Aalto University School of Science

Department of Industrial Engineering and Management

Paradigm Shift from Current Manufacturing to Social Manufacturing

Master's Thesis

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Aalto University **School of Science**	**ABSTRACT OF THE MASTER'S THESIS**

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Abstract:

The emergent phenomenon of social manufacturing is disrupting industries all over the world. Social manufacturing represents a new collaborative manufacturing paradigm. The shift from the current manufacturing paradigm to social manufacturing is facilitated by rapid development of mobile technologies, new digital manufacturing, and online social networks. There are already successful businesses that build upon the social manufacturing paradigm, e.g., in finance, hospitality, and transportation: new banks are born without physical offices (ING Direct), the world's greatest hotel chain does not own a single room (AirBnB), and a taxi company neither owns cars nor employs drivers (Uber). The objective of this study is to construct a model concerning the paradigm shift from current manufacturing to social manufacturing.

The model for the paradigm shift incorporates various topics that are central in the transition process, such as 3D printing, customization, value chains, and social networks. The model is divided into two phases. First, there is an intermediary phase of social manufacturing where customers will co-create with manufacturers. However, here manufacturers still control the manufacturing platform. This phase represents an incremental dimension of social manufacturing. Second, there is the fully-fledged social manufacturing phase that I call it the ultimate phase of social manufacturing. In this phase of social manufacturing, customers can become entrepreneurs, pursuing their ideas throughout the manufacturing value chain by using support from a public manufacturing platform. This phase represents the disruptive dimension of social manufacturing.

To demonstrate the practicality of this study, the proposed model is then applied in the apparel industry for creating insights both to the intermediary and ultimate phases of social manufacturing within this field. Finally, opportunities and risks related to social manufacturing are discussed, the limitations of the study are presented, and future avenues of study are outlined

Keywords: social manufacturing, crowdsourcing, mass customization, value chain, apparel industry, the sharing economy, constructive methodology

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Last but not least, I would like to thank my family and friends for their support throughout the writing of this study. Writing a thesis proved to be more challenging than I had assumed. However, I finally fulfilled this task, and I hope my thesis will be useful for scholars and practitioners.

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Babak Mohajeri

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1 Introduction

1.1 Background and motivation

The emergent phenomenon of social manufacturing is disrupting industries all over the world. The increasingly networked global economy is forcing companies and nations to think beyond current manufacturing systems. In a new manufacturing ecosystem, nourished by Internet technology and new non-hierarchical organizations, customers and suppliers are embedded in a network to co-create. This network in which customers and manufacturers will be embedded is called social manufacturing (see, for instance, Xiong et al., 2014 and Shang et al., 2013). However, the prior studies usually considered social manufacturing as an amendment to the current manufacturing paradigm. From this perspective, the traditional roles of manufacturers and consumers are mixed. Nevertheless, one understudied side of social manufacturing is its revolutionary dimension. This dimension opens up a new perspective for the domain of social manufacturing, developing social manufacturing from an amendment to a revolution in the context of manufacturing. In this study, I construct a model concerning the paradigm shift from current manufacturing to social manufacturing. This paradigm shift is constructed in two phases. First, there is an incremental development in the current manufacturing paradigm that I call the intermediary phase of social manufacturing. This phase has properties aligned with the previous studies of social manufacturing (Wang, 2013; Xiong et al., 2014; Shang et al., 2013). Second, there is a radical development in the current manufacturing paradigm that I call the ultimate phase of social manufacturing. This phase perceives that social manufacturing is a “disruptive concept”. The second phase of social manufacturing represents a revolution in multiple dimensions since in the end social manufacturing is not only a technological revolution, but it is also a form of social and economic disruption regarding the manufacturing of products and services (Soma, 2014).

Generally speaking, manufacturing companies used to focus on building mass standardized products. This strategy started with the product push in the Ford era. However, over time, the strategy changed to respond to market demand. In recent times, conventional manufacturing has been changed into a collaborative manufacturing system. One of the major developments in this transformation has been co-creation with customers.

Co-creation with customers is very important because today's customers demand more personalized products. Because of personalized products and the "long tail effect"[1] (Anderson, 2004), it follows that the importance of economies of scale is reduced (Shang et al., 2013). Changes in behavior, culture, and the ecosystem have also led manufacturing companies to change the manufacturing paradigm by reconsidering their common supply chain management techniques, which means that the focus of the competition shifts from the price and quality of the offerings toward the delivery of value to customers (Vargo & Lusch, 2004). In social manufacturing, the customer is integrated into the entire manufacturing process, from production to delivery. Social manufacturing is able to create totally customized products that meet the unique demands of various customers in society (Murathanoglu, 2012). In social manufacturing, co-creation happens in multiple steps, including the product design cycle, engineering, production, assembly, marketing, and distribution.

There are several ways for companies to face these challenges. For example, they can use the rapid development of Internet technology and the emergence of crowdsourcing solutions to build a unified manufacturing network and fulfill the demand for personalized products.

Another way that many enterprises follow is replacing business models that are based on owning products and services with models that offer access to products and services.

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1 The long tail theory suggests that as it makes distribution easier, the Internet allows consumers to become aware of more obscure products. Thus, demand will shift from the most popular products to more obscure products (Knowledge@Wharton, 2009).

This new trend is called the "sharing economy" (European Commission, 2013; The Economist, 2013; Vision Critical, 2014). The sharing economy embraces different fields, including the shared creation, production, distribution, trade, and consumption of goods and services by different people and organizations.

The sharing economy has already disrupted many industries. For instance, Uber and AirBnB have outperformed established companies in the taxi and hotel industries, respectively. The sharing economy also has the potential to influence other industries. This study argues that manufacturing industries are on the verge of being disrupted by this sharing economy trend.

This study investigates social manufacturing in the apparel industry. I discuss how a manufacturing system can be reframed to achieve social manufacturing. The apparel industry is an ideal candidate for this study because the demand for personalized products in the apparel industry is growing rapidly. As a result, the apparel industry must react to the various needs of different customers. Furthermore, the apparel industry faces intense internal competition, which makes efficient resource management increasingly important (Shang et al., 2013, 2014).

