Master's Thesis – Copenhagen Business School


# Mass customization

## An assessment of the scope of implementation

Cand.merc. Supply Chain Management

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# *Executive summary*

The emergence of mass customization has introduced customized products for the public, which used to be reserved for the elite at premium prices. This unique business concept incorporates the two competitive priorities of customization and price, which are by definition rivaling. An increased demand towards customized goods, and the technical capabilities of the 21st century, has made mass customization a viable strategy for companies to meet the demand and differentiate themselves from competitors.

Implementing mass customization is however a challenging operation, as the agility of customized goods has to mixed with the efficiency of mass produced goods. There will be both internal and external challenges, and the company will have to adjust the supply chain and production, and furthermore manage an increased level of complexity within logistics, sourcing and information management.

This thesis proposes a conceptual framework (figure 4.2) that serves as a tool to evaluate the scope of the implementation process. It is meant as a decision making tool that can help companies assess and identify the success factors, as well as the internal and external changes that have to be made.

The findings show that although mass customization combines the elements of efficiency and customization, the success factors are heavily dependent on the competitive parameter. A company should habitually have a clear focus on either offering a large degree of customization or offering customization at low cost, as these to business models have vastly different supply chain configurations and success factors.

By analyzing and evaluating these factors and the scope of changes, the company can subsequently make a qualified decision on the basis of our framework and analysis, of whether the implementation of mass customization will be an economically viable and sustainable business model.

The framework was conclusively tested on Wilson Sporting Goods Co. for the primary reason of showing how the framework should be applied.

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# 1 Introduction

*"Any customer can have a car painted any color that he wants so long as it is black"*

- Henry Ford, 1909

This well-known quote from Henry Ford concerning Fords notorious Model T, portrays how the production systems from the beginning of industrialization through much of the twentieth century looked like. Mass production was born, and prioritized low cost production in order to reduce prices, to eventually initiate and stimulate mass consumption. Ford simply made cars available to people regardless of their social class, at a time when the car was considered a luxury toy for the upper class. Furthermore, mass production improved the consumption capacity altogether for the working class, by offering cheaper products that became universal consumer goods, shared by the elite and the working class between. Manufacturing industries was characterized by efficient production through highly centralized and hierarchical decision making, specialized assembly lines, fast moving resources and goods, and taking advantage of economies of scale (*Best, 1990* and *Boyer et al. 1993/1997*).

Although mass production made what was considered luxury goods available to any social class, quality was a recurring concern for especially the American manufacturing systems. Over time, manufacturing systems would develop and evolve, and particularly the Japanese automotive industry with Toyota as the frontrunner, was capable of producing quality vehicles at remarkably lower cost than their American predecessors. To be concise, they adapted the Fordist model by having a more flexible and skilled workforce, and offering them life-long employment in order to increase their motivation. By continuously improving production processes, combined with close relationships to their suppliers, they were able derive enormous cost advantages through "just-in-time" deliveries. This provided the possibility to avoid large amounts of inventory and investing in storage facilities (*Dohse et al, 1985*). Over time, mass production systems have progressively become highly advanced and exceptionally efficient.

Despite cheaper products and better quality, countless customers are to a greater extent not satisfied with standard products. As manufactured products became more universal, customized products was however still reserved for the elite, and with an exorbitant price tag

alongside. The more customized a product is, the higher value it has to the customer, and moreover a higher price.

In the late 1980's, the concept of mass customization emerged, although variations had surfaced roughly two decades earlier. The vision of this concept was to offer customized products at essentially the price of mass produced products. It was the result of increasingly flexible and optimized production systems that led to this possibility. It was furthermore a way for companies to get a larger market share, obtain a competitive advantage and differentiate themselves in highly competitive and segmented markets (*Da Silveira et al, 2001*). Although the concept of mass customization frequently appeared in literature by scholars, it was rarely applied in real world business as a strategic tool. The business world simply lacked the adequate and necessary technology to cope with the processes of customer integration and co-creation. Manufacturing and information systems capable of dealing with customer co-creation were basically absent until the internet became a widespread and reliable tool around the turn of the millennium (*Piller et al, 2004*). From then on, mass customization was more regularly implemented by companies as an instrument to address the rapid changing market realities, while still preserving the efficiency of mass production.

In the present day, there are almost unlimited possibilities for customers to customize their product. A well known example is cars, where customers have countless options almost regardless of the maker and price class. Mass customization is by no means limited to luxury goods like cars. For instance, customers can choose the colors of every single section on their Nike sneakers, as well as having their name on it if they like. BoConcept lets you choose the fabric and color of the vast majority of their products. To use their sofas as an example, the customer can chose the size and design of everything, from the armrest to the feet, and anything else in between. The possibilities are endless, not just with BoConept, but regardless of the industry and product the customer is seeking, and all at a relatively small price increase from a standardized product.

## 1.1 Motivation

While there are many success stories, there are irrefutably many stories of failed attempts at implementing a mass customization strategy, which Dell and Levi's are great examples of. Dell, who is known for giving customers infinite options to chose from, could

not keep their costs low enough, relative to the complexity of assembling a computer according to the costumers needs. This would only be possible if they took a premium price, but the co-creation option quite simply did not create enough value for the customers anymore. The result was an inevitable change to a simpler business model with far less customization (*dell.com* and *mass-customization.blogs.com*). One highly essential principle that one cannot forget is that the competitive priorities of price and customization are by definition rivaling, and therefore make mass customization a very unique and also challenging strategy to execute. It poses several challenges for the supply chain and the manufacturing system, as well as additional flow of information.

Although the field of mass customization is certainly not abandoned by scholars, there is a clear scarcity in models that provide decision support within manufacturing systems as well as supply chains according to *Kumar et al* (*2007*). *Pillar* (*2004*) further suggests that mass customization is still far from the peak of its learning curve. There is in other words a need for further research on the topic of implementing mass customization, which is a motivating factor for this thesis. *Da Silveira et al* (*2001*) furthermore states that much of the literature describes different levels of mass customization, but that these studies do not provide much knowledge on how to decide what the appropriate level of customization is for a firm. There is a mutual dependency between implementation and level of customization, as the needed adjustments of implementation rely greatly on the level of customization the company offers.

The aim of this thesis is therefore to elucidate the factors and strategies which need consideration to successfully implement a sustainable mass customization strategy. This will be both from a supply chain management and company perspective, and with great attention to determining the level of customization. A conceptual framework will consequently be built from these factors, and will help serve as tool for decision making and evaluating the scope of a potential implementation.

## 1.2 Problem area

As mentioned in the preceding paragraphs, implementing MC is not an undisputed success, due to both internal and external challenges. When companies go from mass

production to mass customization they are obliged to make changes in their supply chain and their production. They will experience challenges in terms of a less efficient supply chain, inventory and sourcing changes, enhanced production planning and many more. Companies will furthermore be introduced to new strategies such as postponement and modularity, and be able to handle an increased level of information that needs to be managed, as the customers become integrated in the process of designing the products. There are numerous challenges, and as *Kumar et al* (*2007*) mentioned, there is a shortage of decision making tools for implementation of mass customization. There are furthermore a shortage on how to decide the proper level of customization (*Da Silveira et al, 2001*), which are closely linked to the implementation process. It is of great importance to note that companies in some instances will be better off by not implementing mass customization.

This leads us to the following problem statement and research questions.

## 1.3 Problem statement

With the introduction, motivation and problem area in mind, we can formulate the following main question:

***"How can companies assess the scope of implementing mass customization, and moreover evaluate its viability?"***

The desired outcome is to provide an overview and assessment of the different factors that need consideration when implementing mass customization, to help make an eventual implementation more effortless and economically successful. This knowledge will furthermore be used to establish a conceptual framework, which will serve as a decision making tool that can guide companies to create their own unique mass customization business model.

It is important to clarify that the objective of this thesis and framework, is to assess how well a mass customization strategy will fit a company. The company should use it to evaluate the necessary changes and adjustments *before* implementation and not *during* implementation. After the framework has been thoroughly applied and undergone, the company can make a much more reliable and qualified decision, of whether a mass

customization strategy will be an economically sustainable business model. The company can moreover better map and elucidate the changes, and additionally the scope of these changes, to establish an idea of the internal and external readiness of a mass customization project.

The article by *Berman* (*2002*) is fundamentally covering this topic, but from a very different perspective. His article covers a company's readiness to implementing mass customization. This thesis will in essence do the same, but in a much more extensive and thorough way, by proposing what supply chain and company changes that are needed, along with external success factors, depending on what type of product the company produce.

## 1.4 Research questions

1. What are the critical success factors for an economically viable implementation of mass customization?
2. How can companies approach and do an analytical assessment of the mass customization implementation process?
   2.1 How could a conceptual framework for this look like?
3. How does the level of customization impact the supply chain configuration?
   3.1 How should the supply chain accordingly be adjusted?
4. How would the proposed conceptual framework be applied Wilson Sporting Goods Co.?

The above research questions serves as complementary inquiries that should help construct a more comprehensive and sufficient answer to the main problem statement.

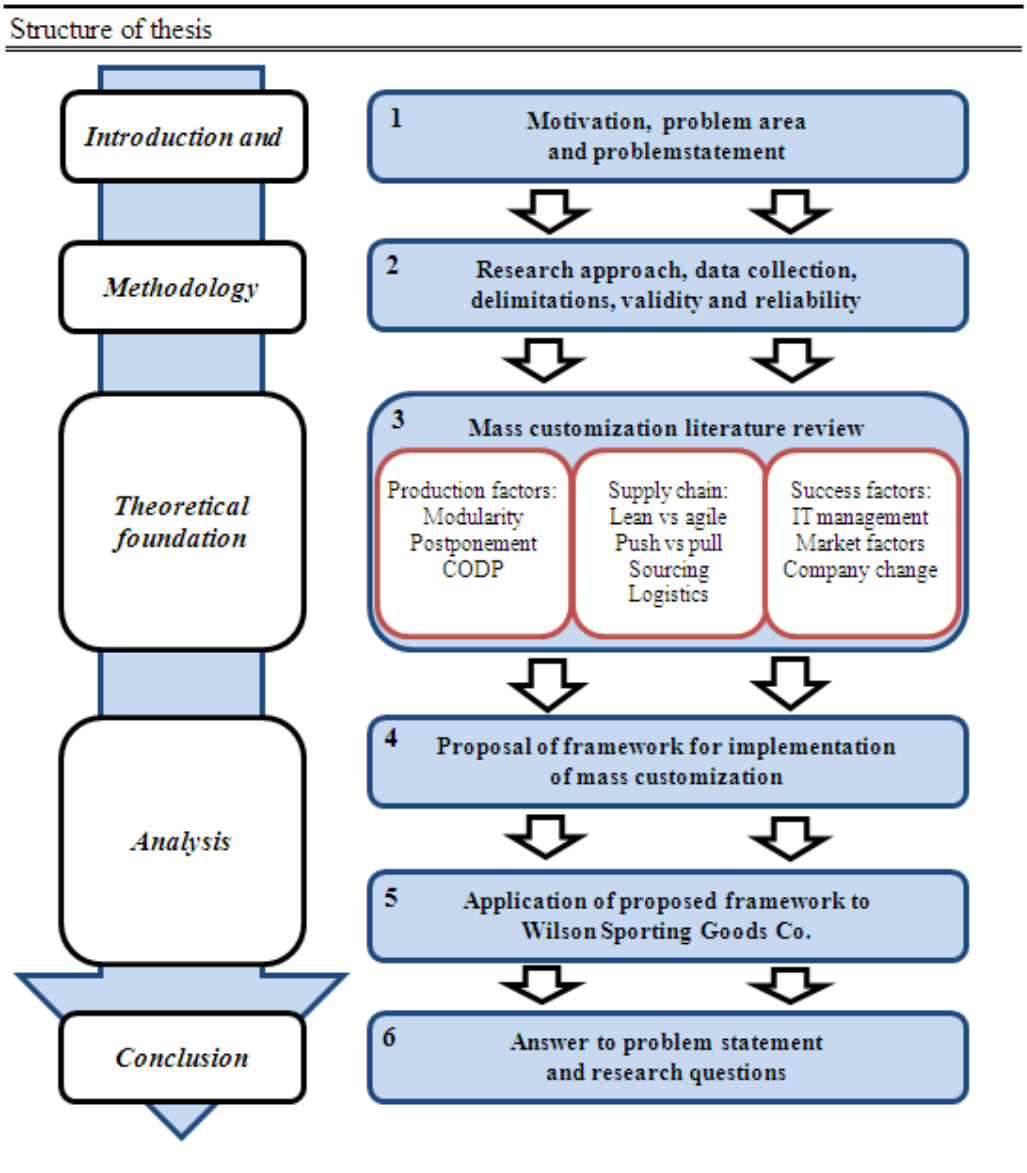
# 2 Methodology

In this section the methodological reflections are covered.

## 2.1 Structure of thesis

The following figure is incorporated to give a better overview over how the thesis is built and structured.

**Figure 2.1**




Source: *Own creation*

## 2.2 Scientific Approach

The methodology that is generally applied throughout this thesis will primarily be based on the books "*Den Skinbarlige Virkelighed*" by *Ib Andersen* (*2006*) and "*Methodology for Creating Business Knowledge*" by *Arbnor & Bjerke* (*1997*) to have a high level of continuity and coherence throughout. These books are considered the standards of business methodology books.

According to both *Andersen* (*2006*) and *Arbnor & Bjerke* (*1997*), when choosing a scientific approach, it is the problem at hand that should determine the method or technique to create the best possible solution.

As the objective of this thesis is to develop a conceptual framework, taking the scientific approach of a theoretical thesis seems to be the most fitting route. This is otherwise known as a theoretical or librarian dissertation (*Rudestam & Newton, 1992*). Doing a theoretical thesis has some important characteristics and principles. The fundamental principle is to contribute with something original to the literature, which there is different ways of doing.

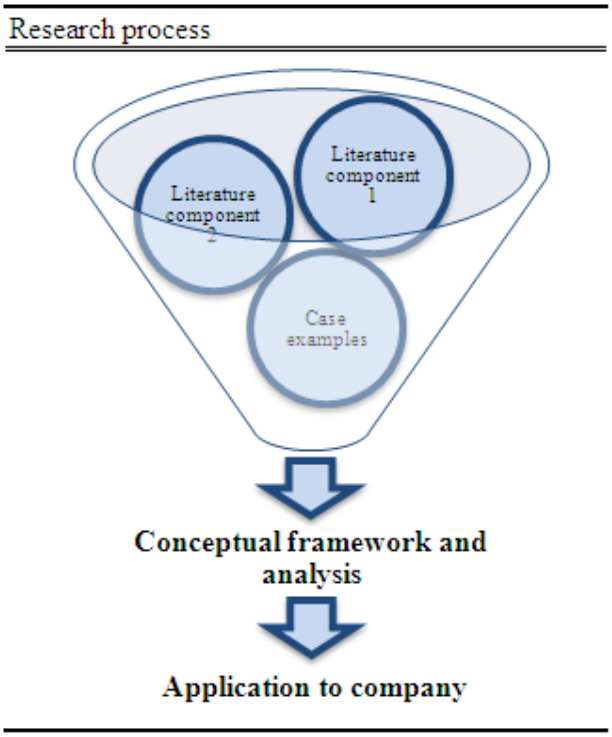
It is often discovering a gap in the literature, which presents opportunities to add new concepts or ideas. It can also be by critically reviewing literature and provide improvements, although this can be a severely hard intellectual challenge due to the intimate study of a field by earlier researchers, and requires a profound knowledge of a specific subject. It can furthermore be an extension of a research that have a unilateral perspective or methodology, which can be improved by researching the topic from a new standpoint or using a new methodology. An analysis which bring together or synthesizes different parts of the literature can also be a way of contributing to the literature (*Rudestam & Newton, 1992*).

The primary approach of this thesis, will be constructing a conceptual framework and the main analysis, on the basis of synthesizing and integrating different components of the existing literature on mass customization. This is consequently done due to the gap in the literature, and will furthermore be backed up by the use of secondary empirical data throughout the analysis. It is then tested on a company for its applicability and usefulness, and furthermore to demonstrate how the proposed framework is supposed to be applied. There are furthermore on rare occasions presented arguments that contradict or discuss some statements made by the original authors, which can be considered to be contributing to knowledge. The

overall contribution of this thesis will therefore be a result of several of the prerequisites that was presented by above by *Rudestam & Newton* (*1992*).

The following model should give a better overview of the research process.

**Figure 2.2**




Source: *Own creation*

With a clear knowledge of how the thesis is constructed, the remaining methodological reflections will now be explored in additional detail.

## 2.3 Research design and conclusion method

### *2.3.1 Inductive vs. deductive*

According to *Andersen* (*2006*) there are two ways to produce knowledge, called *induction* and *deduction* respectively, from which it is possible do draw scientific conclusions.

*"Deductive conclusions are, when we based on general principles formulate conclusions about individual events"* (Translated from *Andersen, 2006*, pp. 32)

This means that new hypotheses are proposed based on the already existing theories on the subject that are considered to be valid. This method is typically employed by consulting companies.

*"Induction is, when we based on an individual event draw conclusions about a principle or general regularities"* (Translated from *Andersen, 2006*, pp. 32)

This means that a new theory is developed based on observations from the empirical data's patterns and occurrences.

### *2.3.2. Position of thesis*

The desired approach for this thesis is effectively a combination of both methods. Although the inductive and deductive methods can be used "alone", they are far more often used either sequentially or in parallel at the same time. It is common to subsequently test the deductive hypotheses and theories on inductive empirical data for verification and validity.

According to *Arbnor & Bjerke* (*1997*) it is actually a weakness to focus on only one method, and *Andersen* (*2006*) further states that: *"in practice it is difficult… - …to separate the inductive and deductive method, as these are merged throughout the entire process"* (Translated from *Andersen, 2006*, pp.33).

