modularity is explained in section 3.2 and the latter two (on-demand manufacturing and customer co-design) are described in section 3.3, which deals about customer integration. Finally, section 3.4 presents a framework that combines modularity on the one hand and customization on the other.

3.2 Mass customization and modularization

Salvador (2007) explains modularization as the breaking up of an object into its components in order to recombine them into customizable alternatives. However, there is some limitation to this breaking up, since service components are a combination of processes, people skills, and materials that must be integrated to result in the designed service (Goldstein, Johnston, Duffy, & Rao, 2002). Piller (2007, p. 631) characterizes a mass customization system by "a fixed solution space, with stable but still flexible and responsive processes. This solution space is utilized by customers who are integrated in the value creation process by defining, configuring or modifying their individual solution within the given set of choice options." This quotation shows the importance of a module-based product range for an organization that tries to develop customized products. Theories and methodologies such as families of services and service platforms based on mass customized product design have been applied to provide solutions in various customized service industries (Meyer & DeTore, 2001). Before modularization is applied at services (section 3.2.2), the literature about product modularization is discussed in the next sub section.

3.2.1 Modularity in product design

From literature, different types of modularity are distinguished. In general, modularity is applied to three different perspectives, being *product modularity*, *process modularity* and *organizational modularity* (Pekkarinen & Ulkuniemi, 2008). This distinction mainly focus on the manufacturing domain.

Product modularity is mostly focusing on the manufacturing domain. For instance, Ulrich and Tung (1991) distinguish six typologies of modularity, which illustrates that a final product can be produced by various configuration options or modules. Figure 12 shows these

typologies and also gives a short explanation and an example for each of them. The following typologies are developed by Ulrich and Tung (1991):

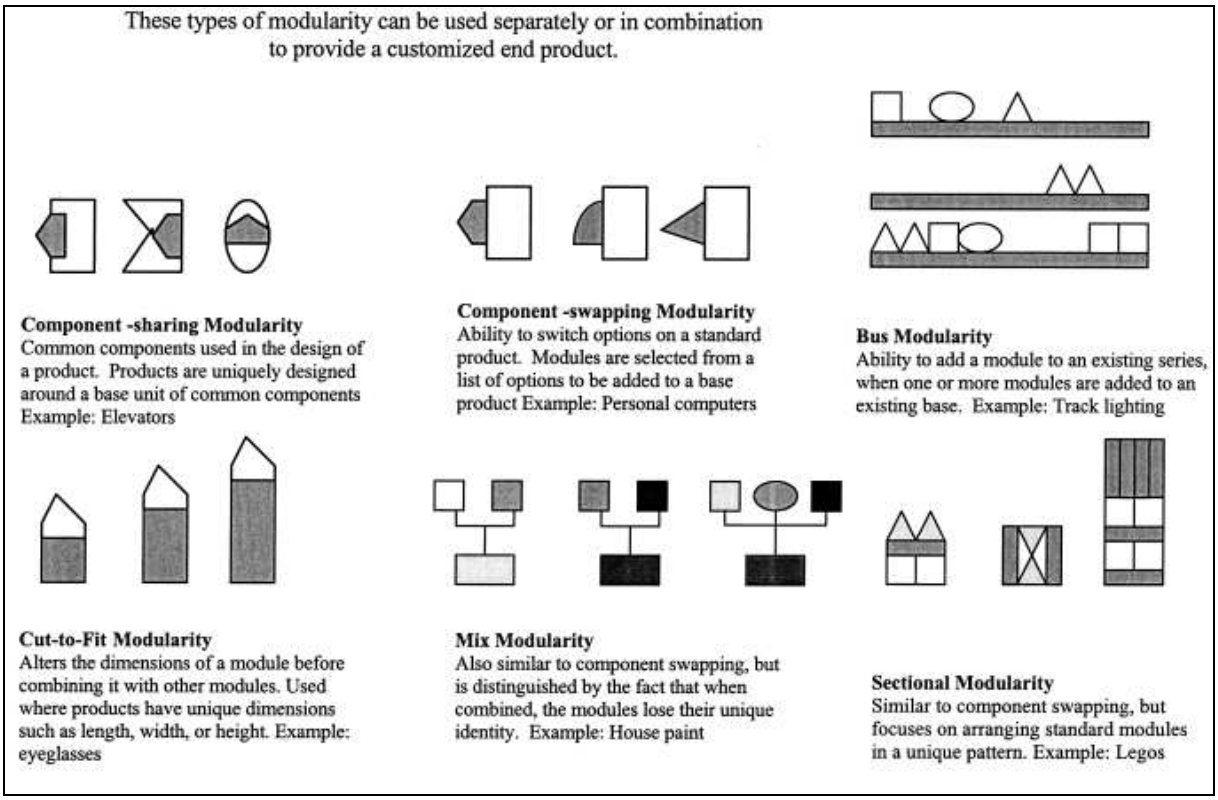

Figure 12 - Product modularity types (Ulrich & Tung, 1991)

- *Component sharing modularity*: different products are designed consisting of common components. This enables organizations to develop unique products with the use of these components;
- *Component swapping modularity*: component swapping uses different components which are paired to the same product, while in the component sharing different products use the same component (Ulrich & Tung, 1991);
- *Bus modularity*: includes a common bus to which other components can be attached through the same type of interface (Ulrich & Tung, 1991). The bus is here the common module;
- *Cut-to-fit modularity*: this type alters the dimensions of a module before combining it with other modules. This enables the production of output with unique dimensions;
- *Mix modularity*: similar to component swapping modularity but can be distinguished by the fact that when the components are combined to other ones, the modules lose their unique identity;
- *Section modularity*: also quite similar to component swapping modularity but focuses more on arranging standard modules in a unique pattern.

Process modularity is described by Feitzinger and Lee (1997, p. 119) when they describe a case study at Hewlett-Packard: "Breaking down the production process into independent sub processes provides companies with the kind of flexibility that effective mass customization requires." According to them, such an approach is based on three principles:

- *Process postponement*: the customization sub process is postponed until a customer request is received. A good example is the way paint stores can 'produce' paint colors by combining generic paint with the desired color pigments (it is separated into two sub processes). That leads to an unlimited number of choices and reduces inventories at the paint store;
- *Process re-sequencing*: the sub processes are rearranged so that the generic sub processes occur first, and the customization sub process occurs last. Hereby the point of product differentiation is also postponed;
- *Process standardization*: the last principle is process standardization, which breaks down the production process into standard and customized sub processes. The first delivers standardized units, whereas the latter further customizes these.

It is not difficult to see similarities between product and process modularity. It focuses particularly on the in-house capabilities of an individual organization to create uniqueness for its customers.

But, there is also evidence for **organizational modularity**, being organizations that for example outsource to, or use organizational capabilities from other organizations. Schilling and Steensma (2001) describe three different modular organizational forms:

- Contract manufacturing (adding capacity of an organization based on contracts);
- Alternative work arrangements (such as the use of contract agency workers, which alters the scale and scope of a manufacturer);
- Alliances, which are partnerships with other firms, access to capabilities and organization lacks. These forms all lead to a wider range of production possibilities, since the organizations become more modular.