In addition to the aforementioned qualitative changes, there are some quantitative changes that may relate to the domain of manufacturing. A study conducted by McKinsey & Company in 2013 revealed that people spend 80% of their online time interacting with social networks. According to this study, almost every company uses social technologies to communicate with their customers. Moreover, this study found that social technologies have the potential to boost the performance of high-skill knowledge workers by approximately 20 to 25% (McKinsey & Company, 2013). We believe that these findings support the increased use of social networks in the manufacturing domain.

This study is a subset study of the comprehensive SoMa research program organized at Aalto University. This three-year program started in 2015. The SoMa project explores social manufacturing to deliver the necessary knowledge and competencies to help Finnish manufacturing companies regain a competitive advantage by 2020 (SoMa, 2014).

1.2 Gap in the literature

Social manufacturing is a new topic, and there are very few academic studies in this field (see for instance, Wang, 2012; Shang et al., 2013; Xiong et al., 2014). Previous studies usually treated social manufacturing as an amendment to the current manufacturing paradigm. The disruptive dimension of social manufacturing is typically absent from the previous studies, although social manufacturing is named as a "third industry revolution" in some studies (Soma, 2014; The Economist, 2102).

Furthermore, few scholars have studied how to use social networks in the apparel industry (Shang et al., 2013, 2014; Mohajeri et al., 2014).

Twelve years ago, Anderson-Connell et al. (2002) claimed that the apparel industry was capable of mass customization. Cantú and Jonsson (2012) studied the 3D printing of end products and analyzed the value chain model for companies that used an e-commerce marketplace to offer 3D printed goods to end users. The authors concluded that 3D printing was able to meet the customer's customized needs and enable mass customization in the e-commerce marketplace.

In this study, I elaborate on the previous findings to provide a macro analysis of social manufacturing. I construct a model concerning a paradigm shift from current manufacturing to social manufacturing. This paradigm shift is illustrated in two phases:

1- an intermediary phase, which represents the incremental dimension of social manufacturing;
2- an ultimate or fully-fledged phase, which represents the disruptive dimension of social manufacturing.

These two phases are applied to the apparel industry to demonstrate the applicability of the study.

1.3 Objective of the study

The objective of this study is to construct a model concerning the paradigm shift from current manufacturing to social manufacturing. This is accomplished in three steps. First, trends and sub trends in the current manufacturing paradigm are identified. Second, the intermediary and ultimate phases of social manufacturing are defined and a model of social manufacturing is proposed. Finally, the value chain of the apparel industry is reframed on the basis of the proposed model to attain social manufacturing.

1.4 Research methodology

A qualitative research methodology is appropriate, considering the objective of this study, as defined already. A constructive methodology is selected from the possible qualitative approaches because it applies well to this study.

Lukka (2001) defines a constructive research methodology as follows: *"*the constructive research approach is a research procedure for producing innovative constructions, intended to solve problems faced in the real world and, by that means, to make a contribution to the theory of the discipline in which it is applied." The key idea of constructive research lies in preparing theoretically grounded solutions for practical purposes (Mattessich, 1995).

The ideal result of a constructive research study is minimizing the gap between academic research and business. Further, this gap is reduced by new theoretical ideas that can be applied in real life (Lukka, 2001). The constructive approach is an appropriate choice for this study because of the novelty of the idea of social manufacturing.

According to Kasanen & Lukka (1993), a constructive method is "a solution-oriented normative method where target-oriented and innovative step-by-step development of a

solution are combined, and which empirical testing of the solution is done and utility areas are analyzed".

The authors mention six key phases in designing any constructive research method.

1. Find a practically relevant problem which also has research potential.

2. Obtain a general and comprehensive understanding of the topic.

3. Innovate, i.e., construct a solution idea.

4. Demonstrate that the solution works.

5. Show the theoretical connections and the research contribution of the solution concept.

6. Examine the scope of applicability of the solution.

This study covers all the above-mentioned phases. In Chapter 1, the research problem is analyzed, with consideration being given to the practicality of the subject (phase 1). Next, in the literature review, a comprehensive understanding of the topic is broadly discussed (phase 2). In Chapter 3, a model of social manufacturing is constructed (phase 3). In Chapter 4, a new value chain in the apparel industry is proposed to attain social manufacturing (phase 4). Finally, in Chapters 5, 6, 7, and 8 the scope of the applicability of the solution is assessed, and the major findings and contributions of the study are discussed (phases 5 and 6).

1.5 Structure of the study

The structure of this study is as follows: in Chapter 2, social manufacturing is introduced. The main trends and antecedents of social manufacturing are studied in the relevant literature and the state of the art of social manufacturing is investigated. Next, in Chapter 3, the intermediary and ultimate phases of social manufacturing are proposed. In this chapter, a model is constructed that concerns the paradigm shift from the current

manufacturing paradigm to social manufacturing. In Chapter 4, the value chain of the apparel industry is analyzed; the intermediary and ultimate phases of social manufacturing in the apparel industry are described. In Chapter 5, the major risks and impediments involved in the adoption of social manufacturing are discussed and further applications of social manufacturing in other industries are explained. In Chapter 6, the main findings and theoretical and managerial contributions of the study are summarized. In Chapter 7, the limitations of the study are explained and finally, in Chapter 8, future directions for social manufacturing are suggested.

2 Literature review

2.1 Social manufacturing

Conventional manufacturing models build on the efficiency of supply chains and concentrate on product development. The role of products is emphasized more than the role of customers. However, basing manufacturing strategies on these conventional models can create serious problems for manufacturing companies today. For instance, because customers' needs change rapidly, manufacturers should continuously modify their products. However, these modifications result in extra production costs and time.

For example, Bamber et al. (2000) suggest that one change in a product can consist of approximately 50 modifications, which take approximately one week. The authors suggest that the changes might frequently happen in an iterative manner. Therefore, the modification process can last around six months. According to Bamber et al. (2000), the modification process could, surprisingly, lead to a 50% increase in production manpower. On top of that, the overall modification causes increased administrative overheads, thus undermining the efficiency of shop-floor production (Bamber et al., 2000).