Therefore, depending on the source, both conclusions methods will be used. When conclusions are based on existing literature it will be deductively, and when concluding on empirical studies it will be inductively. That means that the conceptual framework and analysis is constructed out of deductions from the theoretical foundation, and these are then tested inductively on Wilson Sporting Goods Co.

## 2.4 Data collection

### *2.4.1 Theoretical Data*

When attempting to solve a scientific problem the best possible way, a theoretical foundation (literature review) is essential as *Andersen* (*2006*) points out: *"A thorough and systematic literature review is crucial to get a good result. A literature review can give*

*valuable information about existing theories, the experiences from others in regards to studies, thoughts etc."* (Translated from *Andersen, 2006*, pp. 93)

This thesis will therefore start out by reviewing the relevant literature that already exist on the topic of mass customization to establish a solid theoretical foundation, and additionally review supplementary theory in general that can serve to lay a good foundation for the construction of our model and analysis.

### *2.4.2 Secondary Empirical Data*

There has been a considerable need to collect secondary empirical data in this thesis, in order to construct our framework and as the foundation for the application of the framework to Wilson Sporting Goods Co.

The multiple variations of secondary empirical data includes the 2009 annual report from the Amer Sports Group (mother company of Wilson), several case studies from academic journals and the internet, as well as journalist articles and company homepages which can provide relevant info or data that is useful in this thesis.

When the proposed framework is applied to Wilson, there have been instances where the information out of necessity will be based on qualified assumptions, due to inaccessibility of otherwise relevant information.

### *2.4.3 Primary Data*

Due to the nature of the problem statement, relevant companies are not easily accessible as there by nature are far less companies which exercise a mass customization strategy. There have consequently not been retrieved any sort of primary data, though this does not necessarily mean that the problem statement cannot be answered in a satisfying way. When writing a theoretical thesis, the analysis will habitually be based on existing literature and therefore circumvent the need of primary data collection (*Rudestam & Newton, 1992*).

### *2.4.4 Practical method*

In order to get material for the theoretical foundation, it is the online database affiliated with the CBS library, which has been the primary source to acquire academic articles. Books for theory or methodology have likewise been acquired in the CBS library.

The empirical data has been acquired through various internet sources. Case studies from academic journals have been obtained from the online CBS database, whereas other journalist articles etc. have been found on several websites.

## 2.5 Critique of sources

### *2.5.1 Validity*

Scientific validity is a very important measurement when developing new knowledge, as validity is the assessment of the quality of the produced knowledge (*Arbnor & Bjerke, 1997*). It is therefore of highest priority to ensure a high level of validity, although the generated results are theoretical. The following points have been considered.

The theoretic foundation is established through the use of widely recognized theories, which serve as the basis for our analysis and conclusions. The vast majority of these theories are from peer-reviewed scientific articles from recognized academic journals within the field of our topic. They have in other words undergone a thorough reviewing process from other scholars within the field before being published. The books that are used are also widely acknowledged, and most of them are moreover recognized educational material. This suggests a very high level of validity of the academic theories that is used as the building blocks for our analysis, and furthermore for our conclusions. The secondary empirical and theoretical data is sought out to be the most recent material that exists on our subject, to increase the validity.

To further enhance the scientific validity, we aim to have a logic consistency and coherence between our research problem, methodology, analysis and conclusion (*Arbnor & Bjerke, 1997*).

It is difficult to assess the overall validity of the analysis and conclusion before an actual application, but the validity of the foundation and basis for our results, seem to be very high.

### *2.5.2 Reliability*

The reliability is a measurement of the precision and how accurate we examine our research problem, and to what degree it is affected by random coincidences. Reliability can

moreover be defined as a principle that if the study is replicated under the same circumstances, it would provide the same results (*Andersen, 2006* and *Rudestam & Newton, 1992*).

This can in other words be explained as, if the results we generate can be trusted in connection to the data that is collected. As this thesis is heavily based on secondary empirical data, the reliability is assumed to be high as sources such as academic journals and annual reports should be very reliable. Information obtained on the internet can possibly be biased, but this is presumed to be of little or no significance for the reliability of this thesis.

### *2.5.3 Quantitative vs. qualitative*

The proposed framework will be applied to Wilson Sporting Goods Co. as a way to test it, and can be viewed as a single case study. The reason a single case study was chosen, is that it is assessed to be more relevant to test it thoroughly rather than test it shallower on multiple case companies, as this will get a better indication on how the framework is supposed to be applied.

If a single case study is comprehensive, it is possible to inductively make generalizations from such a study. However the question is often not if it is possible, but rather how valid the generalizations are (*Andersen, 2006*). In this study, it is evaluated to be of rather high validity as the case study is simply used to show how the framework should be used.

### *2.5.4 Secondary vs. primary*

A primary data collection from Wilson Sporting Goods Co. that would provide accurate information about their supply chain configuration, could have constructed a more precise case assessment and analysis of their potential for mass customization implementation. This would however not necessarily mean a more satisfying test of the framework.

## 2.6 Delimitations

This section will explain the limits of the research in our thesis, which will be divided into three sections.

### *2.6.1 Scope of research delimitations*

According to the definition in the theoretical foundation, mass customization includes customer co-creation. It should be noted that customization in some instances can refer to market specific modifications, where Coca Cola for instance use Danish labels on their bottles in Denmark. In this thesis, mass customization refers to production with customer integration in the design phase.

There are several degrees or levels of customization, and some authors include make-to-stock and engineer-to-order in the mass customization definition. This thesis will seek to refrain from the areas of engineer-to-order and new product development to the extent it is possible, but some of these definitions can get very nebulous. Products such as bridges that are completely unique with a quantity of one unit do not have any relevance to this study.

The concept of mass customization in the service industry has recently emerged in the literature and requires a separate study, and will thus be delineated from this thesis. Therefore this thesis will carry a prerequisite, in which only circumstances of actually manufactured products are explored. Other forms of customized solutions that are not produced goods will consequently be refrained from investigating.

### *2.6.2 Theoretical delimitations*

The scientific approach of a theoretical dissertation that is used in this thesis is obviously not the only scientific approach. There are other schools of research within supply chain management and other business studies, where three of the most acknowledged are the Analytical-, the Systems- and the Actors- Approach proposed by *Arbnor & Bjerke* (*1997*). These and other approaches will be completely delineated from using.

### *2.6.3 Empirical delimitations*

During the construction of the conceptual framework, the specific characteristics of each company and manufacturer will not be considered, as the goal is to create a general model. This will for instance include market position, type of product and manufacturing, country etc. This has some implications for the model, which is described later under the section “generalization capability of framework”.

## 2.7 Building models

As the main objective of this thesis is to create a model, or in this thesis referred to as an illustrative conceptual framework, it should be mentioned why creating a model is purposeful. A model can be defined the in the following way:

"*A model is a conceptual apparatus, where the relations between the concepts are clearly indicated. Models are built with the purpose of creating simplified systems, as an excerpt of the reality we seek to study*" (Translated from *Andersen, 2006*, pp. 82).

By creating a model which represents the real world in a clearer and more manageable way, it is possible to make new discoveries and findings, and moreover present these findings in a more uncomplicated form. This is very beneficial as the real world can in many instances seem rather complex and confusing, and a model is therefore very purposeful when the thesis has an analytical nature (*Andersen, 2006*).

A model cannot stand alone and will need a thorough description, as the concepts relations can be misinterpreted if they are not carefully explained. As a model is often a hypothesis or assumption about reality, it should moreover be tested on empirical data (*Andersen, 2006*).

## 2.8 Generalization capability of the framework

Under the delimitations section, we delimited from the specific characteristics of companies, which is reasoned with the consideration that building a model that fits all companies and their specific situations is impossible. The objective of this thesis is however to build a general business assessment model that can serve as a decision making tool, which can instead guide companies to evaluate mass customization implementation under their own unique circumstances. The company can through the model make their own unique assumptions and consequently decisions, where the proposed framework provide the necessary elements and map the factors which need consideration.

# 3 Theoretical Foundation

This section of the thesis contains the theoretical foundation which will form the basis for the analysis and the conceptual framework. There will be a thorough review of the existing literature on mass customization where the goal is to illustrate the important factors, strategies and supply chain adjustments and what role and influence these factors have.

## 3.1 Mass customization

Although it was touched upon in the introduction, the theoretical foundation will in this section start out with a more detailed introduction to the topic of mass customization.

Since the concept of mass customization first surfaced in the late 1980's the definition has varied quite a bit, but have over the years been narrowed down to be rather precise by most authors. It can be defined as follows:

*"They define mass customization as a system that uses information technology, flexible processes, and organizational structures to deliver a wide range of products and services that meet specific needs of individual customers, at a cost near that of mass-produced items"* (*Da Silveira et al, 2001*, pp. 2).

As mass customization includes customer co-design, the production will often be based on modularization and/or postponement. Thus there can certainly be many design options, but these will however usually be capped at a finite number (*Kumar, 2007*). As we will later learn in the literature review, modularization and postponement are key strategies to make mass customization work.

There are several potential advantages of mass customization, where the most obvious one is that many customers finds it appealing that they can design their own product which can translate into higher customer loyalty. Companies can therefore charge a higher price, and perhaps increase their market share compared to competitors who has not deployed mass customization (*Berman, 2002*). *Berman* (*2002*) also suggest other advantages such as increased efficiency due to lower inventory cost, and a more effective use of retail, factory and warehouse space. This is related to the fact that that mass customization responds to actual orders where at least some part of the product will be produced after sales, whereas

standardized products are manufactured before the actual sale, and relies on sometimes inaccurate forecasts.

There are several different levels of mass customization according to *Da Silveira et al* (*2001*) and *Rautenstrach et al* (*2002*) which are shown below. Some of these levels go beyond modularization and postponement, and in some instances the number of possible design solutions will not be capped at a finite number.

The lowest level (2) is simply the usage of the product after the product has been delivered. Then there is a level (3) of customization where the product itself is not customized, but where it for instance has different labels or packaging depending on the customer or market segment. This is called *segmented standardization* where there basically is a cosmetic intervention. Coca Cola could be an example where the labels or bottles differ according to the different markets. It is not customization where the customer actually co-designs the product, but rather the company that customize their product to the specific market segment.

Another level (4-5) is achieved by adding custom work to the product. This can best be described by using Ikea as an example, where the customer buys a standard closet, but can add the interior like shelves and such to their own liking. The next level (6) of customization is where standard components, i.e. modules, are assembled after the customer's desire based on a list of options. Level 4-6 is called *customized standardization* or configuration and is the core of mass customization. There are many examples of this, where the most well known is probably Nike's customization department called NIKEiD. Nike allows customers to choose the color of any part of the shoe, what surface you intend to use it on, and also have your name and number on it. The total number of possible combinations (and therefore different shoes) amount to millions, by choosing a random shoe at nikeid.nike.com. This is offered at a manageable price increase of only 25%[1] (*nikeid.nike.com*).

The highest level (7) of mass customization refers to designs that are tailored to the wish of the customer after a predefined model. This is called *tailored customization*, and could for instance be a tailor made suit or golf clubs. To use golf equipment as an example, Golfsmith not only let their customers chose components (modules) like grips etc similar to

[1] The calculation is based on the model "Nike Zoom Kobe VI" where the base model is listed at 1200DKK and the customized model is at 1500DKK. It is simply all the possible combinations multiplied with each other.

Nike, but will precisely tailor the length or the angle of the club according to the height, arm length, hand size and so forth of the customer (*golfsmith.com*).

These levels are summed up in the following model:

**Table 3.1: Mass customization levels**

Generic levels of mass customization

| MC generic levels | MC approaches [16] | MC strategies [15] | Stages of MC [12] | Types of customization [18] |
|---|---|---|---|---|
| 8. Design | Collaborative; transparent | Pure customization | | |
| 7. Fabrication | | Tailored customization | | |
| 6. Assembly | | Customized standardization | Modular production | Assembling standard components into unique configurations |
| 5. Additional custom work | | | Point of delivery customization | Performing additional custom work |
| 4. Additional services | | | Customized services; providing quick response | Providing additional services |
| 3. Package and distribution | Cosmetic | Segmented standardization | | Customizing packaging |
| 2. Usage | Adaptive | | Embedded customization | |
| 1. Standardization | | Pure standardization | | |

Source: *Da Silveira et al* (*2001*), pp. 3

*Salvador et al* (*2002*) makes a rougher distinction which divides mass customization in to hard and soft customization. Soft means lesser customization and more focus on production efficiency, whereas hard customization means a higher degree of customization where the primary competitive parameter is on customization and customer integration in the design.

An important point to make is that customization is not to be confused with choice (*Duray et al, 2000*). There is a distinct difference in having the option to co-design even if it is limited, and having the option to choose between varieties of the same product even if there are hundreds of possibilities. Customers simply have to be involved in the specification of the product. *Duray et al* (*2000*) moreover points out that the more variety a company offers on its product, the less it is likely that a customization option will appeal to the market.

The following sections will elucidate the strategies or approaches that are used within mass customization, and explain their role and the affect they have in making mass customization a sustainable business strategy.

## 3.2 Modularization

The term modularity is actually widely used, but this thesis will explore the concept in the context of product architecture and production process. The core idea of modularization is to decompose the product into fragmented standardized components. These components are called modules, and provide opportunities of enhanced product variety as well as yielding

economies of scale (*Gershenson et al, 2003*). Let's look at a few definitions of modules and modularity within product architecture:

*"A module is described as a set of components, and the product architecture consists of all the components in the product plus relationships among these components"* (*Newcomb et al, 1996* cited by *Gershenson et al, 2003*, pp. 297). And *"The most modular architecture is one in which each functional element of the product is implemented by exactly one chunk (subassembly) and in which there are few interactions between chunks. Such a modular architecture allows a design change to be made to one subassembly without affecting the others"* (*Ulrich & Eppinger, 1995* cited by *Gershenson et al, 2003*, pp. 297)

There are several benefits of modularity, which is presented in the table below to give a solid overview:

**Table 3.2**

| **Benefits of modularity** | | | |
|---|---|---|---|
| ***Modular products*** | ***Product development*** | ***Product functionality*** | ***Life-cycle*** |
| Component economies of scale due to the use of components across product families | Economy of scale in product development. | Reconfiguration: by changing the arrangement and adding new modules, the required functions can be realized by the existing product | Recycling, re-use, and disposal: Modular design allows grouping of components into easily detachable modules and also components with different materials and different modules. This allows ease of re-use, recycling and disposal |
| Ease of product updating due to functional modules | Increased feasibility of component/product change | | |
| Increased product variety from a smaller set of components | Increased product variety | | |
| Decreased order lead-time due to fewer components | Decoupling risk | Customization: re-arrangement of optional modules can provide customers with a choice of models | Maintenance: Fault analysis and maintenance of the product are easily facilitated. The problematic module can be easily identified and replaced |
| Ease of design and testing due to the decoupling of product functions | | | |
| Ease of service due to differential consumption | | | |

Source: *Own creation* after cites from *Gershenson et al* (*2003*) pp. 303-307

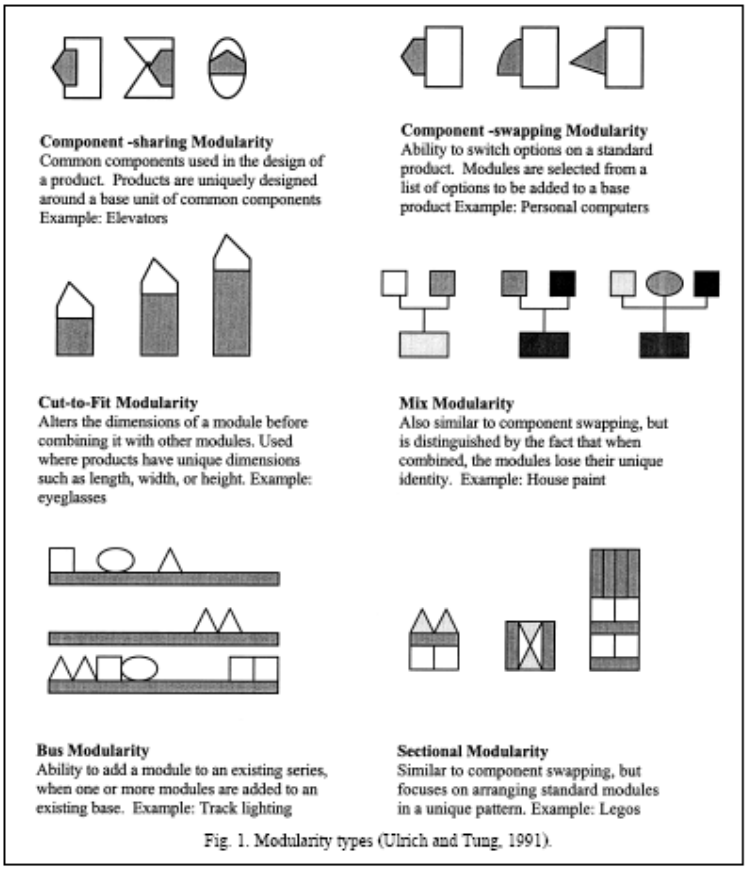
To further elaborate, the characteristics of modularization can be described as joint systems which make up a product, process or a system, where the modules works both individually and also interacts within other modules. As these modules works independently, they can be substituted by other similar units to form a unique new constellation, which will achieve a different outcome. *Gershenson et al* (*1999*) moreover suggests that a component can have different levels of modularity, and that a component that might seem modular can

have structures which are not. The less dependent the component is on other modules the more modular it is, and the effect of substituting it will thus have a less significant effect on the rest of product.

Besides the benefits presented in the above table, *Mikkola* (*2007*) states that a high commonality of modules will lower inventory cost due to the reduced risk of obsolete inventories, as well as overall lower inventory levels.

The figure below shows some different variations of modularity, and these can be combined and mixed to create a customized product.

**Figure 3.1: Modularity variations**




Source: *Duray et al, 2000,* pp. 609

As it is seen from both table 3.2 and figure 3.1, modularity has some key prerequisites and attributes that fit very well with mass customization and it will therefore now be explored in this context.