By presenting these three examples (product, process and organizational modularity) it seems that modularity functions as an important component of mass customization. Evidence from literature (Sanchez & Mahoney, 1996) shows that modularity has been applied in many industries, for example at the production of aircrafts (common wing, nose and tail components creates different types of aircrafts), cars (different engines for different models), and consumer electronics (different variations of Walkmans by mixing and matching modular components).

For the application of modularization into the service industry, the difference between goods and services is a major factor of concern since services (from the process viewpoint) are intangible and cannot be modularized as the above presented modular product designs. However, there is literature available on the application of modularity in services.

3.2.2 Modularity in service design

Literature on modularity in service design focuses almost entirely on process modularity. Pekkarinen and Ulkuniemi (2008) present modularity in service design as the combination of one or several service modules into a final modular service, with the modules being service elements or processes. Each service element (module) offers one specific service characteristic. Figure 13 presents a modular service with two service modules (the smallest unit of a service possible) and one interface (which keeps the service modules together), that connects the interdependencies between the two service modules.

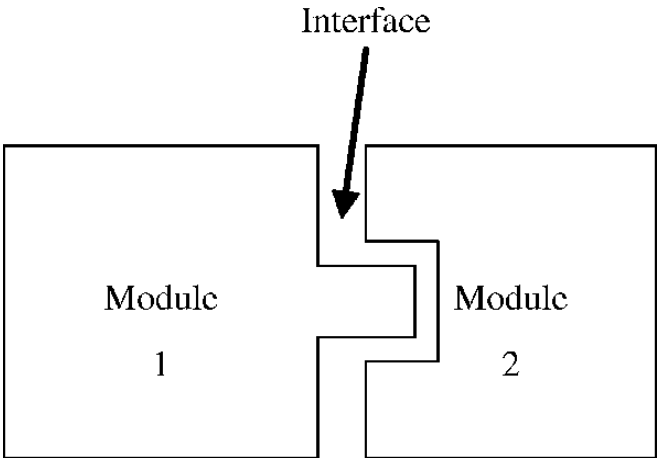

Figure 13 - A modular service: two service elements and one interface (Pekkarinen & Ulkuniemi, 2008).

The question is how these service modules (the smallest unit in which a service can be divided) can be distinguished for a random existing service. To make this generic representation (figure 13) more comprehensible, Moon, Shu, Simpson & Kumara (2010) conclude that the module-based service family design is a solution to develop mass customized services. In their research, different definitions are used to describe a model of customized families of services:

- A *service family*: a set of services based on a service platform, facilitating mass customization by promoting customer value and providing a variety of cost-effective services for different market segments.
- A *service platform* is a common basis that consists of processes, activities, objects, and/or features that are shared and remain constant from service to service, within a given service family.
- A *service module* is a set of service components for performing a service.
- A *service component* is regarded as an activity to satisfy specific services, which are defined by a set of processes, operations, people, objects, and/or features.

This is also known as a value chain model for services (Wijnhoven, 2011). As an example Meyer & Zack (1996) refer to information suppliers who deliver elementary data to data refineries' acquisition processes, and hence create information from the pools of data available.

A module-based service family can be developed using these definitions. "Based on the service platform, we can create a variety of services and families of services for satisfying various market segments depending on service-related design factors such as location, facility design, and layout for effective customer and work flow; procedures and job definitions for service providers; measures to ensure quality; extent of customer involvement; equipment selection; and adequate service capacity" (Moon, et al., 2010, p. 155). The model is presented in figure 14. It consists of three distinguished phases:

1) Service function and process identification;
2) Platform design strategy development;
3) Strategy determination.

These three steps leads to the design characteristics of the service family, but before the first phase is executed by the organization, *customers' needs* should be collected and analyzed in

order to develop a strategy for a service family and to identify the required service functionality.

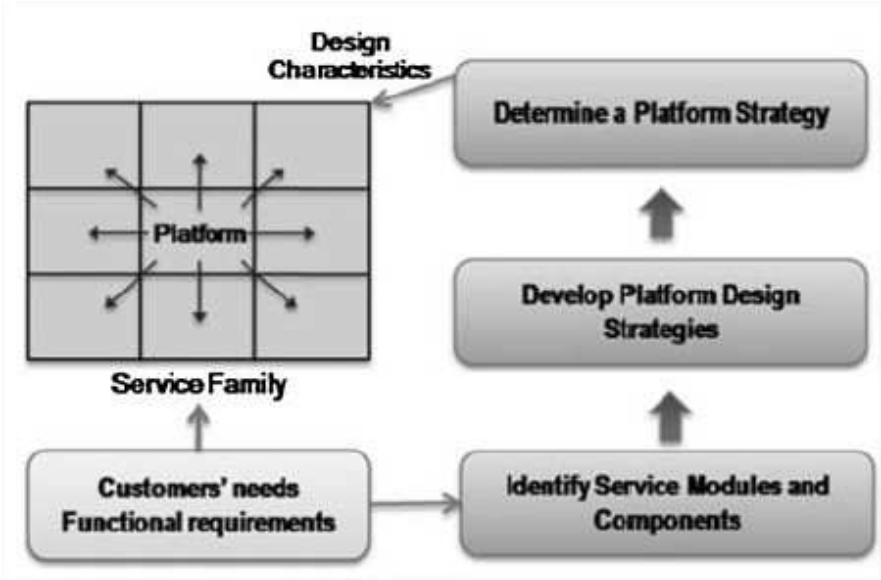

Figure 14 - Process of developing a service family design (Moon, et al., 2010).

Figure 14 shows us that the customer is involved in the process of developing a service family design, and thus is a co-designer of the service together with the organization that provides that service. Since services cannot be physically stored, they need to be 'consumed' at the moment of provision. Tuunanen and Cassab (2011, p. 342) define service process modularization therefore as "the systematic combination of service encounter processes known to both the customer and the firm that generates new, customizable service packages of increased utility to the customer." As a result, the portfolio of a firm's offerings is enhanced. This is also the essence of service science research. According to Hidaka (2006), it seeks to improve the productivity and quality of service offerings by creating new innovations facilitating business management and applying practical applications.

With the concept of modularity for service organizations being introduced, it is mentioned that service modularity is an essential part of a mass customization approach for service organizations. It is also clear that service modularity involves the customer into the service process. Remembering the other two components of a service mass customization strategy next to service modularity being on-demand manufacturing and customer co-design, it is obvious that mass customization is also about customer integration into the service process.

The next section combines on-demand manufacturing and customer co-design, and describes this as the concept of customer integration.

3.3 Mass customization and customer integration

Duray et al. (2000) developed a framework for the production cycle that makes the concept of modularity operational and shows that modularity and customer integration are inseparable for mass customizers. Based on the typology of Ulrich and Tung (1991), as seen in figure 12, Duray et al. (2000) argue that the level of customer integration is a critical factor for the customization uniqueness and the type of customization. For example, if customers are already involved in the design stage of the production cycle a product is highly customized,

and vice versa. Figure 15 presents the framework, with the design stage as starting point. At the design and fabrication stages, customized modules can be produced to meet exact or nearly all the customer specifications. Further in the production cycle (during the assembly and use stage), neither new modules can be modified or components can be produced.