Manufacturing companies look for ways to predict their customers' interests in advance. They try to avoid the extra cost and time of modification by following a proactive offering strategy. Today's emerging technologies permit a new level of customer intimacy by changing the way enterprises connect and build their relationships with customers. Enterprises can move from knowing the customer to truly embracing the customer. The rapid development of Internet technology provides an opportunity to connect the different players in a manufacturing network, which means, for example, that people can use any manufacturing tools that they might have at home for decentralized production. Through this type of crowdsourcing, firms can respond to the demand for personalized products (Shang et al., 2013). This engaging process can ultimately lead to the democratization of the manufacturing process, i.e., I manufacture

products that other customers may use, and they manufacture products that I use. This democratization will create a new customer-to-customer (C2C) business model. This new type of customer-manufacturer relationship makes possible a manufacturing model that we call “Social Manufacturing”.

At the same time, manufacturing companies have begun to focus on their core production tasks and have outsourced their non-core production tasks. This new focus cuts down on labor costs, funding, and other manufacturing capital expenditures, and it also increases the market responsiveness of the manufacturers. Hence, using the advantages of the fully distributed model of social manufacturing enables manufacturing departments to downsize (Ding et al., 2013).

The term “Social Manufacturing” has already been used in some articles and journals. *The Economist* magazine first mentioned the idea of social manufacturing in its special report on manufacturing and innovation, “A third industrial revolution” (The Economist, 2012). Additionally, Professor Feiyue Wang explored new aspects of social manufacturing in his article “From social calculation to social manufacturing” (Wang, 2012). Furthermore, the Institute for the Future (IFTF) has launched an initiative to provide a profound vision of the future of social manufacturing and its effect on development around the world (IFTF, Social manufacturing: Alternative paths to development). Recently, Professor Gang Xiong introduced the architecture of a social manufacturing system that incorporates 3D technology, personalized design, cloud business platforms, and intelligent logistics (Xiong et al., 2014). Cao and Jiang (2014) elaborate on the idea of a social manufacturing system. They predict that in an ideal social manufacturing system, customers will be able to take care of all production-related processes from machining to assembly, and there will be no need to invest in expensive manufacturing systems, such as assembly lines (Cao & Jiang, 2014).

Gorkaespiau (2014) notes five criteria to consider in social manufacturing:

1. manufacturing with a social impact;
2. the modification of the supply chain from socially sustainable development points of view;

3. the democratization of wealth through distributed and open-source manufacturing;

4. manufacturing new products that connect things and people, such as wearable technologies; and

5. redesigning the factories of the future.

The idea of social manufacturing is still in its early stages, and few scholars have studied it. However, the academic world has recently shown more interest in studying the notion of social manufacturing and its application.

This study responds to the shortcomings that have been identified by academic studies and constructs a model concerning the paradigm shift from the current manufacturing paradigm to social manufacturing. To build the model, I define major manufacturing trends by dividing them into four groups and then study their development over time. These four groups are called "the transformation of business models", "the transformation of manufacturing technologies", "the transformation of manufacturing strategies", and "changes in the manufacturing value chain".

2.1.1 The transformation of business models

In competitive business, firms look at new business models to attract more customers. Tough competitive situations force both start-ups and established companies to stand out among their competitors to succeed. Thus, firms seek to offer unique value propositions, diverse revenue streams, and creative solutions to outpace their rivals (Drell, 2014). For instance, new banks are born without any physical offices (ING Direct), and the world's fastest-growing hotel chain does not own a single room (AirBnB). The taxi industry is being affected by companies that do not own any taxis or cars (Uber and Lyft). In this study, I look at four major new business models and investigate how they can lead manufacturing industries in a new direction. These new models are the sharing economy, crowdsourcing, open innovation, and mass customization.

The sharing economy

In many markets in recent years, the conventional business model of ownership, in which companies provide their customers with access to the products and services that are owned by those companies, has shifted toward peer-to-peer accessibility. In a peer-to-peer model, companies facilitate access and connections between their customers. What the customers are able to access within this model is other customers' property, skills, and competencies. Companies can offer such access through online platforms or marketplaces. Customers who offer their assets or skills do so because they do not need them, either at present or in the long term (European Commission, 2013).

Two trends can be observed in the evolution of the rental-like model. First, technological development provides the opportunity to create nimble and agile business models. For example, Spotify, an online music streaming company, offers consumers access to millions of music tracks through smartphones, tablets, or computers. Similarly, Car2Go, a car rental company, gives its members access to flexible individual mobility in their area with its large fleet of rental cars that are distributed across European cities (European Commission, 2013). Second, increased communication and connections via social networks provide the opportunity to create further peer–to-peer (P2P) business models. These peer-to-peer, rental-like business models comprise the idea of the sharing economy (European Commission, 2013).

However, the sharing economy has met some challenges and barriers in terms of diffusion. One major barrier to the sharing economy is the "trust issue". However, this problem is gradually becoming resolved. The trust issue used to have the same effect in other industries, such as online shopping. For example, when Amazon started offering online shopping for the first time, people were anxious about security and trust when buying items on its site. However, customers tried Amazon and usually had positive experiences. Then they recommended it to other customers, and this cycle continued until the trust issue was no longer a major concern. These successful experiences encouraged customers to try other online shopping websites, such as eBay. The same adoption story is happening in the sharing economy. Customers have been paying more attention and credibility to businesses that work in the sharing economy. For instance, AirBnB, the self-styled worldwide accommodations leader, is growing rapidly and has

already outpaced many established firms in the hotel industry. Likewise, Uber recruits more customers and drivers every day. The sharing economy lets some people buy cars just to rent them out (The Economist, 2013). Every day, new industries use the benefits of the sharing economy. Figure 1 depicts some companies and industries that are already flourishing within it.

Figure 1: Taxonomy of the sharing economy and examples (Visioncritical, 2014). This figure shows examples of companies and industries that are using the sharing economy.

This study predicts that the wave of the sharing economy will continue, and this phenomenon threatens to disrupt other industries in the near future. Furthermore, manufacturing industry has the potential to be significantly affected by the sharing economy.