Among several authors, *Kumar et al* (*2007*) and *Duray et al* (*2000*) propose that in order to obtain cost-effective customization, modularization is a rudimental key. There are however rare instances where modularity is not necessary. In the vast majority of cases it is nevertheless essential, and all of the previously mentioned examples use modularity to a large extend. *Duray et al* (*2000*) states that modularity enables flexible manufacturing, and provides an increasing number of product varieties and features, while at the same time decreasing costs. As a result, the modules can be combined in accordance to the customer's desire, thereby creating a unique customized product, without the need (or possibility) to change any of the standardized modules (*Duray et al, 2000*). The goal in cost effective customization is to delay the customization as close to the customers as possible, which modularity permits (*Mikkola & Skjøtt-Larsen, 2004*). This is called postponement and will be discussed in the upcoming section.

In contrast to the many benefits, it should be noted that *Mikkola* (*2007*) points out that the coordination effort of modular products, i.e. logistics, marketing, sourcing, retail etc. will increase. This is often inevitable despite the increased flexibility that arises through modularity, but this topic will be described more thoroughly in the sections exploring logistics and sourcing. She further argues that as the modules are often standardized components, they become far easier to replicate and imitate by competitors, thereby posing a threat to the long term success and even survival of the company. Companies will consequently in some instances have to incorporate unique components into their product architecture, but this can be expensive and time consuming (*Mikkola, 2007*).

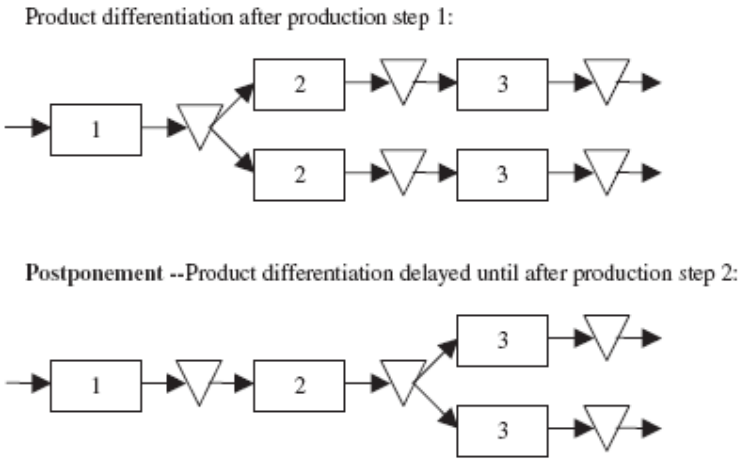
## 3.3 Postponement

As we learned in the previous section by *Mikkola & Skjøtt-Larsen* (*2004*) modularization enables the postponement strategy (see figure 3.2), where the purpose is to delay the customization to after the customer's order has actually been received. That way the products can be formed to its purpose of either specific functions or appearances, by acquiring the information in a precise and timely manner (*Mikkola & Skjøtt-Larsen, 2004*). Postponement is applied in several aspects of both manufacturing and logistics, and the company can therefore delay distribution, packaging, assembling, production and in some instances even sourcing until after the customer order. It can in other words occur along the

entire supply chain (*van Hoek, 2001*). *van Hoek* (*2000*) furthermore argues that postponement is a concept which is able to bring the efficiency of Lean together with the responsiveness of agility, but this topic will be will be discussed later in the thesis.

There are three types of postponement strategies within a supply chain: *Form postponement, time postponement* (delay in downstream until after orders) and *place postponement* (stocking goods centrally until after orders) (*Davila & Wouters, 2007*). Within mass customization form postponement is the most relevant, and allows a change of the product architecture by using standardized components similarly to modularization. It will often require collaborations between organizations in the value chain, so the goal of pushing the postponement as far downstream as possible can be achieved (*Mikkola & Skjøtt-Larsen, 2004* and *Davila & Wouters, 2007*). *Davila & Wouters* (*2007*) points out that ideally the upstream activities are based on forecasts, and downstream activities are based on customer orders.

**Figure 3.2: Form postponement and modularization**




Source: *Davila & Wouters, 2007*, pp. 2248

Other than the ability to customize products there are several benefits of postponement, where the major one is the improved matching of supply and demand, where the demand uncertainty is reduced. A key contribution is the significant reduction in inventories, if the supply chain can postpone the product differentiation until after the customer order. The forecast uncertainty will be reduced, and the need of carried safety inventory is thus also reduced (*Chopra & Meindl, 2007* and *Davila & Wouters, 2007*). Postponement also reduces risk of inventory obsolescence using the same logic as in modularity by *Mikkola* (*2007*). *van*

*Hoek* (*2001*) also mentions another way that inventories can be reduced, which is related to the point that transportation between factories and warehouses can be avoided by delivering the products directly to the customer. This lowers the overall delivery cost although the shipment batches are usually smaller and the distances longer. The following table shows the operating characteristics which are relevant to postponement, and should give a better overview:

**Table 3.3: Characteristics of postponement**

| Factor | Impact of postponement |
|---|---|
| *Technological characteristics* | |
| Limited complexity of final manufacturing operation | Limited loss of economies of scale through postponement and short processing times |
| Limited complexity of technological content in final manufacturing | Short set-up and changeover times, short processing times |
| Modularity | Rapid final manufacturing at low processing costs, increased possibility to adjust products to markets |
| *Process characteristics* | |
| Possible to decouple primary and secondary production system | (a technical pre-condition and needed for manufacturing within the lead time) |
| Limited complexity of final manufacturing process | Short set-up and changeover times, short processing times |
| Sourcing from multiple locations | Direct bulk shipments of modules |
| *Product characteristics* | |
| High commonality of modules | Lowered inventory levels and reduced risk of obsolete inventories |
| Product variety, specific formulation of products | Improved customization possible |
| Product variety; specific peripherals/packaging | Improved customization possible |
| High value density/unit value of products | Reduced pipeline expenses and inventory carrying costs |
| Product's cube and/or weight increases through customization/final manufacturing | Reduced transportation and inventory carrying costs |
| *Market characteristics* | |
| Short product life cycles/fashion cycles | Less risk of obsolete inventories |
| High sales fluctuations | Reduced inventory levels and less risk of obsolete inventories |
| Short and reliable lead times required | Improved delivery service |
| Price competition | Lowered cost levels |
| Varied and (physically) fragmented markets | Better targeting, segmentation, and positioning of products and sales |

Source: *van Hoek* (*2001*), pp. 173

In the context of mass customization, *Chopra & Meindl* (*2007*) suggests that postponement is especially valuable for companies that have a large variety of products where the demand is of high variation, and far less effective if a large fragment of the demand is from a single product. Postponement in product differentiation will reduce the overall complexity of the supply chain, and therefore decrease operational costs. This is a result of fewer steps of unpacking, configuring, repacking and so forth (*Davila & Wouters, 2007*).

Postponement is very suited to E-commerce, as the production can take place after the customer has submitted their order, with fast electronic handling. Another benefit is

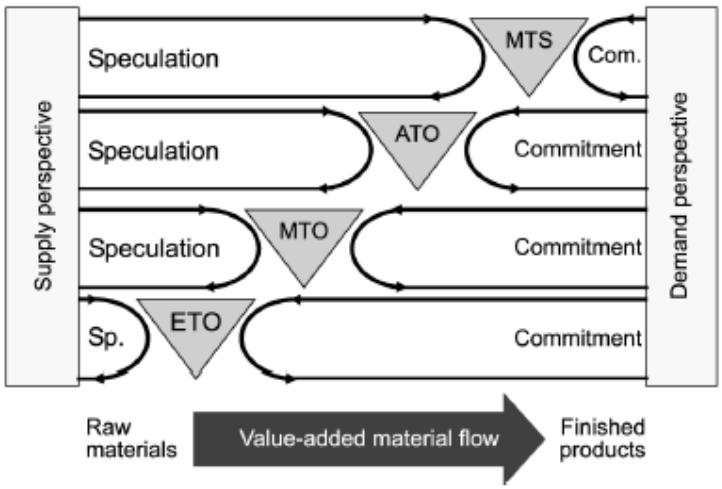
customers expect longer lead times when buying through the internet, and are thus prepared to wait longer, while the postponement takes place (*Chopra & Meindl, 2007*).

An issue with postponement is that the production costs will undeniably be higher with postponement than without. This is a result of a higher number of production steps and possibly additional equipment, combined with common components being more expensive than unique (*Chopra & Meindl, 2007* and *Davila & Wouters, 2007*). There are usually also longer lead times which can put a constraint on the postponement, in order to meet the expected delivery times of the customers (*van Hoek, 2001*).

## 3.4 Customer Order Decoupling Point

In the two previous sections, the time of the customer's orders has been briefly mentioned, but will in this section be covered with greater attention and detail. This concept is called "the customer order decoupling point" (CODP) or the "order penetration point" (OPP) and has considerable importance as it can be used to improve the performance of the supply chain. The CODP is the point of which the forecast driven activities are separated from the demand driven activities. In other words, the CODP is where the product is linked to a specific customer, and the post-decoupling point activities are geared towards satisfying the customer's specific need (*Rudberg & Wikner, 2005* and *Olhager, 2003* and *Mason-Jones & Towill, 1999*).

**Figure 3.3: Different positions of the CODP**



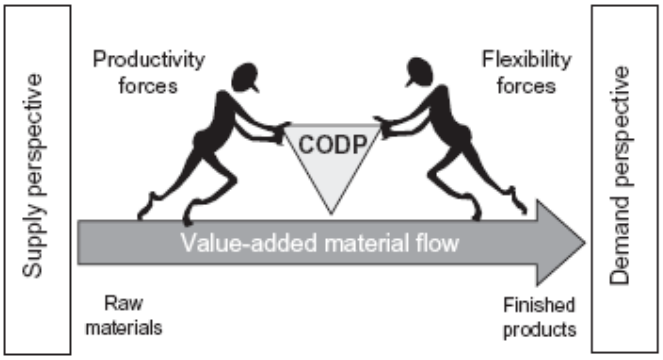

Source: *Rudberg et al, 2005*, pp. 636

The CODP will vary depending on the product and its manufacturing, such as "make to stock", "assemble to order", "make to order" and "engineer to order" which is shown in the figure above.

The above figure represents the traditional material decoupling point, and according to *Mason-Jones & Towill* (*1999*) the "speculation" part should be produced on the basis of forecasting, and the "commitment" part should be produced on the basis of orders. There is however also an information decoupling point which is a separate entity. In many supply chains, it is only the member closest to the end user, who knows the true undistorted demand information, as this is typically where the information decoupling point is. *Mason-Jones & Towill* (*1999*) argues that moving the information decoupling point upstream, so each member would acquire the actual orders and sales, would improve the performance of the entire supply chain. This is however much easier in theory, due to the sometimes adverse relationships where information sharing is not accepted. In order to fully realize an improvement of the performance of the supply chain, the strategic positioning of both the material and information decoupling points, is of outmost importance (*Mason-Jones & Towill, 1999*). So let's look at the positioning of the (material) CODP.

*Rudberg & Wikner* (*2004*) argues that customers demands both products that fit their specific need, and also at standard non-premium prices. Traditionally this was thought of as a conflicting trade-off, where efficiency and flexibility did not work together. This has however become a reality in mass customization.

**Figure 3.4: The trade-off between efficiency and flexibility**




Source: Rudberg et al, 2004, pp. 446

When deciding the position of the CODP, it is necessary to identify the prevalent force in the trade-off between efficiency and flexibility, so the optimal balance can be found (see figure 3.4). So the further downstream the CODP is, the emphasis should be on efficiency and more specifically cost, and vice versa. In mass customization the equilibrium point would be moved upstream to have a higher degree of flexibility (*Rudberg & Wikner, 2004*).

In deciding the position of the CODP, *Olhager* (*2003*) puts the most important factors into three categories, i.e. *market*, *product*, and *production* characteristics which are summarized below.

**Table 3.4: Factors affecting the position of CODP**

| *Market related* | *Product related* | *Production related* |
|---|---|---|
| Delivery lead time | Modular product design | Production lead time |
| Product demand volatility | Customization opportunities | Planning points |
| Production volume | Material profile | Flexibility |
| Production range and product customization requirements | Product structure | Bottleneck |
| Customer order size | | |

Source: Own creation after *Olhager, 2003*, pp. 321-322

To give an example, *Olhager* (*2003*) states that the market and the demand are decisive factors for positioning the CODP. For instance, when demand volatility is low it means the product can be forecast driven. In regards to customization opportunities, the earlier and more widely customization is offered, a make-to-order strategy is necessary, whereas an assemble-to-order strategy will be suitable if the customization takes place later in the production. The relationship between the production lead time and the expected delivery lead time, will limit the number of possible positions of the CODP, where a reduction in the production lead time can widen the possibilities (*Olhager, 2003*).

There are several reasons for shifting the CODP forward, such as increasing delivery speed and improve manufacturing efficiency, but this brings negative effects such as relying more on forecasts, reducing product customization, and therefore also risk of inventory obsolescence. There are additionally also several reasons to shift the CODP backwards, such

as reducing the reliance on forecasts, increasing the customization options, and reduce the risk of obsolete inventories. This in turn has some negative effects, where the delivery lead times becomes longer and often more unreliable, and the production gets far less efficient (*Olhager, 2003* and *Rudberg & Wikner, 2004*). The goal of mass customization is simply to find the optimal balance, which is closely related to the concept of le-agility which will be covered next.

## 3.5 Lean vs. agile and le-agility

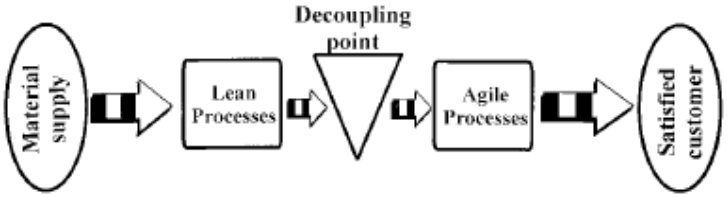
In the previous section the tradeoff between efficiency and flexibility was introduced. This section will cover the concept of mixing two distinct production strategies at opposite poles of the spectrum within the supply chain, so the goal of mass customization can be achieved. The concept is called "Le-agility" and is a combination of Lean and agile principles which is defined as follows:

"*Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place*"… "*Leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule*" (*Naim & Gosling, 2011*, pp. 343).

"*Le-agility is the combination of the Lean and agile paradigm within a total supply chain strategy, by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream, yet providing level scheduling upstream from the decoupling point*" (*Naylor et al, 1997* cited in *Mason-Jones et al, 2000*, pp. 54).

As it is seen in the definition, the Le-agile concept is a *total* supply chain strategy. As already covered a bit in earlier sections, the goal is to use Lean processes of reducing waste and maximizing profits. This is achieved through reducing physical cost and ensuring a level production schedule through stable demand, before the decoupling point. After the decoupling point, the goal is to use agile manufacturing principles of postponement, and use volatile demand as an opportunity rather than a problem to achieve a strategic advantage (*van Hoek, 2000* and *Mason-Jones el al, 2000*).

**Figure 3.5: The Le-agile supply chain**




Source: *Mason-Jones et al*, 2000, pp. 55

Both the Lean and agile principles requires high product quality and short lead times in order to take advantage of and respond to rapid changing markets, but also to reduce waste of time as a principle of Lean (*Mason-Jones et al, 2000*). The below table show some of the distinct differences:

**Table 3.5: Comparison of the attributes of Lean and agile supply**

| Distinguishing attributes | Lean supply | Agile supply |
|---|---|---|
| **Typical products** | Commodities | Fashion goods |
| **Marketplace demand** | Predictable | Volatile |
| **Product variety** | Low | High |
| **Product life cycle** | Long | Short |
| **Customer drivers** | Cost | Availability |
| **Profit margin** | Low | High |
| **Dominant costs** | Physical costs | Marketability costs |
| **Stockout penalties** | Long term contractual | Immediate and volatile |
| **Purchasing policy** | Buy goods | Assign capacity |
| **Information enrichment** | Highly desirable | Obligatory |
| **Forecasting mechanism** | Algorithmic | Consultative |

Source: *Mason-Jones et al, 2000*, pp. 56

The fundamental difference is, that in Lean the value for the customer is the low prices, whereas the value in agile is the service.

*Mason-Jones et al* (*2000*) and *van Hoek* (*2000*) both argue that the flow of information, the information decoupling point, should be integrated in the supply chain for the reasons described in the previous section by *Mason- Jones & Towill* (*1999*). The material decoupling point was also regarded as important, as it is the point of which the Lean and agile processes are separated. *Naim & Gosling* (*2011*) however introduced other types of Le-agile supply chains than the traditional pre- and post decoupling point. He stated that alternative forms of le-agility could e.g. be based on (i) running different Lean and agile processes in parallel, or

on the same process but at different times, (ii) not only postponing the bringing together of components but also the associated resources for the assemblage, (iii) decoupling sales/service activities from the production facility (cited from *Naim & Gosling, 2011*, pp. 351).

## 3.6 Product life cycle

This section will briefly cover the product life cycle (PLC) within mass customization, and how it impacts the supply chain strategy.

*Aitken et al* (*2003*) states that the product life cycle has a great impact on the supply chain strategy and how it should be configured to obtain strategic alignment. Several authors such as *Da Silveira et al* (*2001*), *Fralix* (*2001*) and *Aitken et al* (*2003*), have proposed that products in mass customization are considered to typically be short. *Aitken et al* (*2003*) suggests that it can also be in an introductory stage before a potential commoditization. For customized products, *Aitken et al* (*2003*) suggests that an agile supply chain is desirable, and that it can also be possible to obtain a Le-agile supply chain in some instances.

Products with short life cycles has some key characteristics, as they require rapid time to market as well as rapid product development, innovation, manufacturing processes and logistics to exploit volatile demand. Furthermore, short life cycles require short end-to-end pipelines (supply chains) to allow for continuous replenishments to meet the demand (*Aitken et al, 2003* and *Da Silveira et al, 2001*).