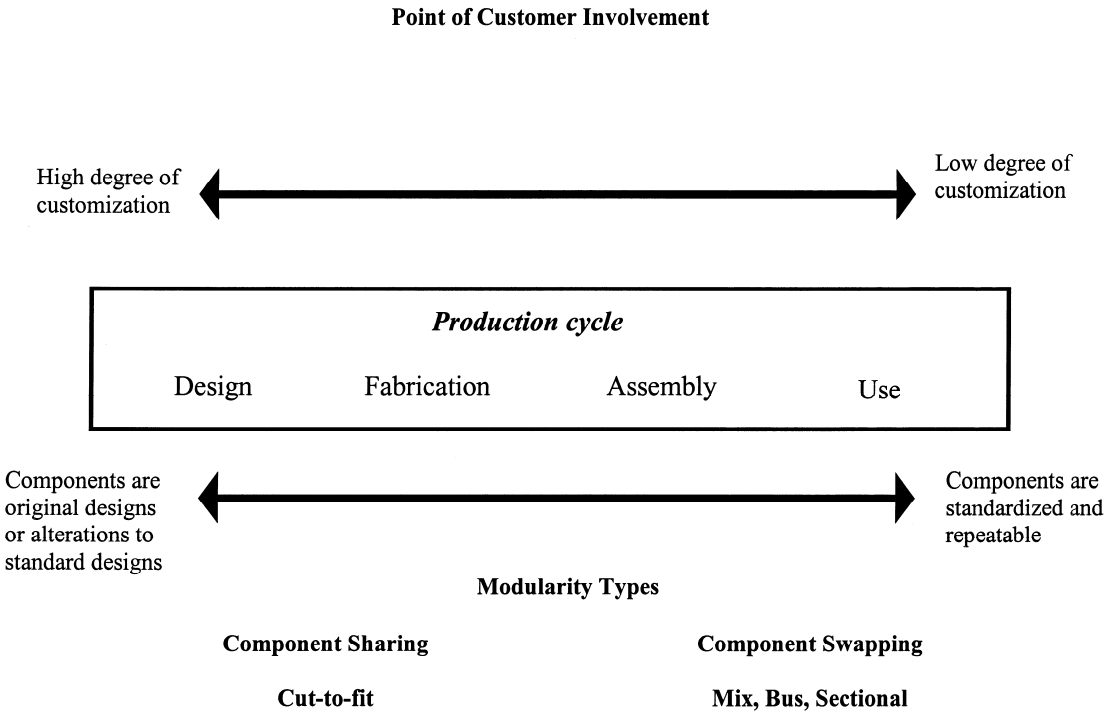

Figure 15 - Customer involvement and modularity in the production cycle (Duray, et al., 2000)

This confirms that the level of customization increases when the moment of customer involvement is earlier in the production stage, referred to as the "decoupling point (Lampel & Mintzberg, 1996, p. 22). It also combines on-demand manufacturing (the stage in which something is modularized) and customer co-design (the stage in which a customer is involved) into one feasible variable, customer involvement. In the end, customer involvement again can be replaced by the variable mass customization (meaning different strategies), as presented in figure 16. Five different strategies are defined, *pure standardization, segmented standardization, customized standardization, tailored customization, and pure customization.* The lowest customization level (pure standardization) takes place when all phases of the value chain are standardized and not customized. In contrast, companies accomplish the highest customization degree (pure customization) if they allow customers to participate and have influence on the design process.

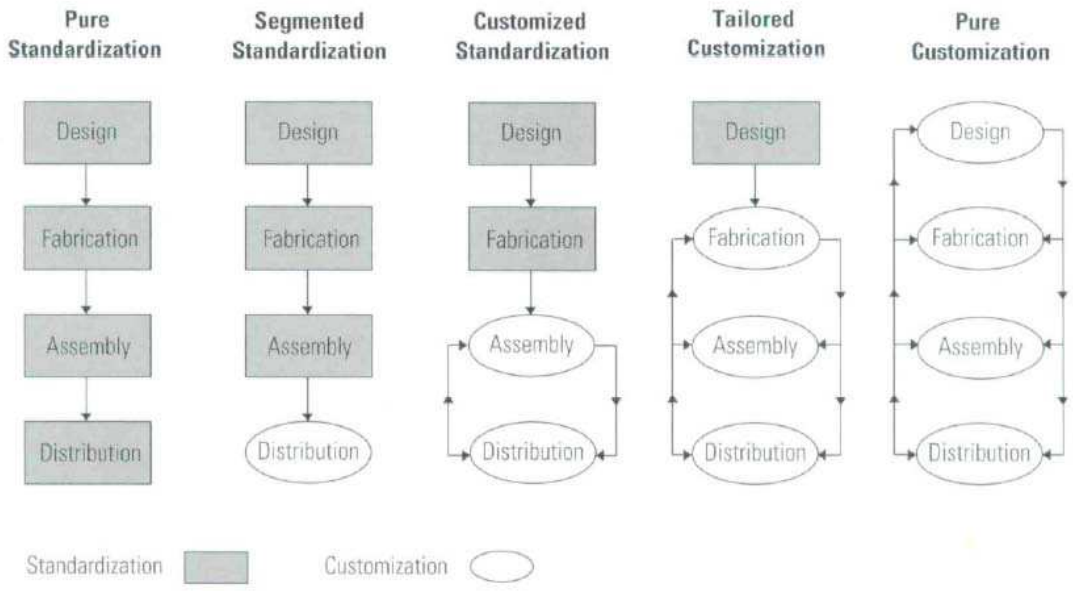

Figure 16 - A continuum of customization stages (Lampel & Mintzberg, 1996).

Customer involvement does not come at no cost. In order to function as desired, mass customization as a strategic approach needs to be supported by appropriate systems that are able to support the extensive interactions due to customer integration and co-creation (Duray, 2002). Piller et al. (2004) mention that organizations' manufacturing systems need to be extended with information technologies that can handle the highly information intensive character of mass customized products or services. Expensive, but there also is a turning point. Piller et al. (2004) introduces this as the concept of "economies of integration", which means the cost-saving potential (increasing returns) as a result of the customer-supplier integration. They distinguish three sources of cost-saving possibilities:

1) The value chain is separated into an order-specific and a customer-neutral part, cost-savings arise from the postponement of activities until an order is placed. An organization wins certainty and prevents costs of misplacement of activities due to imprecise planning information;
2) By integrating the customer into value creation, an organization acquires 'sticky information' (Von Hippel, 1994). The aggregation of this customer information to more precise market knowledge increases the efficiency of market research and product development activities;
3) By using the possibility of customization to increase switching costs for the customer, a firm builds stable relationships with its clients, allowing a better utilization of its customer base (sustainable relationship). Hence, costs for marketing activities and customer acquisition can decrease.

Having said this, the information provided in this chapter should be translated into a framework, that enables us to predict the successful application of mass customization for different service offerings. The next section presents the framework that is also used for case study analysis (chapter 4).