Crowdsourcing models

Rapid progress in information and communication technologies provides an opportunity to access collective and distributed resources that are disseminated in the "crowd" (Chanal et al., 2008). This shift has led to the birth of a new paradigm called "crowdsourcing". In *Wired* magazine, Jeff Howe was one of the first scholars to define crowdsourcing, as follows: "Crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined—and generally large—network of people in the form of an open call." (Howe, 2006). Howe (2009) later distinguished crowdsourcing from similar activities, such as 'wikinomics' (Tapscott & Williams, 2006) and 'commons-based peer production' (Benkler, 2006). According to Howe's definition, crowdsourcing is related to the problems of a particular company or organization, whereas in peer-to-peer activities large unrelated groups work on joint projects. Much new software, including Linux and the online encyclopedia "Wikipedia", builds on the idea of crowdsourcing. The payment method is another difference between crowdsourcing and the peer-to-peer model. Unlike the peer-to-peer model, in crowdsourcing, payment is only made to the winning crowdsourcer(s). White (2009) illustrated the process for crowdsourcing, as presented below.

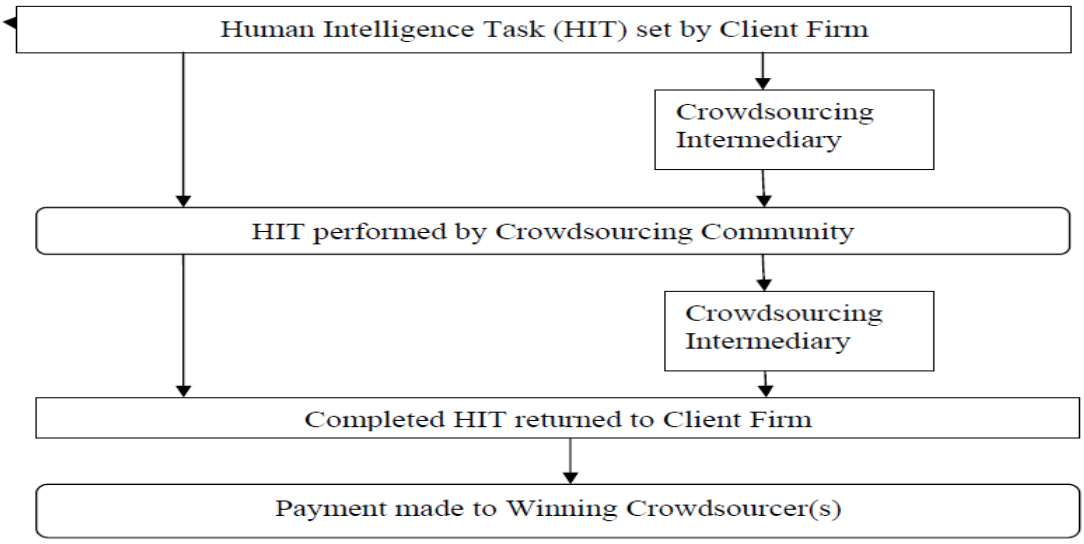


Figure 2: The crowdsourcing process *(*White, 2009). This figure shows the different stages of a crowdsourcing project, from the client's presentation of a problem to the project's completion and the payment of the winning crowdsourcer(s).

Open innovation

Open innovation sees a firm's innovation system as an open system rather than a closed model. Open innovation was developed on the basis of the observations of a number of (large) innovative companies and their deviations from traditional closed innovation practices (Chesbrough, 2003). In one respect, the open innovation model can be seen as a call to return to the late 19th- and early 20th-century model of innovation, with a rich, diverse market for technology and externally oriented R&D labs (Mowery, 2009).

Open innovation can assist companies in two different ways. First, users directly contribute ideas and offer input to enhance the quality and variety of a company's products. There are currently many examples of this type of open innovation. For example, YouTube relies on individual contributors, Wikipedia relies on individuals for both data entry and editing, and Linux relies on a global innovation community. Second, open innovation can create a positive "network effect" (Arthur, 1994) for companies' products and services. In other words, if there are more users of a particular product, there is more perceived value for other users who use the same product or intend to use

it in future. For instance, compared with other social networks, Facebook is perceived as more valuable because of the high number of users who interact on it every day. This additional value can offer the product momentum and attract other companies that produce complementary goods or services (Chesbrough & Appleyard, 2007).

Despite the benefits of open innovation business models, established companies are usually rooted in closed innovation. The transition to open innovation is challenging (Alexy & Dahlander, 2013) and generally introduces problems related to ownership rights, such as intellectual property rights (IPR). However, the successful cases of open-source and open innovation implementation (e.g., Linux, Android) have been able to resolve their legal issues to a great extent.

However, legal trends can also provoke firms to follow an open innovation approach in the long run. This trend can pose obvious risks for the firms who have long worked in closed innovation. However, a group of researchers has wondered how fast firms generally move toward open innovation and how consistent these moves are (Dahlander & Gann, 2010; Alexy & Dahlander, 2013).

Mass customization

In the traditional manufacturing model, manufacturing companies had to choose between mass production and producing customized products. Thus, manufacturing strategies were built on either production efficiency and standardization or on the production of customized products to serve particular customers. Mass customization (MC) is a new phenomenon that proposes an intermediate solution to combine the best elements of customization and mass production. Mass customization offers unique products in low-cost, high-volume production environments (Duray, 2002). Figure 3 shows how mass customization relates to customization and mass production.

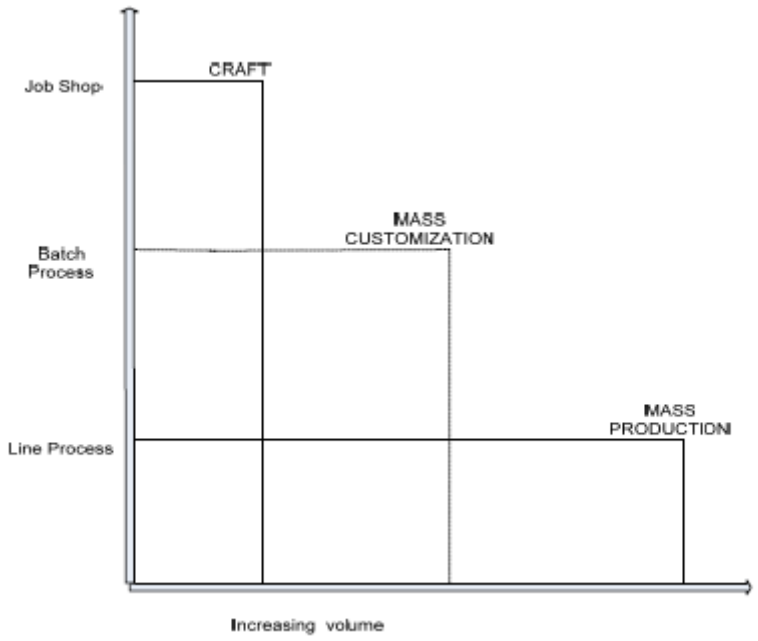


Figure 3: The position of mass customization (Kaj, 2001). This figures shows mass customization's position between craft production and mass production.