## 3.7 Push and pull systems

This section will briefly explore the concept of push and pull systems, and is in essence an extension and continuation of the previous two sections of CODP and Le-agility, and will continue in the forthcoming planning section.

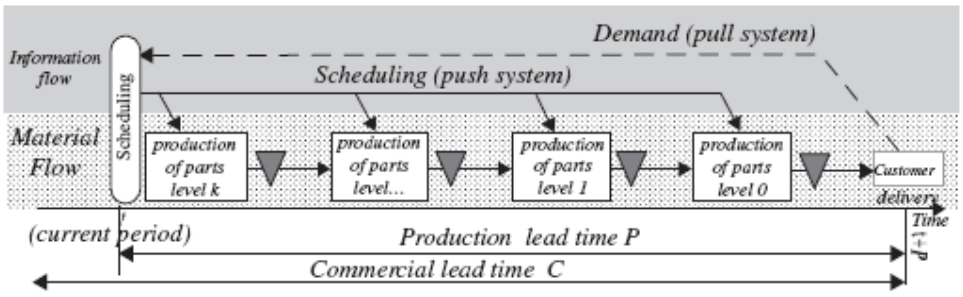
The *push* concept means that the supply chain produces according to demand forecasting to meet the anticipated sales, thus placing inventory at the point of the sale. The *pull* concept means the supply chain only responds to the actual received orders (*Chopra &*

*Meindl, 2007*). Push systems are therefore attached to Lean/efficiency and pull systems to agile/flexibility respectively. *Olhager* (*2003*) therefore suggests that pull-type systems are necessary for activities upstream of the CODP, and push-type systems are necessary for downstream operations.

## 3.8 Production planning and scheduling

These push/pull systems can be used to plan and schedule the production, and they can be very valuable when considering the strategy and design of the supply chain (*Chopra & Meindl, 2007*). Push systems often produce to stock as a result of forecasts, but push systems can also be a result of a calculation to fit a customer's production process. This allows a later delivery date of products that are in accordance with a customer order, in the last process of the supply chain (*Giard & Mendy, 2008*).

**Figure 3.6: Production planning using push/pull systems**




Source: *Giard & Mendy, 2008*, pp. 657

When the production is highly diversified and based on the postponement strategy, it is often favorable to limit the quantity of initiated productions, and only produce the common components to stock. In lower diversity, it is usually economic preferable to produce to stock, if the amount of demand for each part is sufficient. As mentioned a few times earlier, information about the final order can be exploited by the entire supply chain, if that information is shared upstream in a push system approach (*Giard & Mendy, 2008*).

Traditional manufacturing planning based on volume, is not efficient within mass customization due to the high product variety. *Dean et al* (*2009*) proposed a new

manufacturing resource planning system for mass customization. The following points are some extracts from his article:

- Long-term manufacturing resource planning plays an important role in mass customization production to improve production efficiency and to reduce production cost.
- Planning of labor resources becomes critical to meet the due dates of production and to improve utilization efficiency of labor, in a mass customization environment
- Prediction of manufacturing resources should be conducted using the customer demands with uncertainties
- In mass customization production, it is possible to learn the relations between customer demands and resource requirements when sufficient historical data are provided. Future resource requirements can be predicted from the customer demands using the learned relations

Source: Cites from *Dean et al, 2009,* pp. 1266

*Blecker & Friedrich* (*2006*) and *Yao & Liu* (*2009*) states that mass customization induce internal complexity, which affects the operations negatively by reducing the speed of the entire supply chain. They further argue that mass customization cannot be manufactured without loss of efficiency and that the challenge primarily lies in planning and scheduling production. The product variety leads to larger volumes of work-in-progress inventories, balancing problems in the assembly lines, and where the additional product changeovers leads to more routing alternatives on the shop floor (*Blecker & Friedrich, 2006*).

## 3.9 Sourcing in mass customization

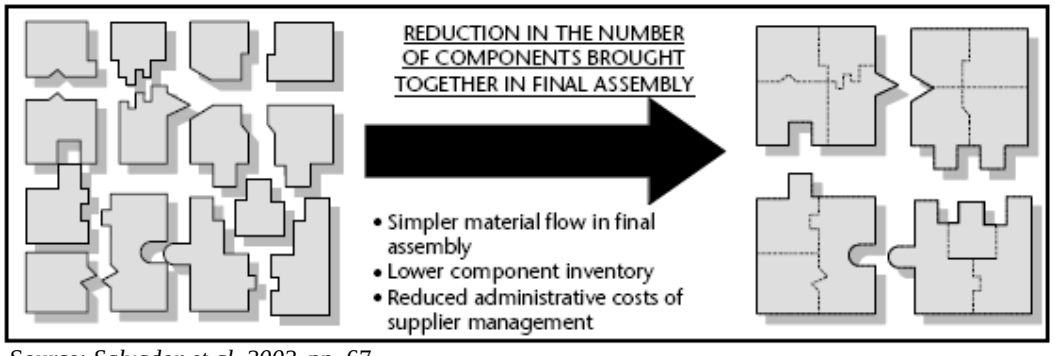
Sourcing can be a means to get a competitive advantage, where the choice of suppliers can potentially reduce costs and increase reliability. This is especially true in an environment that has a decreasing level of vertical integration and where firms are likely to outsource component manufacturing (*Blecker & Friedrich, 2006* and *Salvador et al, 2002*). Dell for instance depends on an intricate network of suppliers who delivers the components that constitutes a significant part of the value of the product (*Blecker & Friedrich, 2006*).

*Salvador et al* (*2002*) suggests that the product architecture has huge implications for the sourcing configuration. They divide mass customization and products into *hard* and *soft.* Soft means high volume and low variety where the products are made of basic body components and substitutable components. Hard means high variety and lower volume through component families that constitutes of combinatorial modularity. Selecting and managing suppliers depends greatly on this (*Salvador et al, 2002*).

For soft mass customization a dual approach for supplier selection and firm/supplier interaction is allowed because of the commonality between basic and substitutable components. The main reason for this is that companies' core competence usually lies in either basic body parts or substitutable components. Thus the suppliers of basic parts can produce in large volumes as they are not affected by market uncertainty. As long as the final customer demand remains somewhat stable, the firm and supplier can enter long term relationships in terms of quantity and delivery timing. Choosing suppliers for the substitutable parts should rely more on delivery time ability, as they are more exposed to uncertainty. This is a big concern as the impact of delivery time in order to meet the varied product demand is important, and because suppliers do not have a great incentive to deliver small volumes at competitive prices. Because the firm is at a bargaining disadvantage, they should purposely aim at selecting smaller suppliers where a great deal of their volume is for the firm, in order to reduce the skewed power balance. If such suppliers are absent, the closer the supplier is located, the shorter the sourcing lead time, and the easier it will be to partly contribute in the decision making (*Salvador et al, 2002*).

For hard mass customization, the market uncertainty is transferred to all of the suppliers, because of the modularity. The firm will usually have a different supplier for each of the components.

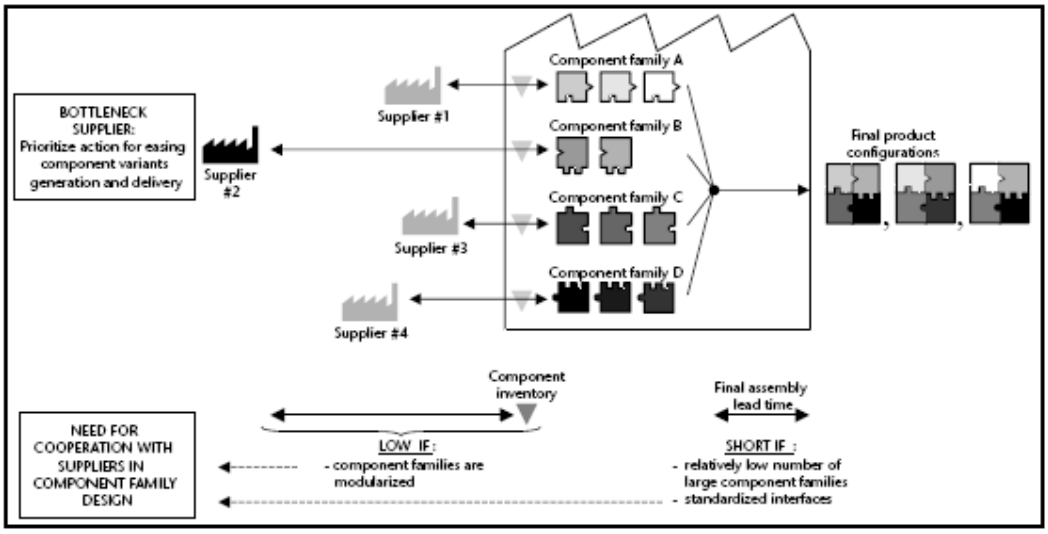
**Figure 3.7: Redesign of the final assembly to decrease complexity**




Source: *Salvador et al, 2002*, pp. 67

Because of the growing complexity of planning production and managing relations with suppliers, the company would have an incentive to reduce the number of component families without compromising the number of possible product variations. It would be advantageous to have one supplier produce components that used to be allocated to multiple suppliers (See figure 3.7). This would cause a higher price from the now larger supplier, but reduce complexity and cost in terms of lower levels of safety stock, and lower complexity in controlling flows for multiple components and managing relations. The challenge is therefore to reduce the magnitude of the price increase even though the supplier now has increased bargaining power, which could partly be done through a collaborative design phase (*Salvador et al, 2002*).

**Figure 3.8: Sourcing configuration for hard mass customization**




Source: *Salvador et al, 2002*, pp. 66

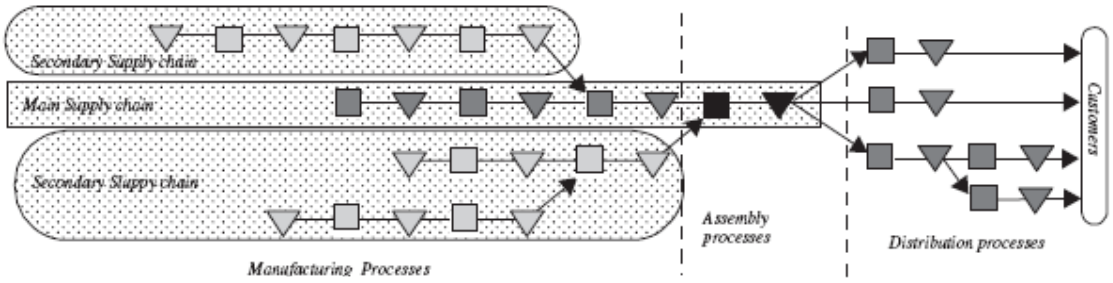
For both hard and soft mass customization, the sourcing configuration decisions should not only be a result of the product architecture decisions. As product architecture and sourcing configurations are interdependent, it should much rather be a simultaneous and coherent decision making process (*Salavador et al, 2002*).

## 3.10 Logistics

The nature of mass customization makes logistics a massive challenge in both upstream and downstream activities. The upstream logistics consists of transportation, warehousing and merging of materials and components that are used to manufacture end products. The main

goal is to deliver components and modules on time, to accommodate the customization firm's schedule. The downstream logistics consists of packaging and shipping the end products to the customer, where the customized products are shipped on a "per-item" basis directly to the end customer (*Blecker & Friedrich, 2006*). The entire logistics chain is usually characterized as a network of processes that unites towards an assembly process of the final product, which is then divided again in the distribution process (*Giard & Mendy, 2008*). This process is shown below.

**Figure 3.9: The supply chain process**




Source: *Giard & Mendy, 2008*, pp. 656

The downstream distribution costs are significantly increased because customers are served individually. Furthermore the delivery has to be quick and reliable, as customers would question the benefits of mass customization if lead times were too long. (*Blecker & Friedrich, 2006*).

As logistics usually require large investments in transportation and warehousing, most mass customization companies outsource their logistics operations to third-party companies, as they are able to achieve economies of scale. The third-party logistics companies will in some instances do the actual customization in the form of customized packaging and individual delivery times, and on occasion even do the final assembly of products as part of their extended service portfolio (*van Hoek, 2000*).

As it was learned earlier, the demand of common components is usually rather stable, whereas the unique components face an uneven demand. *Blecker & Friedrich* (*2006*) suggests that products with stable demand that are sourced locally, should apply just-in-time policies to keep inventories as low as possible. The globally sourced components with variable demand

should apply MRP-based[2] policies (*Chandra & Grabis, 2004* from *Blecker & Friedrich, 2006*).

To avoid large inventories of work-in-progress parts, a just-in-time (JIT) strategy could in many instances be very beneficial. A JIT strategy means that the needed components are delivered at the exact time it is needed for production. Companies can thereby avoid carrying large amounts of inventory of the many components that is required in mass customization environments. The trucks delivering the products are in actuality serving as the inventory facility. This strategy works far better with the suppliers in close proximity, thereby making coordination and timely delivery much more consistent (*Jackson, 1983* and *Blecker and Friedrich, 2006*).

This section of logistics is related to the planning section, and moreover strongly related to the information technology section, as some of the planning and logistics challenges can be resolved by sufficient information technology.

## 3.11 Information technology and management

A well designed information system is according to *Da Silveira et al* (*2001*) essential for the success of a mass customization system. The role of an information system is very extensive, and has to connect the internal divisions as manufacturing and design, to the external groups of suppliers and the customers submitting orders. Advanced technology has to be available, and it is argued that mass customization was not possible before the technical adequacies appeared. This was not only in flexible manufacturing systems, but in powerful information technology (IT) capabilities available in the 21st century (*Da Silveira et al, 2001* and *Frutos & Borenstein, 2004* and *Vrechopoulos, 2004*).

Internet retailing (or E-commerce) has revolutionized the retailing landscape, and become an everyday activity for millions of people. It offers countless more options and extensive information for the customer. The automobile industry is a great example, where customers are able to get detailed specifications about base prices, additional equipment

[2] MRP: Material Requirements Planning, is a software based production planning and inventory control system, where the objective is to ensure that materials are available for production and products are available for delivery, while keeping levels of inventory at a minimum. Planning manufacturing, delivery and purchasing activities.

options and prices, repair records and average used car value (*Porter, 2001*). Internet retailing also enables several opportunities for the company such as the possibility of one-to-one marketing techniques, advanced customer service, direct contact with both suppliers and customers, and the integration of customers in the product design. However for mass customization strategies to be effective in E-commerce, it is of paramount importance to find out who the actual and potential customers are, and moreover understand and continuously research their behavior in appropriate data models (*Vrechopoulos, 2004*).

Although the concept of mass customization existed before, it has been revolutionized as a result of E-commerce. Through the internet and the vast information process capabilities, there is a unique ability to offer customized products and managing the information. Through the internet, the company can create an interface between the customers and the company, which establishes an environment where the customer is integrated in a cooperative design phase on a global scale. The company then provides the manufacturing expertise to meet the personal desires of a customer. In other words, the internet is recommended by several authors as the best way to connect companies, customers and suppliers for mass customization environments (*Frutos & Borenstein, 2004* and *Siddique & Boddu, 2004*).

Thus an adequate information management system is needed for a successful execution of a mass customization environment. It should be able to support product and process data exchange between the different departments of the company, and manage information in a consistent and reliable way. Furthermore, in addition to absorbing the customer orders, the information on manufacturing, procurement, cost, product structure, and supplier information needs to be available and managed if mass customization is to be successful (*Frutos & Borenstein, 2004* and *Siddique & Boddu, 2004*). IT systems can bring increased efficiency in terms of faster information exchanges and faster execution of tasks. IT can moreover create more punctual and coherent processes as well as dependency (*Yassine et al, 2004*). *Yassine et al* (*2004*) and *Porter* (*2001*) suggests that companies, who pursue design customization, should expand their IT investments beyond communication and transactional tools, and invest in collaborative IT systems with suppliers if mass customization shall be economically viable.

*Frutos & Borenstein* (*2004*) proposed the following necessary steps in order to efficiently obtain an individualized customer order by use of information technology:

- defining a catalogue of options to be offered to customers;

- collecting and storing information on customer choices;
- transferring data from retailers to manufacturers; and
- translating customer choices into product design features and manufacturing

Source: Cited from *Frutos & Borenstein, 2004*, pp. 117

It is further stated that an IT system has to be developed, in order to effectively process and communicate the information between customers, company and suppliers (*Frutos & Borenstein, 2004* and *Coronado et al, 2004*). A well developed IT system is simply an essential tool to enable an agile and flexible environment, and interaction between customers and the company. *Blecker & Friedrich* (*2006*) states that products need to be identified at the "single product" level, in order for efficient customization. Products or components can as a result be controlled separately along the supply chain, whether it is in manufacturing or distribution etc. The suggested technology to be used for this activity is radio frequency identification (RFID). This technology is able to store specific product information, but also provides the possibility of real-time modification of the specific product data, during the actual processes of the product. RFID is basically a vastly superior and automated version of the traditional bar code. Using this technology, it enables the assembly line to receive the necessary information regarding the assembly work and directions (of products), from the RFID attached to the product. This improves the streamlining greatly in a mass customization supply chain, but RFID is still a relatively costly technology (*Ngai et al, 2010* and *Blecker & Friedrich, 2006*). Another suggested tool for coordination in a mass customization supply chain is the vendor managed inventory (VMI), which consists of electronic data interchange (EDI). As the supplier retrieves real-time information about inventory levels of modules and subassemblies, this technology facilitates inventory replenishment. Another technology which can improve the agility is the integration of enterprise resource planning (ERP) systems by the key members of the supply chain. These systems can help improve adaptability to unforeseen events, where supply chain members can instantly adjust to unexpected changes (*Coronado et al, 2004* and *Blecker & Friedrich, 2006*).