3.4 Framework description

This research uses the framework that is developed by Bask et al. (2011, p. 306), "by which different customer service offerings can be analyzed in terms of both modularity and customization." As already noticed, the term customization stands for any degree of customer involvement and is a good variable for this research. The framework makes it possible for organizations to analyze their service offerings, and a comparison with other organization can be made. The framework of Bask et al. (2011) presents the degree of customization and modularity separate, resulting in a 2x2 matrix in which service models varying from mass customization to standardization can be framed.

The framework is presented in figure 17, and consists of four categories which depend on the degree of modularity (y-axis) and customization (x-axis).

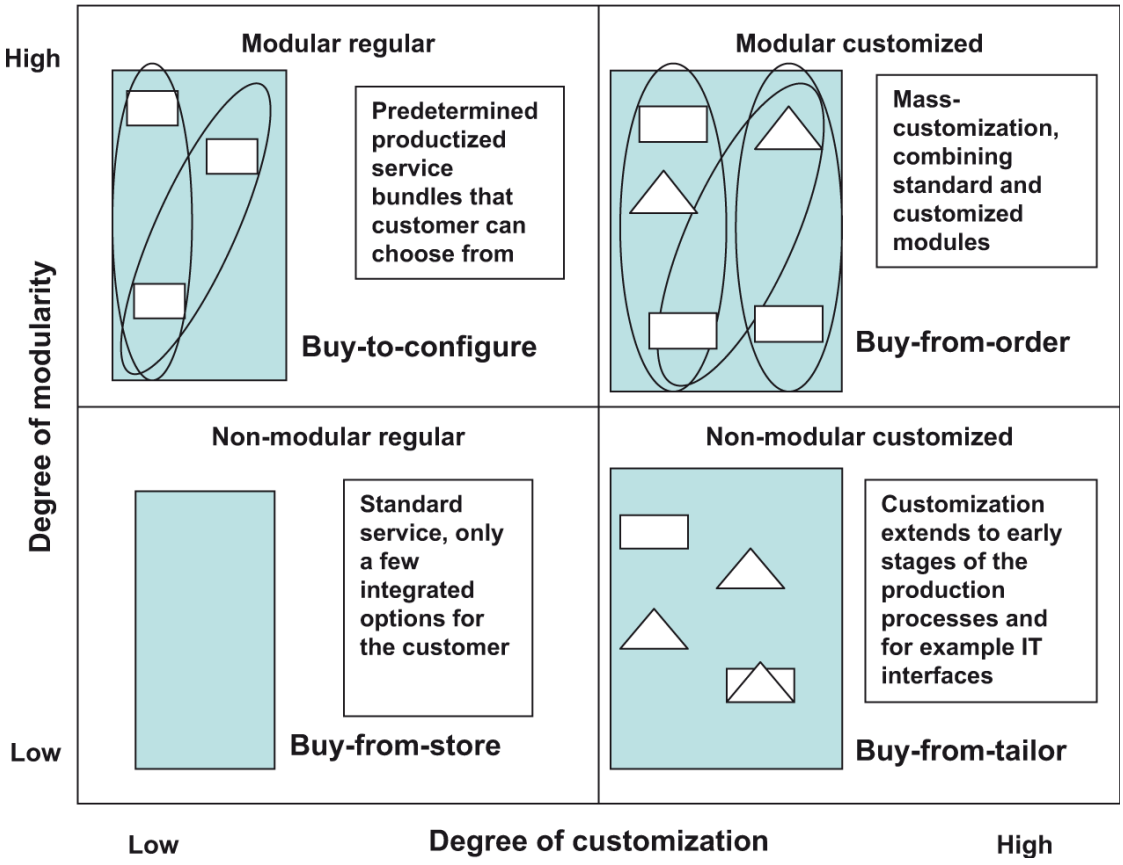

Figure 17 - Combining modularity and customization in a service offering (Bask, et al., 2011).

Four categories are distinguished:

- *Non-modular regular*: these service offerings result in only a few alternatives, and customers are not involved during the process. Customers only can pick out different types of the service;
- *Modular regular*: this service offering is more extensive. There are standard modules as choice options in order to fulfill customer needs.
- *Modular customized*: this service offering gives a large variety at an early stage. Standardized and customized modules can be combined to fulfill customer needs.

- *Non-modular customized*: this service offering is highly customizable, and fulfills all the customer requirements. Customer integration is extensive from the beginning of the process and that results in an integrated product (and not a modular one).

Since the framework of Bask et al. (2011) is quite descriptive, and has limited possibilities (4 different categories), it is helpful to adjust the model and add measurement criteria in order to score different service offerings. This means that both variables (modularity and customization) become measurable.

3.4.1 Measuring modularity

In order to measure modularity for a service offering, this research uses the measurement items of Tu et al. (2004) as a basis (see appendix 1). In their research, they focus on the existence of modules that are available during the production process to the customer or supplier. For this thesis we developed five slightly different scaled modularity variables, scaled from *Modularity0* (no modularity at all) to *Modularity4* (unlimited modularity):

- *Modularity0*: Modularity absent. Service offering does not have any modular units to choose from;
- *Modularity1*: The customer service offering has maximal 1 adjustable module that can be added during the process;
- *Modularity2*: The customer service offering can be broken down into standard sub processes that produce standard base units and customization sub processes that further customize the base units. 2 or 3 modules;
- *Modularity3*: The customer service offering consists of a lot of modules that can be rearranged to fulfill the needs of the customer. 4 or 5 modules;
- *Modularity4*: Extreme modularity. Unlimited modular possibilities (more than 5 modules).

3.4.2 Measuring customization

The same should be done for the variable *customization*. In order to measure customization, we use the classification of Lampel & Minzberg (1996) who did develop the continuum of customization stages (see figure 16). Hence, five variables for customization are defined, scaled from *Customization0* (no customization, but standardization) to *Modularity4* (pure customization) which are based on the time dimension of customization. Modification is possible for the customer in the design, fabrication, assembly and distribution phase:

- *Customization0*: Pure standardization, no influence of customers at all. Service offering has dominant design and is targeted to as much people as possible;
- *Customization1*: Segmented standardization. It is possible for the customer to modify the service offering in the distribution (or use) stage. Organization responds to the needs of different customer groups;
- *Customization2*: Customized standardization. Standardization in design and fabrication phase, customization for the assembly and distribution phase. Services are made to order, from standardized components;
- *Customization3*: Tailored customization. Standardization during the design phase, customization for the design, fabrication and assembly phase. The design is standard, but organization can fully adapt to the customers' needs;

- *Customization4*: Pure customization. Customers have influence and participate during all phases of the production process. Service is completely made to order.

3.5 Revised framework

All five measurement criteria for the variables *modularization* and *customization* can be used now for the creation of our revised framework. Since there are five gradations of each variable, we present a 5x5 matrix, as visible in table 2. This means 25 possible combinations, for which we give a classification name (bold) and an example. Using this revised framework enables us to scale different service offerings or service organizations regarding to their degree of customization and modularity. Using this framework gives an deliberately overview whether an service offering has mass customization features (for existing services) and capabilities (for yet to be developed service offerings).