In his 1987 book *Future Perfect*, Stanley Davis was one of the first researchers to consider the possibility of mass customization. Kotha (1995) and Pine (1993) later indicated that progress in manufacturing techniques, information technology, and management methods was gradually fulfilling the idea of mass customization. Mass customization can be defined either broadly or narrowly. The broad and visionary concept defines it as the "ability to provide individually designed products and services to every customer through high process agility, flexibility and integration" (Pine, 1993; Eastwood, 1996). However, many authors propose a narrower definition of mass customization, referring to it as a system that manufactures a wide range of products and services to meet the particular needs of individual customers.

In the manufacturing context, Da Silveira et al. (2001) combine different studies on mass customization and classify them into eight levels, ranging from pure customization (individually designed products) to pure standardization.

Table 1: The eight levels of mass customization (Da Silveira et al., 2001)

MC level	MC approaches	MC strategies	Stages of MC	Types of customization
Design	Collaborative; transparent	Pure customization		
Fabrication		Tailored customization	Modular production	Assembling standard components into unique configurations
Assembly		Customized standardization	Point-of-delivery customization	
Additional custom work			Providing customized services and rapid responses	Performing additional custom work
Additional services				Providing additional services
Package and distribution	Cosmetic	Segmented standardization		Customizing packaging
Usage	Adaptive		Embedded customization	
Standardization		Pure standardization		

However, the implementation of mass customization is difficult for many manufacturers. For instance, access to the mass market requires huge investments in IT, flexible manufacturing systems, and personnel training. These prerequisites are costly and unaffordable for many start-up companies. Thus, many start-up companies compromise with niche markets and target limited customers. Moreover, mass customization can make production planning very difficult because of the vast numbers of products produced with many variants. The final production portfolio is often complex and hard to plan. It is also very demanding to optimize operational management and mass customization. In a mass customized model, it is very likely that part of the production will not be sold and is thus wasted (Babiarz et al., 2007). Mass customization might also present difficulties for customers. For instance, extended delivery time, more complex purchase processes, and mandatory pre-purchase subscriptions are problems that customers may encounter when they are introduced to mass customization policies (Babiarz et al., 2007).

To summarize, I have presented four new business models that can contribute to a transition toward social manufacturing.

2.1.2 The transformation of manufacturing technologies

IT has dramatically redefined the relationship between suppliers and customers. The Internet provides an online marketplace where suppliers, manufacturers, logistics service providers, and customers can meet and where they are able to search for, order, and sell products and services or use the online market to communicate with other supply chain members. The Internet is one of the most effective tools in providing communication among people, and Internet-based manufacturing is an effective system for following, monitoring, and controlling manufacturing activities (Süleyman & Gürdal, 2014).

Reaching for higher optimization and a competitive advantage has forced many companies to concentrate on increasing their product development rate and manufacturing flexibility, reducing waste, improving their process control and manpower utilization, and broadening their market reach. In this study, I highlight some

of the major new manufacturing technologies that contribute to the transition toward social manufacturing. These technologies are lean manufacturing, 3D printing, cloud computing/manufacturing, and wearable applications.

Lean manufacturing

The core idea of lean manufacturing, or simply "lean," is "doing more with less." This definition might seem holistic or oversimplified; nonetheless, it addresses the main aspect of lean, which is the more effective utilization of available resources (Rymaszewska, 2014). The goal of lean manufacturing is to obtain an efficient, high-quality system that produces very little or no waste and simultaneously responds to customers' needs as soon as possible (Shah & Ward, 2003). The lean model has been successfully applied in many industries. The success of Japanese automobile companies (e.g., Toyota) is only one example of the use of lean manufacturing.

Dombrowski et al. (2010) claim that lean manufacturing has a broad scope and includes various fields and activities, as follows:

- visual management
- workplace organization
- 5S[2] and process standardization
- continuous improvement
- total quality management (TQM) and total productive maintenance (TPM)
- Just-in-time (JIT)
- production leveling

[2] 5S is an acronym that stands for Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke). 5S is a method that is used to create a clear and efficient workplace. 5S guides managers and personnel to remove all unused and extra materials and tools in the workplace and to arrange the required items in an effective way (MBA, A. A. M, 2014).

Researchers have defined the idea of lean from different perspectives. The first group of researchers has a broad view of lean and proposes that the role of leanness in manufacturing goes beyond a set of tools. They treat lean as a groundbreaking process that affects all levels of organizations. Another group of researchers sees lean manufacturing from a different point of view. This group opposes the predominant view of lean and claims that it is a supplement to typical manufacturing methods. I believe that the broad and all-inclusive definition of lean in manufacturing fits the concept of social manufacturing better.

Despite the successful stories of high-performing lean models, the barriers and pitfalls of lean should also be considered. Bhasin (2012) reviews the barriers to lean manufacturing in small, medium, and large companies. He discovers the main obstacles to lean manufacturing in this order of importance: 1) insufficient supervisory skills, 2) employee attitudes, and 3) insufficient workforce skills (Bhasin, 2012). Karim and Kazi (2013) developed a methodology to address the problems lean models face by introducing continuous performance measurement (CPM). However, they conclude that more research should be done in order to integrate the lean model into manufacturing better.