Information sharing have been suggested several times earlier, and *Yassine et al* (*2004*) states this type of IT collaboration is required to improve a company's product development capabilities. This in turn facilitates design customization, as a result of knowledge sharing and creation. In addition to the collaborative IT systems which have been strongly suggested, a

highly sophisticated internal IT system is greatly desirable in regards to managing the extensive varieties of products and subassemblies, which arises in the nature of mass customization environments (*Blecker & Friedrich, 2006*).

## 3.12 Organizational change

*Pine* (*1993*) emphasized the transformation of organizations in his pioneering book, and stated that the often rigidly specialized resources of both resources and technology, and hierarchies with deep functional separations, which often characterizes mass production manufacturing, is not suited for a mass customization environment. Thus an organizational change towards integrated functions with dynamic boundaries, flexible resources and the integration of thinking and doing are required to be successful (*Pine, 1993*).

However if the organization is not originally built towards mass customization from the establishment, the change can be difficult and lengthy. There has to both internal and external learning, to generate knowledge for an effective implementation of mass customization. The organization has to rethink and innovate its structure in terms of the process where they develop, produce and deliver mass customized goods, and furthermore throughout the supply chain that execute these processes (*Huang et al, 2008*).

*Pine* (*1993*) points towards the importance of becoming market driven rather than being product focused, and that every member in the organization is now aware that the customer is the primary stakeholder whose individual needs have to be met. Redesigning processes can trigger the organizational change, by examining the value chain and breaking down the vertical and organizational barriers, towards a horizontal and customer focused manner. When changing processes towards mass customization, the objective is similar to those of mass production on the plant floor: Eliminating waste (eliminate all processes that do not add value) , inventory (crutches such as unnecessary employees and data), and improving quality and lead/cycle times. This should be done continually in order to constantly improve the processes towards customization and acceleration (*Pine, 1993*).

As mentioned above, mass production environments often have a steep hierarchy with vertical communication, which matched the reasonably stable environment. It is however vastly unsuited to fit a volatile environment, where flexibility and responsiveness are

rewarded. Hierarchies are evidently not completely eliminated, but many organizations establish networks within the organization which are self-managed teams. The creation of these clusters are not entirely without problems, but flattened hierarchies which allows for independent groups networking and communicating, are a necessity for long term success in volatile environments. The whole point of decentralization is to push the decision making authority, to where the people that have the highest knowledge actually contribute to the decisions (*Pine, 1993*).

## 3.13 Market and external factors

To this point in the thesis, the majority of the focus has been on factors which enable mass customization, and the importance of these cannot be overemphasized. However, the main driver for the implementation of mass customization is the customer, as it will be unsuccessful if the demand for individualized goods is not present (*Blecker & Friedrich, 2006*). Although the demand has to be there, *Pine* (*1993*) states that the higher the market turbulence, the more likely the market is turning towards mass customization, as a stable market and business environment indicates no demand for differentiation. Many companies will moreover face a decline in the demand for individual products, but will have an increasingly stable demand as a result of their more diversified product portfolio (*Pine, 1993*).

Companies have to evaluate whether the customer needs customized products, by analyzing the potential value mass customization create for customers, relative to mass produced goods. Moreover the company has to thoroughly analyze and clarify the added costs and benefits of customizing products, to assess if the customized products provide greater value compared to mass produced goods (*Broekhuizen & Alsem, 2002*).

One of the most important indicators that suggest the implementation of mass customization, is the level of market variety. The need to offer products that *exactly* meets individual customer demand, occur when the product variety is already very high and the customer has almost endless options. In such an environment the customer can easily be frustrated and overwhelmed, and therefore unable to make the optimal decision (*Broekhuizen & Alsem, 2002* and *Blecker & Friedrich, 2006*). *Pine* (*1993*) further states that the combination of high technical progress and the saturation of a market, leads to an increased product proliferation with short product life cycles, and mass customization as a result. The

reason for this is that companies have a very small edge and relatively low margins as a result of the generally high competitiveness in saturated markets, where it can be difficult to differentiate themselves from competitors. Hence to potentially offer a competitive advantage and to enhance profit margins, mass customization can be a viable possibility. As a side note, if the manufacturer sells their product through a retailer, the willingness and ability of this retailer has to be assessed. (*Broekhuizen & Alsem, 2002*).

There are furthermore industry related factors and trends, which can help determine the need for customized products. Information technology, E-commerce and flexible production systems are the three main factors that influence the probability of success within an industry. E-commerce enables a manufacturer to produce *after* the customer order which allows for customization, and moreover with a longer expected delivery window due to the customers lower lead time expectations (*Broekhuizen & Alsem, 2002* and *Chopra & Meindl, 2007*).

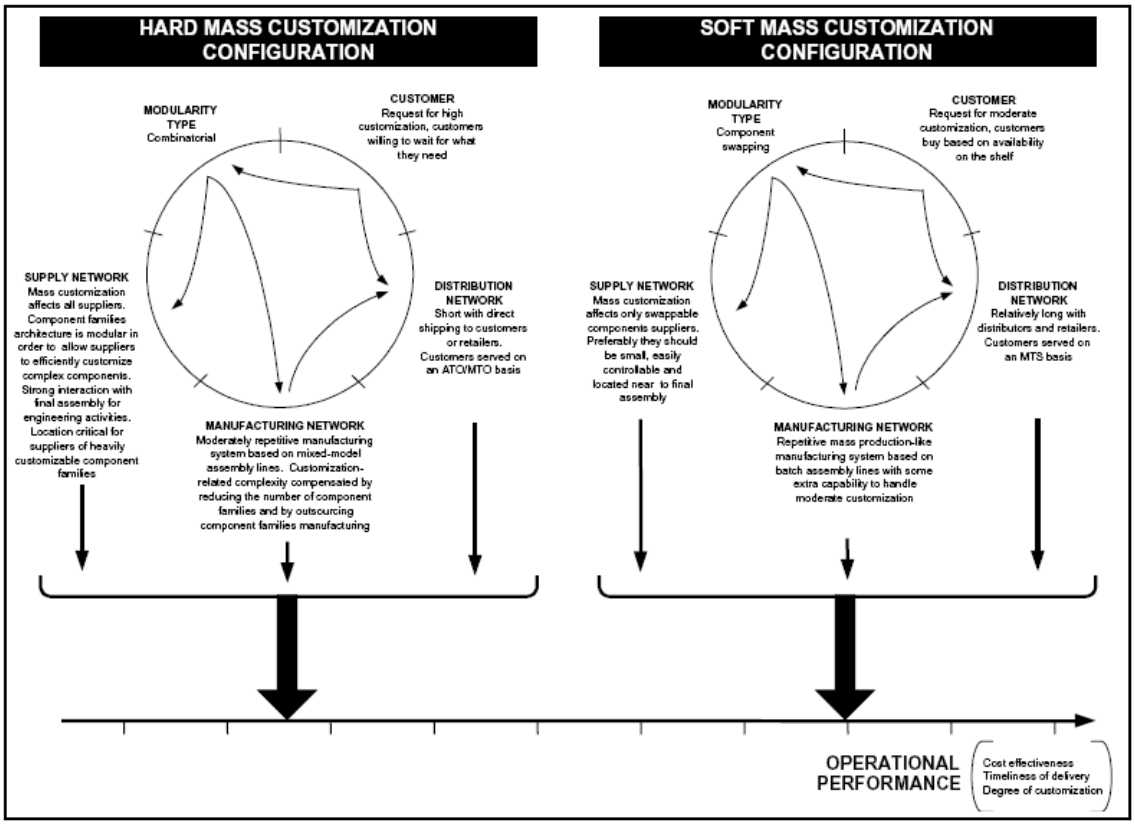
## 3.14 Supply chain configurations for mass customization

Much of the theoretical foundation has provided knowledge about supply chain configurations and adjustments to cope with a mass customization environment, but by looking at concepts individually. This section will look at the supply chain as an overall pipeline, and an overall supply chain strategy of dealing with high volume and high variety products.

*Coronado et al* (*2004*) stated that the combination of high volume products with that of high variety products creates a high complexity supply chain. This presents a huge challenge in terms of the amount of factors that needs to be executed and managed in order to increase the overall efficiency.

The configuration of the supply chain will depend on several factors, but the main consideration will be whether the company offers hard or soft customization (*Salvador et al, 2004*). The following figure (3.10) shows the different characteristics and configuration of supply chains according to a hard or soft customization strategy.

**Figure 3.10: Comparison of hard and soft customization configurations**




Source: *Salvador et al, 2004*, pp. 395

The figure above show the supply chain configurations according to hard or soft mass customization, as well as the distinct differences. Modularity seems to be the cornerstone of any mass customization strategy, but the type of modularity depends on the level of customization.

For soft customization the distribution network is relatively long, and mostly uses a MTS approach, ensuring best selling products are available with the retailers. Component swapping modularity enables the manufacturing and supply networks to swiftly react to demand trends, and thereby replenish the distribution network with the correct product assortment. Component swapping modularity furthermore allows the manufacturing network to obtain economies of scale and scope, given the low level of customization (*Salvador et al, 2004*).

Within hard customization, customers are willing to wait longer to get a higher level of customization, and are therefore served individually on a more direct distribution network,

typically with a MTO/ATO approach. To handle the higher level of customization, the manufacturing network has to be able to handle high product variety efficiently. Combinatorial modularity is useful as it simplifies the assembly lines with mix-modeling (*Salvador et al, 2004*).

Regardless of the level of customization, *Coronado et al* (*2004*) emphasizes the importance of transparency (information sharing) throughout the supply chain. This been suggested by several authors earlier, as it reduce the distortion of demand to the lower-tier suppliers. Although this has been proved to work for low variety product industries, *Coronado et al* (*2004*) showed in his study, that it was also applicable to mass customization. Transparency should help to synchronize production with the final demand, which allows lower-tier suppliers to schedule production better, and with decreased safety stock buffers. He furthermore showed that the entire pipeline inventory was reduced at each tier, as well as the supply chain throughput time (*Coronado et al, 2004*).

*Salvador et al* (*2004*) states that within soft customization, high operational performance is the prevailing force over the offered level of customization as the competitive advantage. In the case of hard customization, the focus is not on operational performance but rather on highly customized product opportunities. These suggestions from *Salvador et al* (*2004*) are not conclusive, but rather theoretic guidelines to supply chain configuration. Every company has unique circumstances, and may for instance be in between hard or soft customization.

## 3.15 Literature review and summary of theory

Throughout the theoretical foundation, which had the purpose of providing a solid basis for our conceptual framework, many important factors have now been elucidated. The topics can be viewed individually, but it should hopefully be clear that they are deeply interconnected. The articles and subjects in the theoretical foundation have been chosen through an extensive literature review, and assigned an amount of attention according to its perceived relevance.

The table below shows the primary articles and books among many others, which were used to construct the theoretical foundation.

**Table 3.6: Main articles and books in theoretical foundation**

| Authors | Research area | Research type |
|---|---|---|
| ***Books*** | | |
| Blecker & Friedrich (2006) | Logistics, IT, market related factors and sourcing in mass customization | |
| Pine (1993) | Organizational change and market related factors | |
| ***Articles*** | | |
| *Aitken et al (2003)* | The impact of PLC on supply chains | Case study |
| *Berman (2002)* | Mass customization | Descriptive |
| *Broekhuizen & Alsem (2002)* | Market and external succes factors | Conceptual model/framework development |
| *Da Silveira et al (2001)* | Mass customization | Discriptive/literature review |
| *Davila & Wouters (2007)* | Postponement | Case study/Empirical research |
| *Frutos & Borenstein (2004)* | Information Technology | Framework development |
| *Gershenson et al (2003)* | Modularity | Discriptive |
| *Giard & Mendy(2007)* | Scheduling via demand information | Discriptive |
| *Mason-Jones et al (2000)* | Leagile supply chains | Descriptive |
| *Mikkola & Skjøtt-Larsen (2004)* | Mass customization, modularity, postponement and the supply chain impact | Discriptive |
| *Rudberg & Wikner (2004)* | Customer order decoupling point | Descriptive |
| *Salvador et al (2002)* | Sourcing in mass customization | Multiple casestudy |
| *Salvador et al (2004)* | Supply chain configurations for mass customization | Multiple casestudy |
| *van Hoek (2000)* | 3rd party logistics in mass customization | Framework development |

Source: *Own creation*

# 4 Analysis

## 4.1 Introduction to framework

As it was mentioned in the motivation, there is a gap in the literature concerning the implementation of mass customization according to *Kumar et al* (*2001*) and *Pillar* (*2004*). They state that there is a scarcity in models or frameworks that provide decision support, especially within manufacturing systems and supply chains. There are numerous studies on the individual topics that are covered in the literature review, but there seems to be a gap in the literature which sufficiently put the concepts together more holistically. Our analysis aims to do this, and will apply the knowledge from the theoretical foundation to create an illustrative conceptual framework. This is done by linking the different concepts together, and further supporting them by the use of many real-life case studies.

The framework is then subsequently applied thoroughly on a case company. Wilson Sporting Goods Co. has been chosen, as they are estimated to be a relevant candidate for implementation of mass customization.

Let's again review the objective of the framework, in order to establish a better understanding of what the analysis is seeking to illustrate. The objective of the conceptual framework is to provide companies with a decision making tool, that can help evaluate the scope and extensiveness of implementing mass customization, and subsequently decide if mass customization is a good economical strategy for them. When companies for various reasons are considering implementing mass customization, it is essential they know what changes would be necessary to make, and what factors that need to be considered.

That is why the framework is useful. It will map and locate where the changes should be made. It is therefore important that the framework is applied as though an actual implementation took place. It can be viewed as simulating the implementation process, and thus be a tool to finally assess the scope and viability of a mass customization implementation.

## 4.2 Proposal of implementation framework for MC

In this section there will be a proposal of an analytical and illustrative framework, which will serve to provide decision support and guidelines for assessing the scope of an implementation of mass customization.

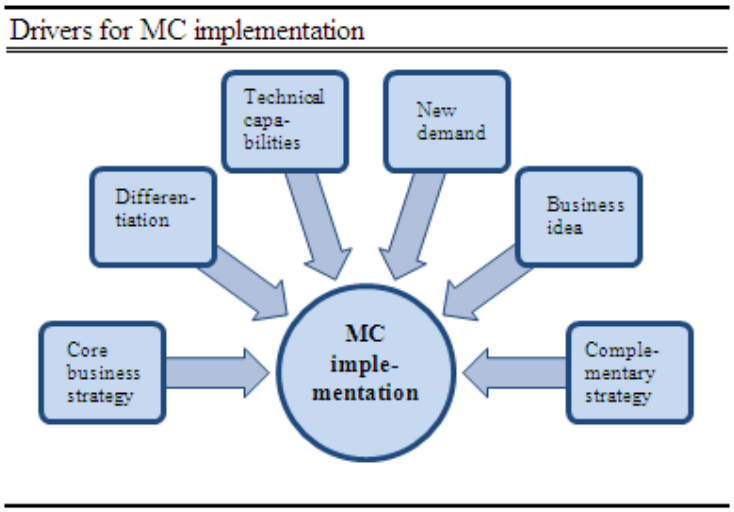
Implementation of mass customization is certainly a relevant study, as there are numerous ways of which companies can have an incentive to use mass customization as a strategy. According to Frank Piller, mass customization is right now enjoying its third wave (*cookiesncode.com*), which makes an implementation study even more relevant at this point in time. Piller suggests this wave is occurring due to improved technical capabilities which makes the processes cheaper, and a mature market that is ready to use the internet for buying and designing products.

Mass customization can furthermore be used as a complementary strategy to a company's primary strategy, where Nike and Adidas for instance have many standardized shoes and athletic apparel, but additionally offer customers to customize both shoes and equipment (*nikeid.nike.com* and *miadidas.com*).

Companies, who use mass production of standardized goods, can deploy a mass customization strategy on either a line or the entire product portfolio, as way of differentiating themselves from competitors or react to otherwise unanswered demand. This is what happened in the automobile industry decades ago, and though it used to be considered as the prototypical mass production, it have since been characterized as becoming very innovative of both products and processes (*Pine, 1993*). Almost every car manufacturer uses a mass customization strategy now, although to different degrees. The electrical motor company MarelliMotori now offers customization on the majority of its product portfolio, where none of the main players in the sector offer the same degree of customization as MarelliMotori (*Forza et al, 2006*).

Mass customization can also be the core strategy of a new company with a unique business idea that has yet to start up, as some companies' primary competitive advantage comes from having an overall mass customization strategy.