	Customization0	*Customization1*	*Customization2*	*Customization3*	*Customization4*
Modularity0	**No Customization**	X	X	X	X
example	First PC: IBM PC				
Modularity1	X	**One-Module Standardized**	**One-Module Customized**	**One-Module Tailored**	**One-Module Pure Customized**
example		1st T-Ford	Quartz watch	Tax administration	X
Modularity2	X	**Regular Standardized**	**Regular Customized**	**Regular Tailored**	**Regular Pure Customized**
example		Next T-Ford	Apple iPhone 4s	Ice-Watch	X
Modularity3	X	**Modular Standardized**	**Modular Customized**	**Modular Tailored**	**Modular Pure Customized**
example		X	Smart (car)	Tailored shoes	Holiday
Modularity4	X	**Personally Standardized**	**Personally Customized**	**Personally Tailored**	**Full customization**
example		X	Video on demand	Bugatti Veyron	Superyacht

Table 2 – 5 x 5 revised framework

- The 'X' means a combination which is impossible. On the one hand, *Customization1-Customization4* in combination with *Modularity0* is not obvious, since there are no modules to choose from. On the other hand, *Modularity1-Modularity4* in combination with *Customization0* does not make sense, because there is no point in time the customer can influence the service offering even though that service offering has one or more modules;
- *Customization0* x *Modularity0*: means no choice for the customer (No Customization), at no specific moment during the process. An example is the first personal computer (IBM PC) which was completely standard and non-customizable;
- *Customization1* x *Modularity1*: One-Module Standardized. One module to choose, only at distribution phase. Example is the first T-Ford, offered only in black;
- *Customization1* x *Modularity2*: Regular Standardized. For example: the successor of the T-Ford has more colors to choose from;
- *Customization1* x *Modularity3*: Modular Standardized. An example is not easy to find, since service organizations from *Customization1* do not allow multiple requests from customers, but respond to different groups of customers;

- *Customization1* x *Modularity4*: Personally Standardized. This combination is not possible, since service organizations from *Customization1* do not allow requests from customers, but respond to different groups of customers;
- *Customization2* x *Modularity1*: One-Module Customized. For example an standard quartz time mechanism that is used by different watch manufacturers;
- *Customization2* x *Modularity2*: Regular Customized. An example is the request for an Apple iPhone 4s at a phone shop, since the only two module to choose from are memory and color;
- *Customization2* x *Modularity3*: This means customization from the assembly phase, for example a configurable car like Smart. Offering is built from larger standards, like the coloured plastic bodypanels.
- *Customization2* x *Modularity4*: Personally Customized. For example video-on-demand services, where customers can choose a title out of a non-limited range of films;
- *Customization3* x *Modularity1*: One-Module Tailored. For example a person who fills forms (part-time) for customers regarding their tax administration.
- *Customization3* x *Modularity2*: Regular Tailored. The service offering of Ice-Watch is a good example. On the Internet customers can choose a model and a specific color and order the watch, which has an characteristic look;
- *Customization3* x *Modularity3*: Modular Tailored. For example the Italian shoe-maker who offers hand-made shoes to its customers;
- *Customization3* x *Modularity4*: Personally Tailored. For example the Bugatti Veyron, which can be customized in dozens of varieties before it is fabricated;
- *Customization4* x *Modularity1*: One-Module Pure Customized. Only one module to choose is hard to think up since the customer is already involved in the design phase;
- *Customization4* x *Modularity2*: Regular Pure Customized. This is almost not possible when customers have already influence during the design phase;
- *Customization4* x *Modularity3*: Modular Pure Customized. For example the compostion of an exclusive holiday, such as a trip nobody else made before;
- *Customization4* x *Modularity4*: Fully Customized. The ultimate customization phase. This is everything that is offered fully personalized and fully customized, for instance a superyacht.

3.6 Concluding remark

This chapter introduced modularity, customer co-design and on-demand manufacturing as the most crucial components for service mass customizers to overcome. By given additional information on modularity and customer integration, the usefulness of a framework was evident. Therefore the Bask et al. (2011) framework , which combines these two variables, was presented. This answers the second research question "*What is an effective framework to analyze the degree of mass customization for service organizations?"* Our framework presented in table 2 enables us to frame service offerings and draw conclusions on the degree of mass customization.

4. EMPIRICAL FINDINGS AND INTERPRETATION

In this chapter the previously presented framework is discussed and analyzed by means of three case studies. All cases have a service dimension, in order to determine the degree of mass customization and modularity. Each case is portrayed with general information about the company, the industry, and the service offering. Next to this, the service offering is rated on the framework of Bask et al. (2011).

4.1 Research method: case study

Case study research is mostly practical when the phenomenon under investigation is difficult to study outside its natural setting and when investigated concepts and variables are difficult to quantify. Case study is performed when "how" and "why" questions are asked, when the researcher has little control over events and when the current phenomenon is investigated in a real-life context (Yin, 2003). Next to this, case study research is considered as 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). Research on mass customization of services is lacking, and a contribution with an empirical character reduces this research gap.

For this research, a multi-case study approach is adopted, since according to Yin (2003), multiple cases are used if "replication logic" is expected to expose support for theoretically similar results or contrasting results for predictable reasons. The applicability of the presented framework therefore can be tested on different service organizations.

For case selection, the following criteria have been considered:

- The company provides customers with services;
- The companies belong to different service-industries. This gives rise to generalization of our framework;
- The company is able to pursue mass customization as their business strategy.

In the following sections the cases are presented.

4.2 Banking industry – ING

Company's website: http://www.ing.nl/zakelijk/

4.2.1 Company overview

The case study is conducted at the Dutch Retail division of ING Bank N.V. During the period of six months, the service process of unauthorized account overdraft for business checking accounts is investigated at the business unit Product Management Payments (part of COO & Producten), see figure 18.

ING is a global financial institution of Dutch origin, focusing on the delivery of financial products and services in the way its customers want them delivered: with exemplary service, convenience and at competitive prices. ING wants to set the standard in helping their customers managing their financial future. The business strategy of ING Domestic Bank Nederland focuses on 'building the preferred bank'. Core value of this strategy is customer

centrality, which is closely connected to the integration of customers into the organizational processes of ING, being drivers of process improvement. Based on these company facts, it is plausible that ING pursues mass customization as business strategy.