3D printing

In 3D printing, also known as additive manufacturing (AM), a model is initially generated using three-dimensional computer-aided design (3D CAD). Software is then used to convert the 3D CAD file into multiple two-dimensional (2D) cross-sections (layers). After that, the 2D models are sent layer by layer to 3D printers. This process continues until the entire model has been printed. Printing an object is an automated process, and the machine mainly does it without supervision. The machine puts each layer upon other layers until the entire object is shaped (Khajavi et al., 2014). Once the 3D printing machine has completed the building stage, the parts must be removed. Post-processing and application steps include cleaning up or priming and painting, which are mainly completed by hand (Hopkinson et al., 2006). Figure 4 demonstrates the entire process of 3D printing.

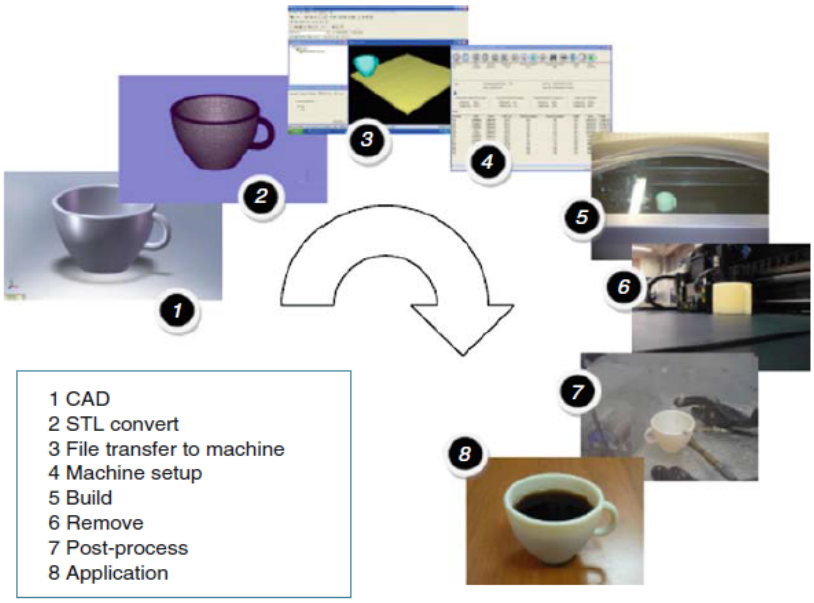


Figure 4: The eight stages of the 3D printing process (Hopkinson et al., 2006).

Table 2 presents the benefits and shortcomings of 3D printing compared with conventional manufacturing methods.

Table 2: Benefits and shortcomings of 3D printing (Zäh & Hagemann, 2006; Holmström et al., 2010).

Benefits	Shortcomings
- More flexible development - Easier design and construction - Integrated functions - Less assembly - Fewer spare parts in stock - Less complexity in business because there are fewer parts to manage - No production tools need to be held in stock (only digital/CAD data) - Shorter time-to-market for products - Faster deployment of changes - Individual product offerings	- Available software is a limiting factor - High machine and material costs - High calibration effort - Quality of parts needs to be improved - Reworking of parts is often necessary (support structures) - Building time depends on the part's height in the building chamber

3D printing is generally used for rapid prototyping. However, in recent years, further applications of 3D printing have expanded rapidly. One of these applications is manufacturing "end products".

The Economist's special report mentions 3D printing as the foundation of the third industrial revolution. This report highlights how 3D printing can reshape the typical structure of manufacturing, shifting it toward a collaborative manufacturing model. This report also mentions that this new trend in manufacturing is turning mass manufacturing toward more individualized production, thanks to 3D printing (The Economist, 2012). 3D printing provides citizens in society with a chance to become micro-entrepreneurs.

The price of general 3D printers starts at approximately $1,500; however, the prices of machines and materials are continuously decreasing (Wirth & Thiesse, 2014).

In this study, I analyze two companies that successfully base their new business models on 3D printing. The first of them, Shapeways, is an independent New York-based company that has created a marketplace for 3D printed end products. Shapeways acts as a connection point between 3D manufacturers, customers, and independent designers and coordinates the entire process of production, payment, shipment, and after-sales service (Wirth & Thiesse, 2014). The platform of Shapeways is built on the following steps.

Invent: Anyone with an interesting idea can be a potential designer for the company.

Design: Potential users can tweak and design their products with 3D printing software or hire a third-party designer. They can then upload the final design to the Shapeways website.

Configure: After uploading the design, designers can choose a material according to their personal preferences. In this regard, Shapeways offers various types of materials. The chosen material specifies the production method and its perceived quality. It also determines the approximate price of the final product.

Fabricate: After the previous steps are completed, Shapeways allows its customers to manufacture a prototype for their idea using its own 3D printers. The customers are then able to sell their design or product by opening their own shop on the Shapeways website. Shapeways organizes the actual production process through external suppliers. Thus, the Shapeways platform also acts as a marketplace for its users. Thereafter, other users who browse the Shapeways website will be able to see the uploaded ideas and order them online. In this way, Shapeways significantly reduces the time-to-market from years to days. Ultimately, Shapeways ships the final product, and customers receive it in approximately 10 to 21 business days (Wirth & Thiesse, 2014).

The second company, Quirky, is another New York-based company and uses a different approach. Quirky has based its business model on transforming lead users' ideas into actual products and creating a marketplace for them. Quirky's products include

electronic gadgets, travel goods, and household items. A new project starts in Quirky as follows. First, a user submits an idea. People then vote for it on the Quirky website or on social media, such as Quirky's Facebook page. If enough people like an idea, then Quirky's product development team makes a prototype of it. In the next steps, users review the prototype online and contribute to its final design, packaging, marketing, and price setting. In the next stage, Quirky locates viable manufacturers. The product is sold on the Quirky website and, if demand grows, by retail chains such as Best Buy (The Economist, 2012).

Figure 5 depicts the aforementioned steps from start to finish.