**Figure 4.1**



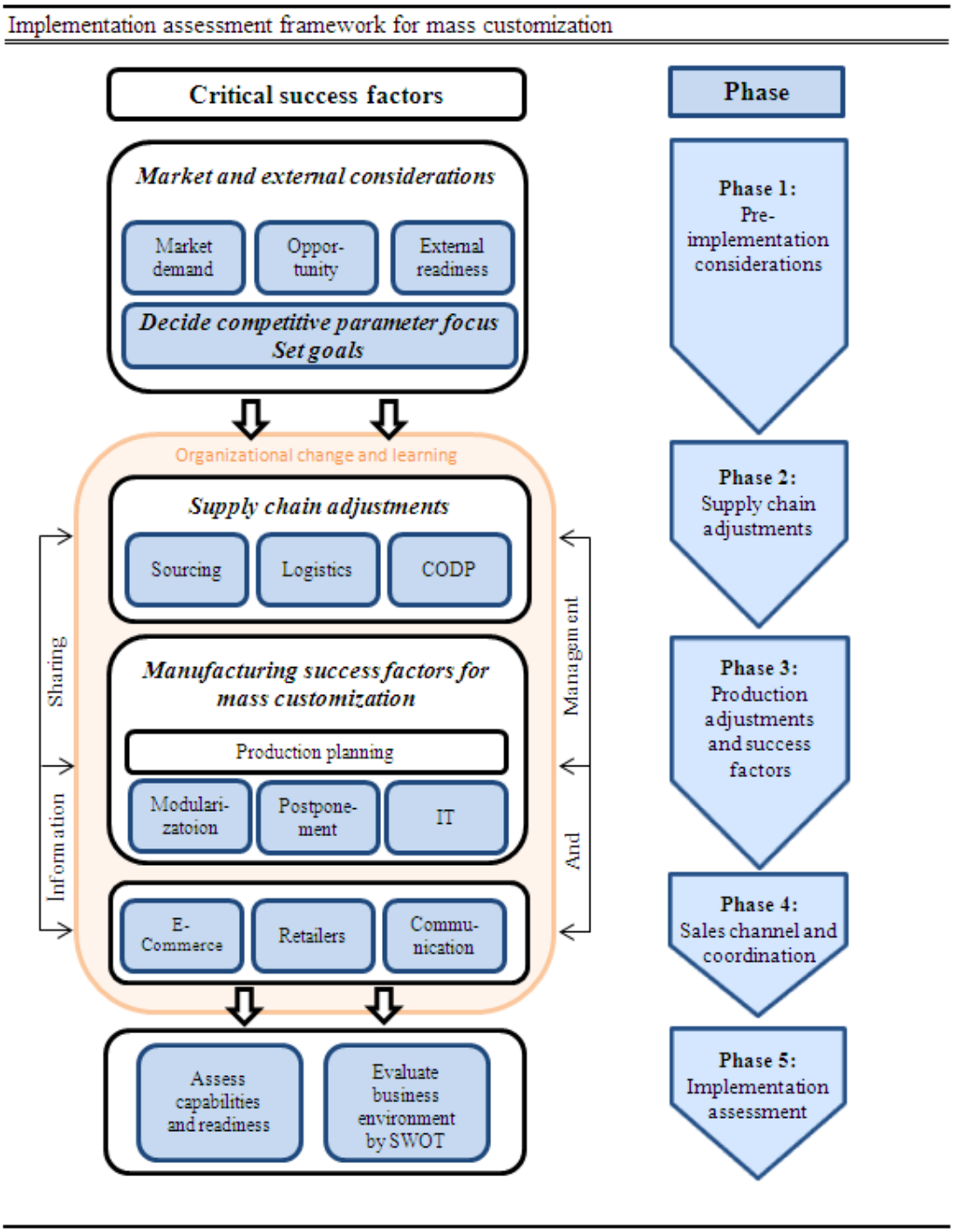

Source: *Own creation*

*Duray et al* (*2000*) states that mass customization can be implemented in both companies which mass produce and companies who make customized goods. Both types of companies will thus have to learn their respective weakness, where the mass producer have to learn customizing and the customizer will have to learn to standardize and increase their efficiency. Organizational learning is therefore an important aspect of implementing mass customization, as both internal and external learning will contribute effectively to the process of implementation. Learning is by nature knowledge generating, which can effectively be translated into the company's manufacturing processes, and therefore towards an improved implementation process of mass customization (*Huang et al, 2008*).

There are obviously many reasons why companies could benefit from implementing mass customization. This is why an overall guideline to evaluate what needs to be changed is important, and moreover to evaluate if the needed changes are realistic to carry out, in order to maintain a sustainable business model. Every company's situation is different, and the framework will thus serve as a guideline for companies to undergo it step by step, and apply it to create their own unique business model.

The analytical and illustrative framework below is the proposed approach, as to how to make decisions and what critical factors to consider, when a company are deciding whether to implement mass customization or not. The framework will be followed by a thorough explanation and case examples.

**Figure 4.2**




Source: *Own creation*

The above framework will now be undergone phase by phase, with supporting examples from real-life case studies to increase the understanding.

### *4.2.1 Phase 1 - Pre-implementation considerations*

As it was described before the framework, the company can have several incentives for implementing mass customization, as it can be an opportunity for differentiation or to meet new demand trends etc.

There are however many other considerations that the firm has to address. Although it can be an opportunity to differentiate themselves from competitors, there clearly has to be a demand for individualized goods, and companies have to make thorough evaluations and calculations of whether customization will create a sufficient added value for customers (*Broekhuizen & Alsem, 2002* and *Blecker & Friedrich, 2006*). Dell is a great example of a too complex, and therefore costly manufacturing and assembly process, relative to the customers' perception of added value (*dell.com* and *mass-customization.blogs.com*). In other words, the market has to be ready.

Although *Pine* (*1993*) stated that a stable market indicates that the there is no demand for differentiation, I would argue that this is not always true. I would assume that the athletic shoe market is relatively stable, and when athletes wear out their shoes, they have to buy new pairs. The point is that many markets and industries which have been relatively stable, have evolved from mass produced goods to customizable goods, or at least had companies within the industry apply mass customization successfully. I would even go as far as to say that in certain industries, a stable demand means that there is a general interest in the product, and probably also a demand for personalization, as the standardized products can in lack of a better expression be "boring". *Pine's* (*1993*) suggestion is very likely to be a result of the time his book was published.

The sales channel, whether it is a retailer, E-commerce or an internal sales force, should have the ability to interpreting and eliciting the customers' desires, and have effective communication links to the customers. These factors are essential for a sustainable mass customization model, or preconditions that companies should be able to adapt to (*Berman, 2002*).

Having the adequate technical capabilities both within information technology and manufacturing is fundamental, or at least having a sound basis for the possibility to adapt to obtaining it. *Berman* (*2002*) stressed the importance of technological capabilities to computer aided design and manufacturing, or that the firm can be adapted to incorporate it. Automated

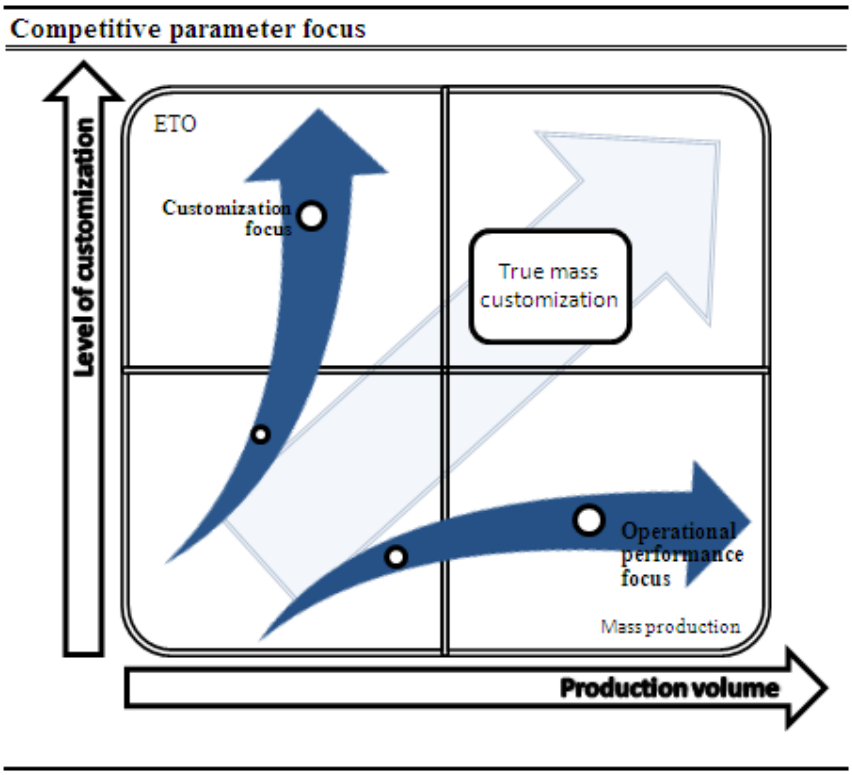
handling systems and other IT systems are very important, and will be explored in much greater detail in phase 3.

When the company is considering implementation, it can be beneficial to set goals within the following three areas, as this will give the company a solid understanding of what they hope to achieve with mass customization:

- Strategic: e.g. differentiation from competitors
- Operative: e.g. produce based on orders instead of forecasting
- Financial: e.g. higher profits due to added value and improved efficiency

When companies have a rational motivation to apply the strategy of mass customization, and additionally possess the necessary external prerequisites, they have to decide and consider the focus of their competitive parameter. This decision is a direct result of the mass customized product and its nature, but nonetheless a very fundamental and important consideration about how the supply chain should be configured. The decision tool is shown in the figure below.

**Figure 4.3**




Source: *Own creation*

Figure 4.3 shows what competitive priority or focus the company should go for. As mentioned in the introduction, price and customization are by definition rivaling. Although mass customization is a unique business model, which in essence should be capable of accomplishing a combination of the two, the company will in most cases benefit from either focusing on one or the other. Operational focus means in essence that the company competes on the price parameter, by having the supply chain operating very efficiently with large volumes, economies of scale and with fewer options of customization for the customer. A customization focus means that the company competes by offering greater customization opportunities than the competitors, but with lesser volume and regularly higher relative prices.

An example of a company that have an operational focus, is the mass customization giant Zazzle. They offer t-shirts, posters, cases, covers, mugs etc, where customers can get their desired print and/or text on it, by simply uploading a picture (*zazzle.com*). The customization opportunities for each product are very few and the products very cheap, and they are essentially using a postponement strategy with the CODP very close to the final consumer. The basic body components are pre-produced and then finally printed (final assembly) at the Zazzle's production facility, using a just-in-time delivery strategy (*outsideinnovation.com*).

A completely different type of mass customization company that have a customization focus is bordpladen.dk, which have focus on offering a large degree of customization. They offer tables for kitchens, bathrooms and dinner etc, where the customer can get any size and thickness, and get it in any shape measured with laser technology, but at a relatively high price (*bordpladen.dk*). The CODP is thus seemingly very far back, almost immediately after extraction of raw materials, and a rare instance of where modularization and postponement are actually not success factors.

A company that would fit under the "true mass customization", which compete in both price and customization is itailor.com. They offer millions of variations to shirts, suits and ties, at prices which are much lower than most non customized suits (*itailor.com*). Postponement and modularity are critical success factors, and they are assumed to exercise a Le-agile supply chain.

Although there has been a characterization of operational efficiency and customization focus, it is not to say that companies who focus on customization should not seek to optimize its efficiency. It is simply that their supply chain profiles are vastly different, and have different critical success factors, which will be further explored in the next section. The higher degree of customization, the higher price the customer is willing to pay, and therefore the supply chain can focus on offering the right product and not compromise quality to become more efficient. It should also be made very clear that the division of companies into operational performance and customization are merely the basis for the analysis of a firm, as there will obviously be operational minded firms that offer a much larger degree of customization and vice versa.

### *4.2.2 Phase 2 - Supply chain adjustments*

The supply chain adjustments are as mentioned completely dependent on the nature of the product and the competitive parameter. Flexibility and agility are however an important factor independent on the product type and competitive parameter, as mass customization has a very large product variety and in general shorter life cycles (*Di Silveira et al, 2001* and *Aitken et al, 2003* and *Berman, 2002*). Let's first explore the supply chain adjustments based on the competitive parameter focus.

#### *Operational performance focus*

The CODP should be moved as close to the end customer as possible, and thereby have a primary focus of push activities, using Lean principles throughout most of the supply chain. The flexible part will be final assembly, typically using postponement and simplistic modularity strategies (*Mason-Jones et al, 2000*). Apple's iPod or iPad among other products are great examples where the CODP is very close to the customer. Apple offers engraving on these products, and can do this after the complete production of the basic products (*apple.com*).

The sourcing will be characterized by having very few suppliers, and preferably one for each necessary body component. This will create a relationship where the supplier delivers in high volumes with reliable processes, long term agreements, and thereby have the ability to take advantage of economies of scale. In cases where the company will outsource the production of the customized components, it is preferable that the supplier is within close proximity to ensure fast delivery (*Salvador et al, 2002*). It can be difficult to get access to the

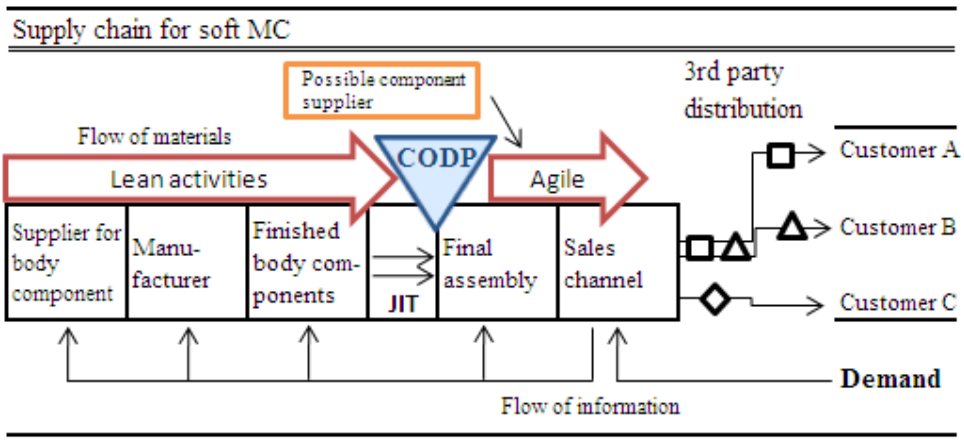
sourcing information, but it is assumed that zazzle.com use one supplier for the body components they use, such as t-shirts, mugs etc.

The upstream logistics should be characterized by information sharing, as planning and scheduling of production will be much smoother, which is argued by several authors (*Mason-Jones et al, 2000 and van Hoek, 2000*). The main goal is to unite a network of processes, and deliver the right components on time for a final assembly and customization. A just-in-time (JIT) strategy would be ideal to the extent it is possible, as warehousing and transportation would primarily be the responsibility of the supplier. As an example, Zazzle use a JIT strategy, where the pre-made body component is delivered to the production facility, and then customized and shipped within 24 hours (*outsideinnovation.com* and *zazzle.com*). The upstream supply chain could greatly improve the streamlining and efficiency by implementing RFID, ERP or EDI as products and subassemblies can be controlled separately, and the supplier will receive real time information about inventory levels, and will thus facilitate JIT inventory replenishment (*Blecker & Friedrich, 2006* and *Coronado et al, 2004*).

The downstream logistics which is the packing and shipping will have to be done by 3rd party logistics companies to achieve economies of scale. In some simple instances, the 3rd party may even be able to do some postponed customization of the packaging. Zazzle for instance use FedEx and UPS to ship their products to the customers (*zazzle.com*).

The figure below illustrates the coordination between the actors of an operational performance driven mass customization supply chain, based on the factors explained above.

**Figure 4.4**




Source: *Own creation*

Let's now explore some supply chain adjustments for companies which use customization offers as their competitive parameter.

***Customization focus***

When companies offer a much larger degree of customization, it will rarely be possible to use postponement and final ATO strategies, as the customization part will usually be more comprehensive. The CODP will therefore have to be placed further back in the supply chain, and there will be a primary focus of agile and flexible pull activities throughout the supply chain (*Rudberg & Wikner, 2004* and *Olhager, 2003*). BoConcept can only make some very basic modules after Lean principles, as there are no separate body components. The CODP therefore have to be further back, as the end product is essentially a mix of many different sub-components which consists of different fabrics and modules in different shapes.

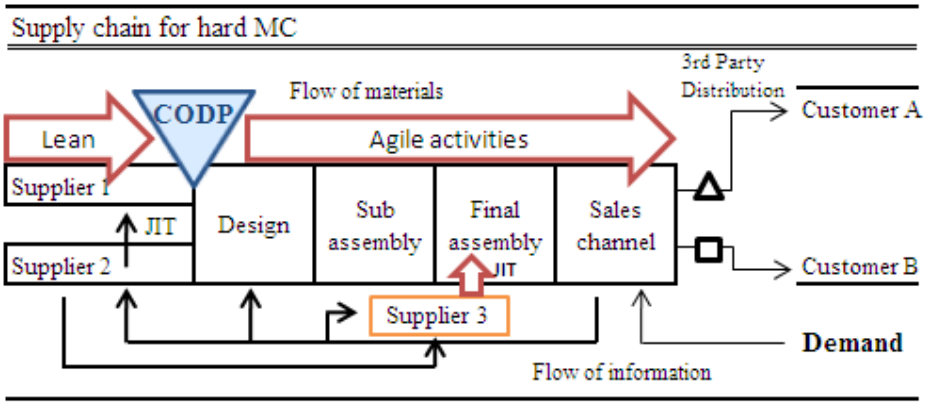
In many cases, the company will have a supplier for each of the components, but it could benefit immensely if it could reduce the number of suppliers without reducing the number of product variations. This will however not always be possible, but it would reduce supply chain complexity and the need for safety stock of some components, and furthermore operate towards economies of scale (*Salvador et al, 2002*). As mentioned earlier, Dell used to rely on an intricate network of suppliers but this got too complex (*dell.com*). A company that was able to keep its sourcing configuration simple, despite a relatively high level of customization was the finish shoe manufacturer Left Foot. They preferred durable partnerships and high quality, and therefore went with only one reliable supplier of leather (*Sievänen & Peltonen, 2006*).

In some instances it can be advantageous to use a postponement strategy in the sourcing (*van Hoek, 2001*), which is for instance done by usacustomguitars.com. There are certain materials and components that are not bought, until after the customer order is placed (*usacustomguitars.com*).

Information sharing is even more necessary in a customization focused supply chain, as planning and scheduling of production will get very inefficient when several suppliers deliver different components (*Giard & Mendy, 2008*). It is only the basic common components that should be produced to stock, and if there is sufficient communication and information

sharing, timely deliveries will decrease the production lead time, and will furthermore reduce inventory of subassemblies. These upstream logistics activities could benefit from additional coordination between suppliers with further information sharing between them by using ERP or EDI systems, and using a JIT strategy to the extent it is possible (*Blecker & Friedrich, 2006*). A JIT strategy gets increasingly difficult as there will in many instances be more vendors supplying different components to one end product. Occasionally these are from different countries, thereby making coordination far more difficult. BoConcept for instance use ERP systems in order to streamline the flow of both products and information, to allow faster order processing and improve productivity (*BoConcept Annual Report 2010*).