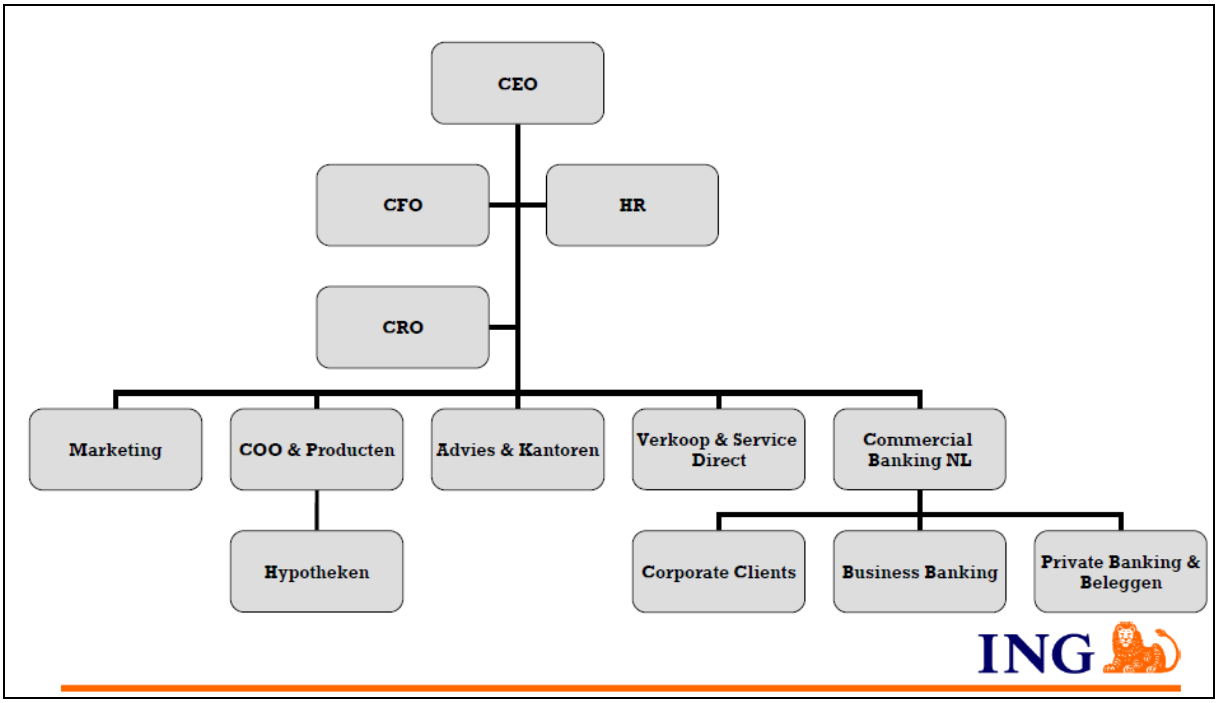

Figure 18 - Chart ING Bank N.V.

4.2.2 Industry

The banking industry has undergone a major downfall. The consequences of the financial crisis did also affected ING. In October 2008 ING received a capital injection of € 10 billion from the Dutch government. As a condition for this, ING had to sell the insurance division Nationale Nederlanden and a part of their banking activities (asset management and the division of the American branch of online bank ING Direct). The banking industry in general has made a downward shift in performance. The recovery of consumer confidence is crucial in the current economic situation. Many banks opt for strategic plans centered around the topic of consumer trust which should increase customer retention. ING's strategic focus is aimed at customer-oriented banking activities that easily respond to changing market conditions. This makes ING a relevant research object, since the characteristics that are described above fit into ING's operating and strategic model.

4.2.3 Service offering

The service offering that is analyzed for this case study considers the collection of unauthorized overdraft on business checking accounts (see figure 19). On this moment, this service offering is executed based on the amount of debt on the one hand, and on specific customer characteristics on the other hand. A higher amount of debt means a more stringent treatment, whereas the legal entity of an account holder (business account) sometimes leads to settlement with the private account of the customer (in case of joint and several liability).

This service offering is now rated, according to the measurement criteria developed in chapter three. Table 3 presents the service offering of ING positioned in the framework.

	Customization0	*Customization1*	*Customization2*	*Customization3*	*Customization4*
Modularity0 example	**No Customization**	X	X	X	X
Modularity1 example	X	**One-Module Standardized**	**One-Module Customized**	**One-Module Tailored**	**One-Module Pure Customized**
Modularity2 example	X	**Regular Standardized** ING	**Regular Customized**	**Regular Tailored**	**Regular Pure Customized**
Modularity3 example	X	**Modular Standardized**	**Modular Customized**	**Modular Tailored**	**Modular Pure Customized**
Modularity4 example	X	**Personally Standardized**	**Personally Customized**	**Personally Tailored**	**Full customization**

Table 3 – ING positioned in revised framework

Based on the revised framework, ING's service offering is regarded as 'Regular Standardized'. This means *Customization1* x *Modularity2*, since at the end of the debt collection process the module of settlement can be arranged for the customer. There are different modules, since the process allows different ways of customer treatment.
Customization is only possible at the use phase of the process, since customers cannot change the way debt collection is offered. The only modification is to pay the debt, and exit the process.

For ING this means they are not able to offer their clients a customized solution, mainly caused by a low customization level. On the one hand this is not in line with their business strategy of customer centricity, on the other hand it is a conscious choice because of the monitoring role in the debt collection process.