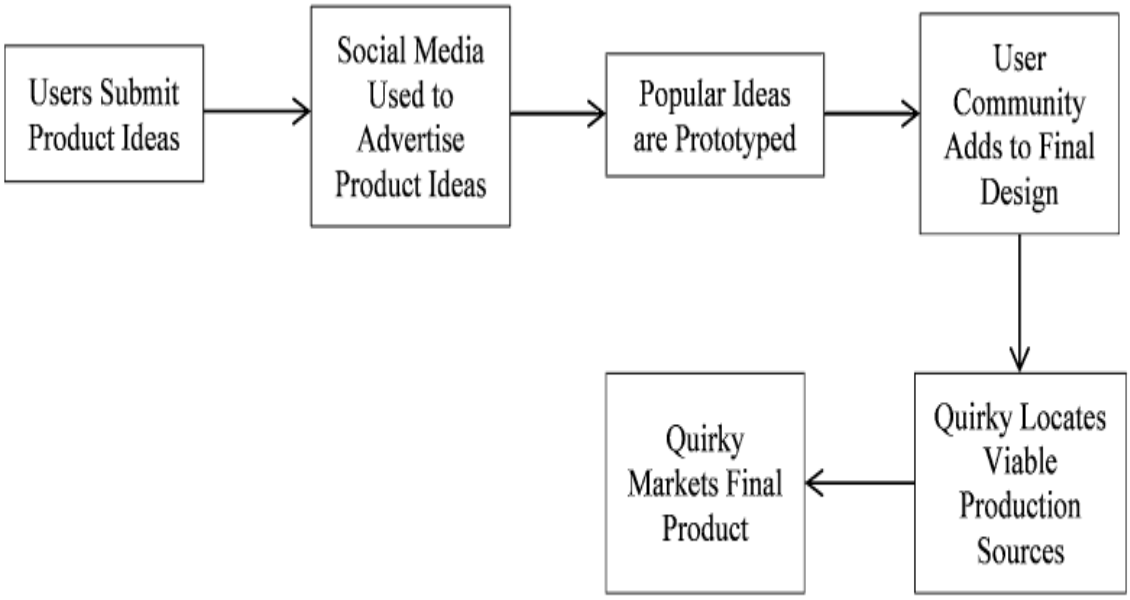


Figure 5: Quirky development process (Wu, Dazhong et al., 2012). This figure shows how Quirky transforms an idea into a product.

Quirky uses a pipeline diagram to monitor the status of its ongoing projects. This pipeline visualizes a timeline for any idea from its birth to its completion, and a tag or picture symbolizes each idea. If the idea manages to complete a stage (i.e., design, prototype), then its picture will move from that step to the next. This visualization is repeated for all the projects on the Quirky website. In this way, Quirky can monitor the status of all ideas as they are created and developed (see Appendix 2).

These two companies use 3D printing in a way that disrupts traditional manufacturing models. One interesting point is that neither of these companies owns the ideas or the final production equipment, but they use social networks and crowdsourcing platforms to run their businesses. Currently, the 3D printing of end products is only a small niche market. However, many startups are entering this market every day, and the market opportunities and applications are growing rapidly. As Mohajeri et al. (2014) discuss, 3D printing is able to directly connect manufacturers to customers, thereby increasing the performance of all the players in the supply chain and their responsiveness to the market. As a result, it is possible to make customized products that are based on the needs of every single customer.

Cloud computing

Cloud computing is an overarching smart technology that offers on-demand and tailored computing services with high reliability, scalability, and availability in a distributed fashion. In manufacturing, cloud computing is used to increase flexibility and to construct an interconnected resource-sharing platform. The different branches of a manufacturer typically have many variations that relate to their capacity, inventory, production order, technology, and number of suppliers. Thus, each branch needs its own production plan. Without the integration of systems, this type of individual planning would be too laborious. Zhang et al. (2014) suggest a new manufacturing paradigm, cloud manufacturing (CMfg), where information technologies and advanced manufacturing technologies can be used to resolve manufacturing development needs (e.g., by integrating various branches of a manufacturer into a centralized resource management system).

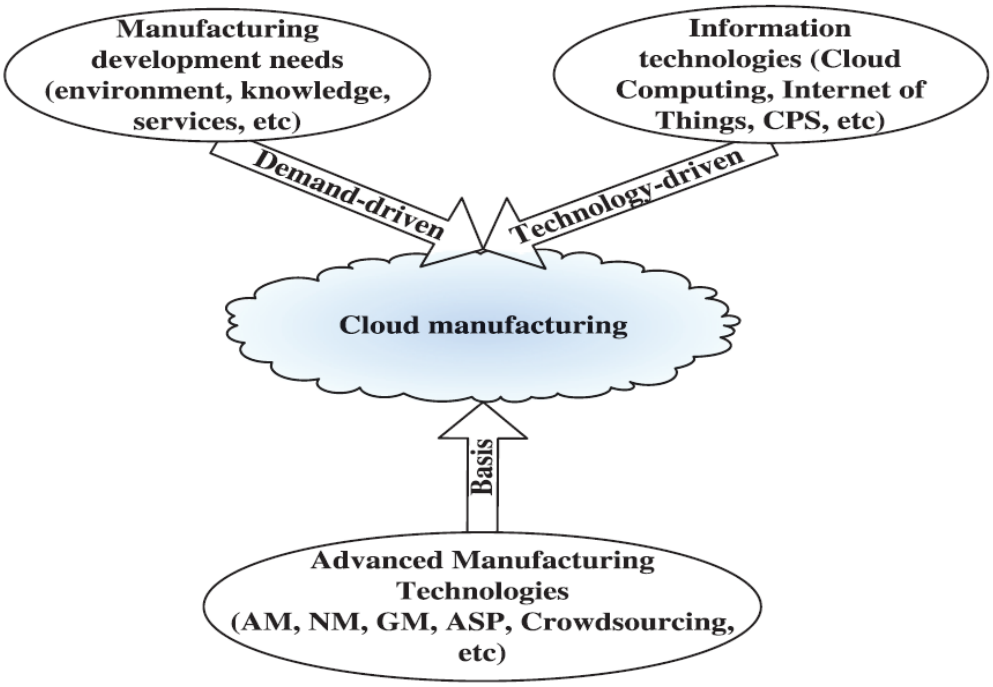


Figure 6: The proposition of cloud manufacturing (Zhang et al., 2014). This figure shows the different elements of a cloud manufacturing system.