**Figure 4.5**




Source: *Own creation*

The downstream logistics of distribution should again be done by 3rd party logistics companies, although there will likely not be the same possibilities of them doing any postponement activities due to the more diversified and complex product assortment. BoConcept and Left Foot among many others outsource their logistics to 3rd party companies (*BoConcept Annual Report 2010* and *Sievänen & Peltonen, 2006*).

For companies that use customization as their competitive parameter, I would argue that there are fewer supply chain activities that can be adjusted, except for detailed information sharing and excellent coordination. I would further argue that their competitive edge will come from internal proficiency, such as efficient use of modularity and assembly processes, as well as a skilled sales channel. This will further be explored in the next phase.

***"True" mass customization***

True mass customization can be described as a combination of the aforementioned supply chain adjustments, but should obviously be adjusted to the specific product and manufacturing processes. True mass customization will not be explored in the same detail for a couple of reasons.

I would argue that virtually any company, who consider implementing mass customization, should in the vast majority of the times decide a clear focus on either an operational or customization parameter. This is consistent with a number of authors who strongly argue that finding the right level of customization is important (*Rudberg & Wikner, 2004* and *Piller et al, 2004* and *Da Silveira et al, 2001*). The number of companies who offer a very high variety and large volumes are few and far between. One example is Dell, and as mentioned earlier, their business model was not sustainable because the assembly complexity was too high, as a result of too much possible customization (*mass-customization.blogs.com*). One rare success story is Nike. Their NikeiD line offer millions of varieties and have large volumes (*crossroadinnovation.com/nike-id*), but I would argue that their success is a result of extremely advanced technology. IT is their production equipment, as well a very sophisticated IT system that provides a user friendly interface for customers, and are able to translate it electronically to its manufacturing plant. In essence it's a highly refined example of advanced postponement, using a large degree of modularity, and is in actuality exercising an operational performance strategy. MarelliMotori is also an example of a company that specifically competes at both the price parameter while still offering millions of possible customization options (*Forza et al, 2006*).

### *4.2.3 Phase 3 - Production adjustments and success factors*

In this phase of the implementation process, the production adjustments and success factors will be explored, and once again divided into the two categories of competitive parameter focus.

#### *Operational performance focus*

When the CODP is close to the end customer, a form postponement strategy is preferable for several reasons. It allows for the basic body components to be produced with economies of scale, and is thus in coherence with the statement that postponement can bring the efficiency of Lean together with the responsiveness of agility (*van Hoek, 2000*). In many instances modularity will be a prerequisite for this strategy.

There are numerous examples of companies which use the postponement strategy to execute their overall mass customization strategy. The fashion giant Ralph Lauren offers customers to choose a shirt or polo in their desired color, have them print three letters of choice and color, and the color of their logo (*ralphlauren.com*). Apple will personalize your iPad and iPod etc, with an engraving on the back (*apple.com*). These two examples show products, where the core body component can be completely mass produced, with a final cosmetic form postponement very far downstream and close to the end consumer. MarelliMotori is another great but more advanced example. They offer a larger degree of customization and have a high degree of modularity in their products. They implemented IT-supported product configuration and used form postponement along the material flow, which enabled them to reduce the lead time and prices in a market where customers are not willing to wait (*Forza et al, 2006*).

The production planning of the postponement strategy will clearly require coordination and information sharing between organizations in the value chain, so the goal of pushing the postponement as far downstream as possible, can be achieved. MarelliMotori for instance has a very proficient planning system. As it was mentioned above, they have an IT-supported product configuration, and this technical configurator will automatically display the needed materials in order to build the customized product. It will moreover initiate the production and automatically insert the code of the motor and sales, which is handled by their ERP system (*Forza et al, 2006*).

***Customization focus***

When there is a higher degree of customization offered, having a modular product architecture will often be vital. Modularization has several benefits such as decreased order lead times, the ease of design, and a lesser risk of obsolete inventory as the components can be mixed and matched in many variations (*Gershenson et al, 2003*). Postponement can occasionally be beneficial, but more as a complimentary strategy. Although in many cases modularization is essential, bordpladen.dk is an example of where it is not the key to success.

Although modularity enables flexible manufacturing (*Duray et al, 2000*), it also requires an increased coordination and information sharing, as there will often be more suppliers of different components to the same end product. Each supplier therefore has to use the same type of modularity.

In essence, BoConcept has a large amount of modules the customer can mix together to form their own sofa. They can chose between many different types of fabrics, colors, sizes, armrests and feet, creating thousands of opportunities for a unique sofa, while completely relying on modular product design.

### *4.2.4 Phase 4 - Sales channel and coordination*

#### *Operational focus*

When the company employs a soft mass customization strategy with large volumes, I would argue that E-commerce as the sales channel, would be far best suited. For this to be successful there have to be a fairly advanced IT system, which should be able to provide an interface that define the catalogue of options that are offered to the customers. It should furthermore be able to collect the customers' order information and translate this data into product configuring and to the manufacturing facility (*Frustos et al, 2004*). Postponement is often the preferred strategy in soft mass customization, where E-commerce was stated to be a very good fit because of the electronic handling and expected delivery times (*Chopra & Meindl, 2007*).

The benefits would be shorter lead and handling times, and it would reach out to more customers, as well as being far more efficient than having a retail shop. zazzle.com exclusively sells products online, and does not have a retail store (*zazzle.com*).

#### *Customization focus*

Companies that offer a great degree of customization will in most cases need a retail store, and a skilled sales force that are able help and explain the customer the customization and configuration possibilities. Using the internet as an interface to give customers an idea is preferable, but it will rarely be sufficient to integrate customers in the design. An advanced internal information technology system is far more important, to manage the extensive varieties of products and subassemblies (*Blecker & Friedrich, 2006*).

At BoConcept, it is necessary for the customer to go to a store to place the order, although their website has a design tool for the customer to create ideas (*boconcept.dk*). Adidas offers a larger degree of customization to their shoes than Nike, and as a result they do not have an online configuration system. Their price increase from standardized products is moreover 30-50%, compared to Nikes 25% (*Moser et al, 2006*).

### *4.2.5 Phase 5 - implementation assessment*

In order for companies to determine a potential mass customization strategy, it is imperative that they systematically undergo each of the first four phases from figure 4.2, as it will illustrate what changes that needs to be made. It is not essential that a company have all the attributes that is needed at the moment, but the question is if companies are able to change in order to obtain these qualifications and attributes, while avoiding a too costly changeover process (*Berman, 2002*). It is moreover important to illustrate that the necessary changes should not only be possible, but also make for a sustainable long term business model after implementation.

To further assess if the mass customization strategy is viable, it can be very beneficial to use the SWOT model as a tool. This can help to not only establish an overview of the drivers for implementation, but it can create a holistic view of the entire business environment and how it will be affected. Our conceptual framework gives the company a tool to determine the success factors for the company and the supply chain, and the SWOT model can support this by evaluating the business environment and the stakeholders. The combination of these two models should give the company a solid foundation to make a good decision, of whether implementation of mass customization will be a viable and sustainable business strategy (*Moser et al, 2006 and Forza et al, 2006*).

There will however always be an organizational learning phase, where the company has to innovate or modify certain structures, processes and supply chain configurations, as well as generating knowledge to have an effective transformation (*Pine, 1993* and *Huang et al, 2008*). Levi's attempt at mass customization failed partly due to inadequate amount of learning and improvements (*mass-customization.blogs.com*).

One of the most important factors that cannot be overstated is getting the right level of customization. Nike iD offer customers to basically mix modular components, but *mi*adidas also offers customization of both fit and performance of their athletic shoes. Adidas is thereby the industry leader in customization but is however only marginally profitable, while Nike is hugely successful using a simpler model. Nike furthermore provides an online configuration system while Adidas only offer their customized shoes at selected stores, which limits the quantity (*Moser et al, 2006* and *crossroadinnovation.com/nike-id*). This furthermore demonstrates the importance of information technology. It is imperative to use it in a holistic

way, so it will serve as a sales channel that can translate sales data to the production facility. By sharing information it is possible to greatly streamline the supply chain with efficient communication and coordination with suppliers (*Frutos & Borenstein, 2004* and *Kay, 1993*).

The framework is mostly pointed towards companies that use mass production of standardized goods, or new company start-ups. It may at first seem like going from mass production to incorporate a customization focus is unlikely to be successful, but there are several examples of this. BoConcept and Adidas went from offering standardized goods, to offering a large degree of customization to a selected line of products.

The overall assessment in this thesis is of strategic nature, and companies will therefore have to make a deeper analysis on the operational level. They have to evaluate factors such as the level of offered customization, and for instance where the customization takes place, and if the product architecture can easily be changed. The big question is how companies can make this analysis? This is why this thesis will conclude with an extensive analysis of Wilson Sporting Goods Co., which currently does not exercise a mass customization strategy. Wilson will thoroughly be analyzed by undergoing each phase of the implementation framework, and thus generating an overall assessment of the viability of a mass customization implementation. There is unfortunately some information about Wilson's production and supply chain that is unknown, which could have made for a more accurate analysis of the operational factors that Wilson has to consider.

## 4.3 Discussion: Implementation barriers

The main transitional barriers and challenges of changing from mass production to mass customization that have not been covered sufficiently, will briefly be elucidated in this section. The overall recurring issue is that companies that are operating and managed to be mass production companies, are not prepared and configured to be mass customization companies.

It is always unknown if the market is demanding mass customized products, and if the customization provides enough added value for the customers, relative to the price increase (*Piller et al, 2004*). *Blecker & Friedrich* (*2006*) even go as far as stating that customization can overwhelm the customer with too much product selection, as a result of lack of

knowledge about the product. They further state that companies' online configuration tools for the customers are far from adequate, and need substantial improvements in the way they present product options (*Blecker & Friedrich, 2006*). I would argue that this is by far not always true. Nike and itailor.com for instance have extremely user-friendly and intuitive interfaces, where customers may even design products for fun (*nikeid.nike.com and itailor.com*). This statement is probably a result of the time the book was written, and obviously is dependent on the means of the company.

Moreover the marketing approach has to be converted from identifying and exploiting similar needs within large segments, to identify real differences in customer needs and offering a solution space that can fulfill these diverse needs (*Rungtusanatham & Salvador, 2008*). I would argue that in many cases the marketing does not have to altered, as the companies in many cases will use mass customization as a supplementary strategy. The customers will know about the customization possibilities as long as they know about the standardized product.

There are internal challenges that have already been covered, which are related to an increased product variety and configuration. These will undeniably slow down the supply chain, and decrease the efficiency. Although there are several strategies of overcoming this, such as modularization and postponement, the challenge of production planning and scheduling becomes much larger. These are related to more product alternatives, and therefore more routing alternatives on the shop floor, and sometimes unwanted volumes of sub-assembly inventories (*Blecker & Friedrich, 2006*). This deserves mention here, due to the fact that it can also create concerns for accounting procedures toward allocating direct product costs. It is important to accurately calculate how adding product extensions affect the costs, and to determine exactly what products or processes that cause an increased production cost (*Rungtusanatham & Salvador, 2008*). If companies are unable to do this, it can be difficult to determine the soundness of a mass customization strategy.

The production equipment in mass customization is also not configured to make customized products, and the company will have to invest in new manufacturing assets. This makes the past investments sunk cost and creates a paradox. The decision makers cannot sell of the past investments to pursue a mass customization strategy, as the payoff for doing so is too uncertain. Furthermore the change of the product architecture towards modularity to ease product configuration can also be severely demanding (*Rungtusanatham & Salvador, 2008*).

However in many cases, mass production companies will add mass customization as a supplementary strategy rather than a complete changeover, and will hence be able to keep their present manufacturing assets.

Sourcing can also create issues, as companies will need more vendors as product variation increases, and at smaller volumes. This is not beneficial for the company or supplier, as economies of scale are lost, as well as the delivery planning and coordination can get very complex. Some internal constraints like these can be reinforced, as some of the adjustments are in the hands of other reluctant supply chain members (*Blecker & Friedrich, 2006* and *Rungtusanatham & Salvador, 2008*).

These barriers are certainly factors that also need reflection, when a company considers implementation of mass customization.

# 5 Analysis of Wilson Sporting Goods Co.

The proposed framework for assessing implementation of mass customization from the previous section will in this section be applied to Wilson Sporting Goods Co., to test for its applicability and usefulness. It is specifically the customer integration of designing and personalizing their line of basketballs that will be explored. It is in other words an analysis of how Wilson should adjust their current environment to a mass customization strategy.

## 5.1 The company and market description

Wilson Sporting Goods Co. was founded in 1914 by Thomas E. Wilson, as it was a small subsidiary of a meat packing company, which used its by-products to create tennis racket strings (*fundinguniverse.com*). It has since evolved to be the world's leading manufacturer of sports equipment in sports such as baseball, American football, basketball, tennis, squash, golf, badminton and softball, dividing their business structure into three core areas of: racquet sports, team sports and golf (*wilson.com*). Wilson Sporting Goods Co. is an entirely owned subsidiary of the Finnish Amer Sports Corporation, after it was acquired by them in 1989 (*nytimes.com*). Wilson Sporting Goods Co. has its headquarters in Chicago and employs over 1600 people worldwide, while serving customers in over 100 countries. Wilson is furthermore the number one racquets sports company, and number one and two in American football and baseball respectively (*amersports.com*).

The Amer Sports Corporation, including Wilson, is increasingly outsourcing the production of both end-products and components to improve operational efficiencies. Although they maintain production facilities in Austria, France, Finland, Canada, Bulgaria and the United States, the majority of production is outsourced to Asian sub-contractors. They are using 3rd party companies to distribute products from the 40 total distributions centers worldwide, including 16 in the United States (*Amer Sports Annual Report 2009*).

Wilson provides the official basketball for NCAA[3], and has a total market share of 38% in the United States and 23% globally in the year 2009 (*Amer Sports Annual Report 2009*), in a market that is dominated by four large actors. The three others are Spalding, provider of the

[3] North American college basketball (National Collegiate Athletic Association)

official NBA[4] ball (*spalding.com*); Molten, provider of the official ball of FIBA[5] tournaments, including World Championships, European Championships and the Olympic Games (*fiba.com*); and Nike, a giant within basketball shoes, balls and other apparel.

**Table 5.1**

| **Overview of Wilson Sporting Goods Co.** | |
|---|---|
| Name | Wilson Sporting Goods Co. |
| URL | www.wilson.com |
| Year of foundation | 1914 |
| Number of employes | 1600 |
| Net sales total (2009) | 476,7 EUR (millions) |
| Net sales, basketballs (2009) | 28 (est.) EUR (millions) |
| Industry | Sports Industry |
| Products | Racquets, balls, apparel, equipment |
| Markets | Global |

Source: *Own creation* after *Amer Sports Annual Report 2009*

## 5.2 Why mass customization?

Although Wilson had a sizeable market share of basketballs of 38% in the United States and 23% worldwide, it is still a constant battle to maintain and preferably heightening this number against the three other giants of the basketball market. While improving production efficiency and good marketing are of high importance, Wilson has a unique chance of separating themselves from its nearest and fiercest competitors by using a mass customization strategy, which none of the competitors offer (*nike.com* and *spalding.com* and *molten.com*).

There is a huge possibility of reaching out to many customers, as it is the official ball of the widely popular NCAA, and has thus gotten increased recognition by the many fans. This has already increased sales significantly as a result of the huge television broadcasting deals with CBS and Turner continuing until year 2024 (*wilson.com* and *chronicle.com*). There are furthermore an estimated 450 million people playing competitive basketball globally (*fiba.com*), and therefore a considerable amount of potential customers which could potentially demand a personalized basketball. This could be both in terms of individual customers, as well as clubs and schools.

[4] National Basketball Association
[5] International Basketball Federation

## 5.3 Implementation using framework

In this section the implementation framework will be undergone step by step, and applied to Wilson basketballs.

### *5.3.1 Phase 1 - pre-implementation considerations*

There should first be an estimation of the readiness of the project, in terms of the market and the company itself. Wilson is a subsidiary of the Amer Sports Group which had net sales of 1.533 million EUR, and has several distribution and production facilities around the world, including one in the United States that produce leather Wilson American Footballs (*Amer Sports Annual Report 2009*). There are furthermore initiatives of using ERP systems and an overall supply chain focus to strive for operational excellence by using Lean principles (*Amer Sports Annual Report 2009*). These above mentioned factors points towards a company that internally is ready to introduce mass customization.

It seems that the market demand for Wilsons team sports has been relatively stable, with maximum fluctuations of 15% since 2005[6] (*Amer Sports Annual Report 2009*). As a result of my arguments in the analysis, it would seem that the market is ready, as it would provide opportunities that have not existed before.

Deciding the competitive parameter and choosing the right level of customization is of outmost importance. A basketball consists of 8 “pieces” total on top of a core body, where each piece can be seen as a module. These modules should be customizable of color, and the pieces without logo should furthermore be customizable to contain letters or a personalized logo. This would be relevant for schools and clubs, and furthermore create demand in bulks instead of only singular orders[7]. This will serve as a complimentary strategy, and Wilson should obviously keep producing standardized balls.

The customization possibilities are few and simple, and Wilson should thus have operational performance focus as their competitive parameter, where the price increase should be relatively small for a customized ball. Although Wilson was not described as being agile, they still appear to be ready for implementation, as the majority of the supply chain is already performing Lean activities, and the agile activities are few.