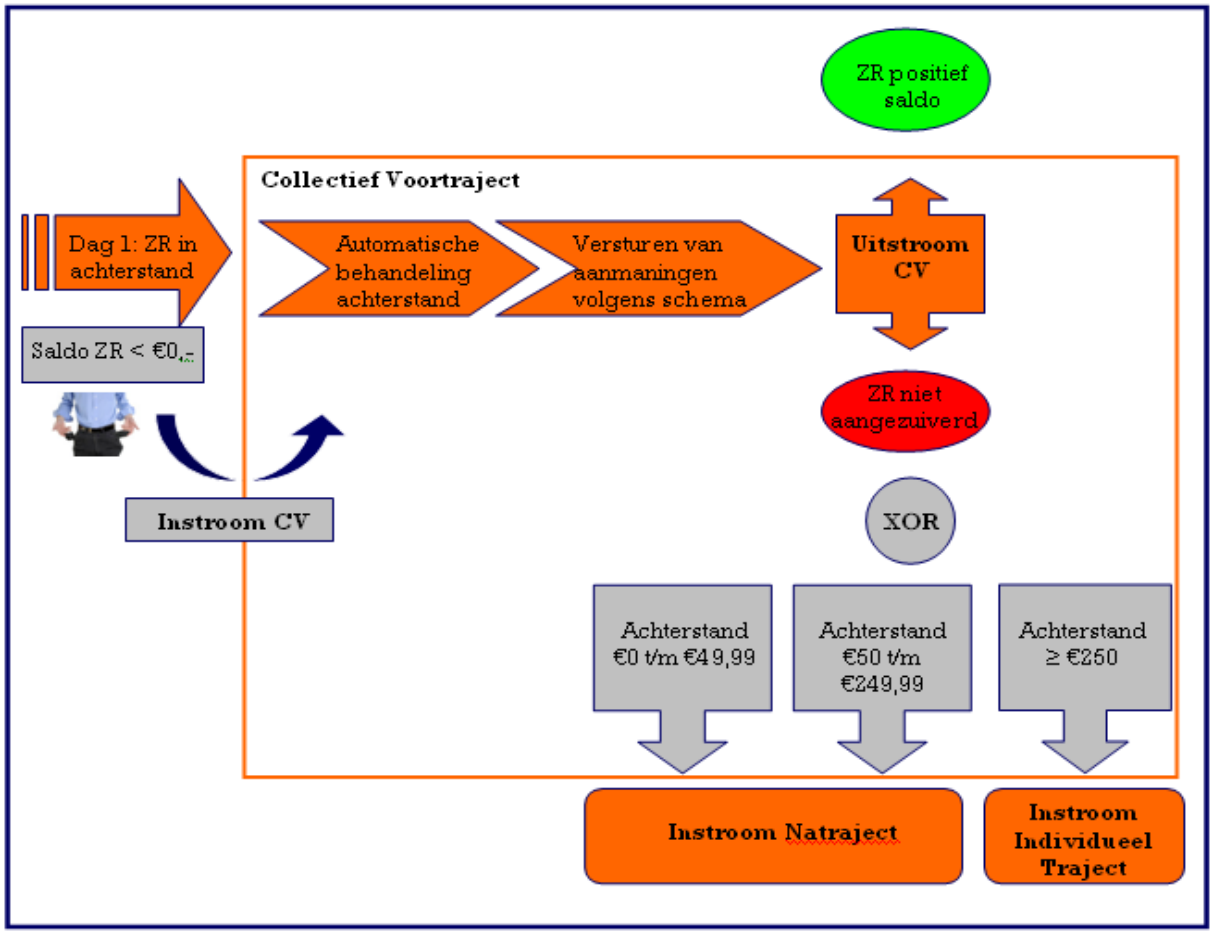

Figure 19 - Treatment ING's unauthorized checking account overdraft (Dutch)

4.3 Software industry – Microsoft Office 365 (SaaS)

Company's website: http://www.microsoft.com/nl-nl/office365/online-software.aspx

4.3.1 Company overview

This case study is conducted based on information from the mentioned website. Microsoft was founded in 1975 by Bill Gates and Paul Allen, and became over the years the most important software producer in the world. Microsoft is (based on sales volume) the world's biggest software company, and primarily known from their products, such as MS-DOS, Windows, and Microsoft Office. Profits and turnover in 2010 amounts respectively 18,7 and 61,9 billion dollar. Technology is still multiplying, because in 2011 Microsoft Office 365 is introduced, an internet service that can be categorized as SaaS.

4.3.2 Industry

Software as a Service (SaaS) is also referred to as the on-demand software industry. SaaS is a software delivery model in which software and its associated data is hosted in the cloud (centrally). SaaS is applicable to all sorts of business applications, such as CRM, ERP, invoicing, etc. According to Wikipedia, SaaS applications support application customization. This shows that this case is useful for the framework testing. A single customer can configure

different options that affects functionality and interface. The application can be customized to the degree it was designed for based on a set of predefined configuration options.

4.3.3 Service offering

Microsoft Office 365 is an online Office equivalent, which is hosted in the cloud. All connected users have online access to e-mail, on-line meetings, documents and agenda's which is secured and supported by Microsoft. Employees can easily access the same Office tools and information. Microsoft Office 365 is licensed on a flexible, per-user per-month subscription plan. The IT staff of the organization can simply set up new user accounts, and control access to new features. Microsoft offers a variety of plans that meet the needs of individuals, organizations, and government agencies of all sizes with varying IT needs.

Also Microsoft Office 365 will be rated according to the measurement criteria. Table 4 shows this case being applied on the developed framework.

	Customization0	*Customization1*	*Customization2*	*Customization3*	*Customization4*
Modularity0 example	**No Customization**	X	X	X	X
Modularity1 example	X	**One-Module Standardized**	**One-Module Customized**	**One-Module Tailored**	**One-Module Pure Customized**
Modularity2 example	X	**Regular Standardized**	**Regular Customized**	**Regular Tailored**	**Regular Pure Customized**
Modularity3 example	X	**Modular Standardized**	**Modular Customized**	**Modular Tailored**	**Modular Pure Customized**
Modularity4 example	X	**Personally Standardized**	**Personally Customized** MS Office 365	**Personally Tailored**	**Full customization**

Table 4 – Microsoft Office 365 positioned in revised framework

Based on the revised framework, MS Office 365 as a service offering is regarded as 'Personally Customized'. This means *Customization2* x *Modularity4*, which shows that Microsoft Office 365 has a high degree of modularity. The service offering can easily be divided in modular sub processes, and adjustment is the intention of this SaaS equivalent. There is also a high degree of customization for this service offering. Customization is only possible during the assembly and distribution phase, since MS Office 365 makes use of pre-determined modules.

Overall, this service offering thus has a high degree of modularity and average customization. As a service, SaaS in general is customizable, but is dependent of different modules that are brought together. Hence, aging of the service offering is a risk, and the continuous development of new software packages are highly important for software providers.

4.4 Car manufacturing – Citroën

Company's website: http://www.citroen.nl/home/#/auto/

4.4.1 Company overview

Citroën is a French automobile manufacturer, founded in 1919. Citroën was the first mass-production car company outside the USA. According to Wikipedia, Citroën has earned a reputation for innovation and revolutionary engineering, like the first all-steel-bodied car, the first front-wheel drive car, and the world's first hydro pneumatic self-leveling suspension system. Citroën is part of the PSA Peugeot Citroën group. In 2009, Citroën launched a new brand identity to celebrate its 90th anniversary. A premium series of cars under the DS name and logo was brought to market in 2010 with the DS3.

4.4.2 Industry

Citroën operates in the automotive industry, which designs, develops, manufactures, markets and sells motor vehicles. This industry was long characterized by mass producers, pushing products through the dealer channel. But efficiency in production methods started early, for example at Toyota's manufacturing plant. There the TPS (Toyota Production System) was developed, also known as lean manufacturing. Nowadays, car producers try to attract customers by producing based on customer demands, thus pulling product into the channel. It is more customer-driven than market-driven, by building cars for individual customers within a previously-decided range of options.

4.4.3 Service offering

The Citroën DS-series is a great example of a car that is pulled into the retail channel. No mass production efforts, but premium models, that have distinguished configuration options. At the moment, Citroën provides the DS3, DS4 and DS5 for customers with a high variety of appearance modifications. For instance the rooftop, chassis, side mirrors and lamps could be modified differently according to the customers' taste. There is a variety of unique-look paint jobs, patterned chrome, etc. Customers can customize their DS using the car configurator at Citroën's website. Table 5 presents the result of rating the Citroën DS-series for modularity and customization:

	Customization0	*Customization1*	*Customization2*	*Customization3*	*Customization4*
Modularity0 example	**No Customization**	X	X	X	X
Modularity1 example	X	**One-Module Standardized**	**One-Module Customized**	**One-Module Tailored**	**One-Module Pure Customized**
Modularity2 example	X	**Regular Standardized**	**Regular Customized**	**Regular Tailored**	**Regular Pure Customized**
Modularity3 example	X	**Modular Standardized**	**Modular Customized**	**Modular Tailored**	**Modular Pure Customized**
Modularity4 example	X	**Personally Standardized**	**Personally Customized** Citroën DS-series	**Personally Tailored**	**Full customization**

Table 5 – Citroën positioned in revised framework

Based on the revised framework, Citroën's production of cars seen as a service offering, is regarded as 'Modular Customized'. This means *Customization2* x *Modularity4*, which shows that Citroën has an high degree of modularity. During the process, different modules can be added (representing the multiple choice options for the individual DS-series) and customers can make modifications to a great extent. Citroën offers a variety of configuration options relative to competitors that is should be seen as almost unlimited. But, when the car is in the production stage, nothing can be changed. Therefore, customization is only rated as average.