[6] Calculated by looking at total net sales since 2005
[7] See appendix A

It can only be assumed that the market is ready, as numerous clubs, schools and individual players would find it attractive to get their names and club colors on the ball. Wilson already has the advantage of appealing to fans as their ball is of high quality and as it is the official NCAA ball. The goals of implementing mass customization would be:

- Strategic goal: Differentiation from competitors by offering personalized basketballs
- Operative goal: Producing and selling based on orders instead of forecasts, while maintaining economies of scale.
- Financial goal: Higher profit due to added customer value and increased market share

### *5.3.2 Phase 2 - supply chain adjustments*

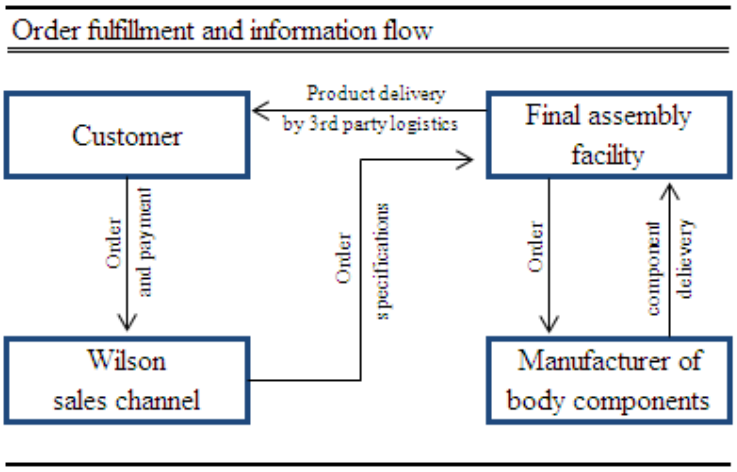
As Wilson has an operational performance focus, the CODP should be moved as close to the end customer as possible, to ensure that as much as possible of the supply chain can operate after Lean and mass production principles. A form postponement strategy is then used based on a modular composition of the ball. This should take place at Wilson's production facility of final assembly.

Implementing mass customization to Wilson does not include changes in materials or composition of the balls, as it will basically only undergo a slight cosmetic change with no unique components. This allows Wilson to remain with the same suppliers and not change their sourcing configurations. This is advantageous as Amer Sports underlined great relationships to all of their present vendors (*Amer Sports Annual Report 2009*).

There is however going to be some changes in their upstream logistics, as Wilson is now going to respond to specific individual customer orders instead producing according to forecasts. It is unfortunately unknown which off Amer Sports' production facilities that produce Wilson basketballs, but as they outsource the majority of their production to Asia, which is by far the largest supplier of rubber as raw materials, it is assumed that at least the inside of the balls is produced in Asia (*Amer Sports Annual Report 2009* and *bloomberg.com*). As Amer Sports produce their Wilson leather American footballs in the United States, it is assumed that this is also where the Wilson basketballs are produced. There are over 30 million basketball players in the United States, and the facility would thus be close to a huge market (*Amer Sports Annual Report 2009*). It would clearly be beneficial to combine the mass manufacturing and customization in the same facility, but if this is not

possible a JIT strategy will be highly beneficial to keep inventories at a minimum. This can however be difficult if the producer of sub-assemblies is in Asia and the final assembly facility in the United States. The supply chain information management will nonetheless be different, and the below figure shows the order fulfillment process, and the new information flow.

**Figure 5.1**




Source: *Own creation*

As the customization does not require a complex sourcing configuration, the need for advanced information sharing becomes less important. Amer Sports already use ERP systems, which is an efficient tool to improve agility and adaptability to unforeseen events, and is therefore an essential tool for their mass customization strategy. The downstream distribution is already performed by 3rd party logistics, and will consequently not need changes (*Amer Sports Annual Report 2009*).

### *5.3.3 Phase 3 - Production adjustments and success factors*

As mentioned above, the preferred operational strategy will be form postponement, based on a simple modular product configuration. The production of the inside balloon, the outside core and basics of the modular components can be made according to a mass production principles. A large part of the production can thereby probably be unchanged. The last customization of the modules can then be performed and applied to the basic core body, after all the components have been manufactured. If the parts are not already modular, it is

expected to be a relatively uncomplicated process to switch to modularity, as some of the pieces already are different.[8]

### *5.3.4 Phase 4 - Sales channel and coordination*

At this point in time, Wilson does only sell basketballs through retailers or independent online shops. If mass customization should be implemented, an E-commerce sales channel would be a fundamental necessity. Wilson would need an IT system that would be capable of presenting customers with a catalog of options, and at the same time capable of collecting orders and translating them to product configuration at the manufacturing facility. This would make the handling of orders much more efficient, and furthermore establish a stronger customer relationship, as it could otherwise lose potential customers. The standardized balls should obviously continuously be sold at retail shops.

### *5.3.5 Phase 5 - Implementation assessment and concluding remarks*

Wilson has a unique opportunity to differentiate themselves from its nearest competitors, by offering customizable basketballs which can appeal to individual players, clubs and schools. Implementing mass customization can furthermore contribute to brand building, and positioning Wilson uniquely on the market, which is an excellent foundation for future growth.

The necessary supply chain adjustments are moreover quite few, with no apparent changes in the sourcing strategy and presumably few changes in the logistics and production strategy. This is undoubtedly dependent on some conditions that are unfortunately unknown, but are regardless estimated to be relatively minor.

The biggest change is related to responding to orders, instead of producing according to forecasts. The new order fulfillment process will certainly require some changes in terms of setting up an online sales channel, and coordinating the production, and it will be a challenge for Wilson to keep the operational efficiency at a comparable level, while redesigning some of the IT flow and processes. These challenges are by no means impossible to overcome, but the change to mass customization requires adjustments of certain processes, and must constantly be improved upon to make sure their mass customization business environment is economically sustainable. The SWOT model below should give an overall assessment of

[8] Some pieces has logos and some pieces are plain. See appendix A.

Wilson's strategy of implementing mass customization to their line of basketballs, and other factors surrounding the project.

**Table 5.2**

SWOT analysis of Wilson

| Strengths | Weaknesses |
|---|---|
| •Few supply chain changes<br>•First mover advantage<br>•Already strong brand name<br>•Differentiation from competitors<br>•Financial ressources from Amer<br>•Bulk orders from clubs/schools<br>•Online sales | •Changes of IT and processes can be costly and complex<br>•Dependence on Asian manufacturers<br>•Increased logistics costs<br>•Organizational learning of new processes |
| **Opportunities** | **Threats** |
| •Reduce inventory levels<br>•Build stronger customer relationships<br>•Introduce mass customization to other Wilson equipment | •Unexpectedly low demand<br>•Competitors likely to follow<br>•Longer delivery times<br>•Unwillingness from customers to handle price increase<br>•Potential loss of efficiency |

Source: *Own creation*

Most of the points in the SWOT model have already been explained, but a few needs elaboration. The first mover advantage is not only a way of differentiation from competitors, but can also add to brand building and awareness (*Lieberman & Montgomery, 1988*). Almost every customized product will be sold on an individual basis, but Wilson has a rare opportunity to sell customized balls in bulks, as having the name and/or color on the ball can certainly be appealing to both schools and clubs. The stronger customer relationship can come from customers that would return to Wilson because of the personalization offer, where they normally would be indifferent to the maker. If mass customization is successful for Wilson, the competitors are like follow up and offer customized balls as well. This can result in loss of some of the obtained benefits.

By the use of our framework and analysis, we have elucidated the success factors and moreover the necessary changes within production and the supply chain. Wilson Sporting Goods Co. can on the basis of this analysis make a qualified assessment and evaluation of a mass customization strategy, and decide whether or not an implementation would be within their capabilities, while maintaining a sustainable business model.

An overall assessment of the success factors and the scope of implementation, would in my opinion suggest that Wilson Sporting Goods Co. could benefit from a mass customization strategy. There are definitely some valid weaknesses and threats, such as increased logistics costs, changes of IT and some processes, and potential loss of efficiency. These are however far outweighed by the strengths of the very few needed supply chain changes, the clear differentiation from competitors, and the possibility of introducing mass customization to other equipment by having a successful mass customization formula ready.

# 6 Conclusion

The conclusion will start out by answering the four research question, and subsequently answer the main problem statement conclusively.

**Research Question 1:** *What are the critical success factors for an economically viable implementation of mass customization?*

The majority of the topics that were covered in the theoretical foundation can be considered as critical success factors for mass customization implementation. Modularity and postponement are very often the solution to maintain an efficient production of customized goods, as they allow many components to be produced with great efficiency, and then assembled in a manner that creates a unique product. The position of the CODP can be used strategically, where the objective is to construct a Le-agile supply chain. The pre-CODP activities can be performed according to Lean principles to accommodate forecasts, and the post-CODP activities are responding to specific orders by customizing the product according to agile principles. Responding to orders creates new challenges in terms of production planning, logistics and information management. It requires a sufficient IT system to conquer these challenges, and information sharing is deemed to be essential. Systems such as ERP, VMI and EDI can streamline an otherwise flexible supply chain immensely, and make production planning far more efficient. Outsourcing of distribution is critical, as customers are served individually. These factors and how they are applied, are however very dependent on the product type and level of customization the company provides to its customers.

**Research Question 2:** *How can companies approach and do an analytical assessment of the mass customization implementation process? 2.1: How could a conceptual framework for this look like?*

To answer 2.1 first, we refer to see figure 4.2 on page 49, to illustrate our proposal of a conceptual framework for an assessment of the mass customization implementation process.

By following the conceptual framework phase-by-phase, companies can identify the success factors, and assess the necessary changes. By analyzing the pre-implementation factors they can evaluate whether the market is ready, and decide the level of customization. They can subsequently recognize how the supply chain should be adjusted to meet the new

strategy, and moreover contemplate which production configuration that would seem most fitting, and lastly determine the sales channel. By thoroughly analyzing the first four phases of figure 4.2, the company can illuminate and map the potential implementation process, and identify how extensive this process would be.

**Research Question 3:** *How does the level of customization impact the supply chain configuration? 3.1: How should the supply chain accordingly be adjusted?*

Although the mass customization concept combines the elements of efficiency with customization, the supply chain configuration can have vastly different configurations depending on the offered level of customization. Companies should have a clear focus on either offering a large degree of customization, or less customization at a low price. When the competitive parameter is of customization at low prices, the supply chain should have an overall goal of operational efficiency and keeping costs low. When offering a high degree of customization, there should be a focus on offering a high quality product, and not compromising on the level of customization, thus having an overall agile supply chain will be beneficial. How the success factors from question one is used, is greatly dependent on this.

When the focus is on operational performance, it is in many instances possible to mass manufacture body components, which can afterwards be altered by the use of a simple modularity and postponement strategy according to the customer order. The CODP is thus very close to the end user, and the preferably few suppliers can maintain economies of scales and deliver large quantities.

With focus on providing a high degree of customization, there will often necessarily be more suppliers, which will have to deliver smaller quantities. As a larger part of the production cannot be made until after the customer order, the supply chain will therefore need great coordination and an adequate IT system, to still maintain some efficiency in the production. The production will often be characterized by a more complex degree of modularity, and the CODP has to be placed further back in the supply chain.

**Research Question 4:** *How would the proposed conceptual framework be applied Wilson Sporting Goods Co.?*

To sufficiently answer this question, we refer to chapter 5. The conceptual framework and analysis was thoroughly undergone phase-by-phase, with a final assessment of the

implementation process. It was concluded that the extensiveness of the changes were relatively low, and that the overall viability of the mass customization strategy was considered to be high, when all things were considered. The overall objective was however not to make an accurate assessment of the Wilson case, but to illustrate how the framework is supposed to be applied.

**Main problem statement:** "*How can companies assess the scope of implementing mass customization, and moreover evaluate its viability?*"

When companies have an incentive to implement a mass customization strategy, they will obviously benefit from evaluating its economic sustainability before implementation. By thoroughly undergoing our proposed conceptual framework and analysis, companies can identify the necessary changes they have to make, based on the product and customization level. These specific changes have been covered throughout the analysis, and have been constructed through our extensive literature review.

The company has to first evaluate the market and the appropriate level of customization. Based on this, there will indisputably be changes in the supply chain and the manufacturing process, as well as the often needed change of the product architecture towards modularity. There can moreover be changes in the sourcing configuration, and the complexity of logistics and production planning will certainly increase.

By outlining the required changes, it thus provides a guideline for companies to assess their readiness and capabilities, and furthermore enables them to make a qualified decision. By supporting the implementation scope assessment with a SWOT analysis of the project and the stakeholders, the company can better determine if the business environment is surrounded by too many external uncertainties.

By undergoing this proposed approach and analysis, companies can assess the scope of the implementation, and lastly make a much more qualified evaluation of its long term economical viability.

## 6.1 Future research

During the work of this thesis, my understanding of mass customization and its implications has become severely increased. The subject of mass customization is from every supply chain perspective a vastly extensive topic, as well as the individual sub topics such as modularization, postponement etc. Through the work of this thesis, it has moreover provided me with some insight to topics that would be relevant to further and more thoroughly research, as an extension of what have been studied in this topic.

This thesis has taken a very holistic view of the implementation process of mass customization, where the individual topics have been combined. Although the individual topics have generally received much attention, there are certainly some smaller processes within the system that could benefit from a greater amount of research.

One area of research that could be specifically interesting and beneficial is the use of just-in-time (JIT) strategies within mass customization. JIT has been mentioned briefly in *Blecker & Friedrich* (*2006*) and it is known that zazzle.com for instance use a JIT delivery strategy, but other than rare mentions it has not been explored sufficiently. zazzle.com is as mentioned exercising a simple customization strategy, with very basic body components and a high production output, which are factors that suggest JIT as a valuable strategy. In a more complex mass customization environment JIT would still be a favorable strategy, but the coordination between suppliers as well as planning with the production unit are much more difficult. This topic could therefore benefit from a much more thorough study on how this coordination and planning should be executed.

The literature review as well as the analysis seeks to explore and elucidate the critical success factors throughout the entire thesis, but these are however mostly based on theoretic assumptions. It could be a relevant study to make a thorough empirical data research with a large quantity of companies, asking them what they found to be the most critical factors for their successful implementation of mass customization. Such a study would however require a massive amount of both quantitative and qualitative primary data, but could as a result provide important new knowledge.

The vast majority of the mass customization literature covers *why* concepts are important, rather than *how* to approach and execute these strategies. There are numerous studies on why for instance postponement is an efficient strategy, but the literature could

benefit from further research on how to approach implementing it in the manufacturing process. *He et al* (*1998*) has for instance proposed a methodology for implementing delayed product differentiation, but it is still very theoretic with mathematic rules for product structures and designs. It could be interesting to do a detailed research on the coordination and approach to how companies, which have manufacturing assets set up to produce standardized products, could implement postponement. The focus should here be on the coordination of additional information management and production equipment. This would again benefit greatly by extensive case studies and empirical data.

Many companies use mass customization as an additional strategy alongside the production of standard products. It could be relevant to study how mass customization would affect the efficiency of the standard production, as well as the perceived value of the standardized products. The study of efficiency would however in many cases be dependent on the individual companies' circumstances, and moreover a rather extensive and difficult study.

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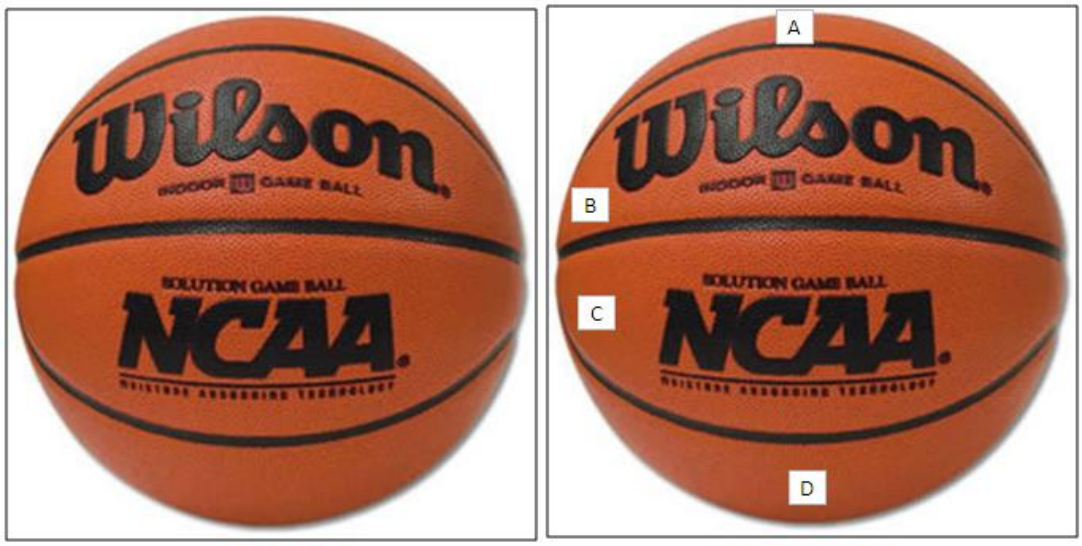
# 8 List of abbreviations

| | |
|---|---|
| ATO: | Assemble-to-order |
| CBS: | Columbia Broadcasting System |
| CODP: | Customer Order Decoupling Point |
| EDI: | Electronic Data Interchange |
| ERP: | Enterprise Resource Planning |
| ETO: | Engineer-to-order |
| FIBA: | Fédération Internationale de Basket-ball |
| IT: | Information Technology |
| JIT: | Just-in-time |
| MC: | Mass Customization |
| MRP: | Material Requirements Planning |
| MTO: | Make-to-order |
| MTS: | Make-to-stock |
| NBA: | National Basketball Association |
| NCAA: | National Collegiate Athletic Association |
| OPP: | Order Penetration Point |
| PLC: | Product Life Cycle |
| RFID: | Radio Frequency Identification |
| VMI: | Vendor Managed Inventory |

# 9 Appendices

## 9.1 Appendix A – Wilson customization

Basketball split into customizable modules




Standard ball Customized ball

Source: *Own creation*

A, B, C, D represent modules that can be customized individually.

A: Customizable of color and/or text and logo

B: Customizable of color

C: Customizable of color

D: Customizable of color and/or text and logo

To reduce complexity, only one of the eight total modules (only four shown in the picture) should be allowed to be modified to contain text or logo, whereas all modules should be customizable in colors, however with only 3 total colors per ball. A logo instead of letters should also be possible, as this has great relevance for both schools and clubs.