For car producers, this is the most customizable way to produce cars at the moment, on the one hand not allowing customers influence the design and production phase, but benefit from a high degree of modularity possibilities.

4.5 Summary of results

This chapter provides an answer to the third research question *"What is the result of implementing this revised framework?"*. By using the revised model, service offerings can be scaled along a 5 x 5 matrix, which conclude on the degree of modularity (y-axis) and customization (x-axis). This framework is an effective tool considering the analysis of mass customization in the service industry. The 3 cases are placed into the framework and it became clear that for each case a typology could be found.

All three companies actually consider the customer as an important factor for their service offering. To find companies which allow customers to make modifications in early stages of the production process (high customization) is however difficult. Mostly this causes service offerings to become more expensive, and the process of making them too complex.

5. CONCLUSION

This research started with the notion that the service industry has gained importance during the last decades. Services should be viewed as a process of customer co-creation which create substantial customer value for each individual customer. This is practically the same as mass customization is aiming at; providing custom-made products and services, with near mass production efficiency. However, the differences between goods and services (product view) and a service offering (process view) are important in this research. Therefore in chapter 2 the main challenges that apply to the service industry are distinguished, giving rise to the fact that mass customization is difficult to apply for service organizations.

This research focused on the development of a framework that makes it possible to analyze mass customized service offerings. Therefore, chapter 3 applied mass customization into the service context through working towards a framework that overcomes the most important obstacles to mass customized service: *modularity, on-demand manufacturing,* and *customer co-design*. This framework is developed by combining the degree of *modularity* and *customer integration (customization)*, which finally is applied to multiple cases of service offerings. Measurement criteria were developed for both variables, and scaling the different case studies gave us interesting insights. All three cases fit into the revised framework and could be 'rated' along the variables *modularity* and *customization*. The higher the degree of customer interaction and offering choices, the higher degree of mass customization should be reached in the revised framework.

Our revised framework is the answer to the main research question (*how can mass customization be analyzed in the service industry?)* of this thesis. Using our framework gives researchers and managers the possibility to determine the degree of mass customization for random service offerings.

5.1 Theoretical and practical contribution

Since most of the previous research on mass customization was performed for the manufacturing domain (Piller & Tseng, 2010), this research contributes to the research gap in the service domain. Developing the revised framework (see table 2) based on the framework of Bask et al. (2011), provides a solid addition to the existing knowledge base. Obviously, it is evident that mass customization for the services domain is worthwhile to investigate even further.

The increased importance for organizations towards services that perfectly matches customer needs is evident after performing this research. The purpose of this study was to present an evaluation framework that guides researchers and organizations in the right direction, deciding whether a service offering matches customer needs (being heterogeneous) with modular, customized components offered at mass production efficiency. By revising Bask et al's (2011) framework, this research developed a more integrated and cohesive tool for this decision, since the framework is no longer based solely on qualitative assumptions but also on quantitative metrics. Next to this, the framework is created by using the most important literature in this field of study. The literature analysis (found in chapter 2 and 3) creates order in the wide variety of mass customization research, by determining the position of the service management area in this sometimes intangible field of research. The case study results indicate that our framework is applicable for theoretical use and research of the service industry.

For managers this framework is a helpful tool to evaluate their service offerings and gives them insights for the expansion of their business activities in the right direction. For them it is an useful framework which allows them to rate their service offering according to two variables (modularity and customization). Previously, those variables were difficult to identify simultaneously. Managers and businesses can change their process of offering an individual service according to the findings from this framework. The case study results indicate that our framework is applicable for practical use. Managers can use it as a tool to determine whether a mass customization strategy, in order to become more customer oriented, is appropriate for their services offerings.

5.2 Limitations of our study

Despite the fact that the developed framework in this thesis contributes to as well theory as practice, we mention some limitations of our study. Remember, this thesis is primarily based on modularity and mass customization in a service setting and it gives a framework for measuring modularity and customization for service offerings only.

- The limited sample. Although evidence is based on three case studies in three different service areas (banking, automobile and software), this may not be representative for the service industry as a whole;
- The variable 'modularity' used in this research is quite often related to the manufacturing industry. Since this research is based on existing knowledge of that variable, using it for further research is risky in terms of misinterpretation issues;
- Services differ in terms of characteristics and attributes from physical goods, which means that in services the modules may mix together because of the process view. This characteristic of services and service modules brings extra challenges for customers, because it is hard to identify the exact components involved in the service production and service offering. The identified production stages which are appropriate for analyzing the production of physical goods are also difficult to distinguish for the service setting;
- This research did not distinguish the variable 'cost' in the developed framework. It is plausible that expenses play an important role for organizations that are using mass customization as a strategy. It is still unclear what level of investment is necessary for organizations in order to develop a beneficial mass customization strategy.

5.3 Suggestions for future research

Future research should concentrate on the validation of the results from our framework. A more in-depth case study in the service industry is recommended to verify the initial value of our framework for application on all service offerings as well as for theory. Our initial findings also demonstrate the usefulness of this framework for managerial purposes. Hence, extending the scope is beneficial for both researchers and business managers. Besides that, further research gives rise to our initial finding that our framework is usable for scaling service offerings on their mass customization capability.

Our research focuses on the provision of service offerings, which are in case of mass customization created in cooperation with the customer. The developed framework shows that 'created in cooperation with the customer' could be measured using the variables *customization* and *modularity*. This assumption holds true for our study, however further research should focus on the applicability of these variables for a service setting. Especially

the variable *modularity* is due to the intangibility of most service offerings quite difficult to interpret and to measure for a random service offering. This research shows that this variable could be formulated more comprehensively since it raises questions, and that a modification of it is required.

Future research should also focus on the cost perspective of mass customized service offerings. Although it is already proven in previous literature that mass customization is beneficial for both customers and service organizations, it still remains unknown what level of investment is required for organizations to apply a mass customization strategy, and whether customers profit from buying customized service offerings produced by organizations with mass production efficiency, facing lower prices or not.

In short, there are multiple open ends where future research should focus on. However, future research is indispensable to provide us with a greater inside in the complex and relatively unexplored field of mass customization for the service industry at the end.

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APPENDIX 1

Code Names	Questionnaire Items
	Dynamic Teaming (DT)
DT1*	Production teams that can be reorganized are used in our plant
DT2*	Production teams can be reorganized in response to product/process changes
DT3*	Production teams can be reassigned to different production tasks
DT4	Production teams are not permanently linked to a certain production task
DT5*	Production team members can be reassigned to different teams
DT6*	Production team members are capable of working on different teams
DT7	Production teams have no difficulty accessing necessary resources
	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	Our products can be customized by adding feature modules as requested
PM5*	Product modules can be reassembled into different forms
PM6*	Product feature modules can be added to a standard base unit
PM7	Product modules can be rearranged by end-users to suit their needs
	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 subprocesses* that produce standard base units and *customization subprocesses* that further customize the base units
PRM5*	Production process modules can be rearranged so that customization subprocesses occur last
PRM6	Production process modules can be rearranged so that customization subprocesses be carried out later at distribution centers

*Items that are retained in the final measurement instrument.

Figure 20 - Modularity based measurement items (Tu, et al., 2004).