Cloud manufacturing offers features such as pay-as-you-go, flexibility to scale up and down per demand, and increased customized solutions. Cloud manufacturing is a new approach in the manufacturing domain. However, software cloud service providers can play an important role in accelerating the use of cloud manufacturing. For instance, two popular PaaS (platform as a service) providers, Salesforce and Model Metrics, provide services to build cloud manufacturing systems within firms (Xu, 2012).

It is highly probable that more companies will use cloud manufacturing in the near future, in part because it can be an effective solution for the servitization and globalization of manufacturing companies. In cloud manufacturing, everything is treated as a service, whether service users request services or provide them.

[3] AM: Additive Manufacturing; NM: NanoMeter; GM: Global Manufacturing; ASP: Application Service Provider; CPS: Cyber-Physical System.

Wearable and smart consumer applications

Wearable technology (also known as wearable gadgets) is a category of technological devices that consumers wear to aid them in tracking information that usually relates to their health and fitness (Beal, 2014). Recently, many people have started using wearable devices in their daily lives. The most well-known examples include pedometers, activity monitors, and sleep monitors. Although many people use wearable gadgets to quantify their personal behaviors, one question remains: How does this trend affect manufacturing models?

The popularity of wearable technology has increased year by year, and approximately 90 million wearable devices will have been sold by the end of 2014, according to recent market studies (Young, 2014). At this time, large manufacturers are frequently unveiling smart watches and glasses. Android-related devices have already been introduced and accommodated in the market. Apple has just released its Apple Watch, an intimate and personal wristwatch (Young, 2014).

The wearable market shows promising signs. Customers' growing interest in having wearable devices might attract more manufacturers and vendors to realign their manufacturing strategies. We might soon see more companies joining the wearable products industry. In addition, customers' attitudes have changed, and it is easier than ever before to persuade customers to wear tracking devices. These changes suggest that wearable technology's market size will probably continue to grow.

The wearable market also presents a great opportunity for start-up manufacturers to launch their businesses. Many start-ups have already entered this market by creating wearable electronic tracking devices for nearly every part of the human body, and they have been funded through websites such as Kickstarter and Indiegogo (Andrew, 2013).

2.1.3 The transformation of manufacturing strategies

Manufacturing companies are encountering tough competition; profit margins are declining, and products are becoming more standardized. Under these conditions, any differentiation is difficult and complex.

Oxford Economics conducted a survey of the executives of over 300 global manufacturers. They found that the following trends are affecting global manufacturing industries:

Economic realignment: the falling power of some manufacturers in the developed world has coincided with the rise of fast-growth emerging economies;

Technological changes: the emergence of big data, the Internet of things, and social computing;

Talent challenges: the number of educated people in the emerging economy is increasing rapidly, whereas the developed world has stagnated in its position;

Supplier and partner complexity: the increased amount of distributed sourcing, engineering, and production leads to companies managing more partners across multiple aspects, such as quality, compliance, and risk;

Greater global competition: in modern business, firms compete in their domestic markets against their foreign rivals while simultaneously aiming at overseas markets in their international strategies;

Increased regulation: the increase in the number of meticulous rules and regulations arises from increased environmental concerns and standards-based considerations, such as ISO compliance;

Changing customer behavior: the shift in customer demand is fragmented as customers seek out more customized products (Oxford Economics, 2013).

Following the aforementioned trends, this study identifies three major trends in manufacturing strategies: integrated servitization, going green, and the digitization of the manufacturing business.

Integrated servitization

Many product-orientated manufacturers have recently started including services with their products, in an effort to become more service-oriented. They try to bundle products and services to attract more customers. This sector of service manufacturers is one of the fastest-growing business sectors (Cai et al., 2014). Servitization changes the role of the manufacturer—from a supplier of objects to a supplier of services. This change also affects the manufacturer's value chain. Within the new system, customers can decide on desirable services, and manufacturers will respond to these needs (Vandermerve & Rada, 1988; Wise & Baumgartner, 1999; Reinartz & Ulaga, 2008; Lightfoot et al., 2011). The consequences of this development can be seen in new manufacturing strategies, such as increased outsourcing, the mass commoditization of the market for the product, and selling manufacturing equipment, such as software and hardware, to customers (i.e., open-source developers buy the manufacturer's platform software to start working). This transformation leads to an integrated manufacturing strategy. The shift from product-oriented manufacturing toward service-oriented manufacturing results in substantial changes in the manufacturer's value chain because the point of value creation will be changed (the service at the end of the value chain gains importance). The new value chain will create new industry categories (i.e., product-service manufacturers), new types of value assertions, new pricing and revenue models, and new business architectures, and promote the growth of open-source and crowdsourced manufacturing models (Lin et al., 2014). Technological innovations can accelerate the trend of servitization within the manufacturing domain and strengthen the legitimacy of servitized manufacturing (Finne, 2014).

On the basis of the discussion above, industry experts believe that the servitization of manufacturing will result in the increased outsourcing of products and services, the emergence of new core competencies and platforms, new pricing models and revenue streams, and the extension of the industry value chain to the customer side. This transformation then leads to social manufacturing.

Going green

Over the past decade, the impact of organizations and manufacturing companies on the natural environment has been increasingly scrutinized. Manufacturers' stakeholders, including regulators, customers, shareholders, board members, and employees, are concerned with their increased environmental responsibility (Rusinko, 2007). The customers are particularly interested in the environmental effects of the products they buy (Ackerman, 1996; Deif, 2011). Rules and regulations also require manufacturing enterprises to review their manufacturing strategies and become more environmentally friendly. Green manufacturing uses fewer resources, reduces material waste, energy consumption, and production costs, and shortens production time (Deif, 2011).

Green manufacturing also addresses the issue of sustainability, which is defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on the Environment and Development, 1987). Sustainability is currently an important subject, and many manufacturers highlight it in their strategic decisions. For instance, they describe how to reduce hazardous emissions, reduce waste in resource consumption, and improve recycling technologies. Green manufacturing is progressing rapidly, and manufacturers should ensure that their manufacturing strategies are updated in this area.

The digitization of manufacturing businesses

The main objective of digitized manufacturing is to replace physical prototypes with virtual prototypes and simulation models, thereby optimizing the product design and manufacturing process (Xiong & Yin, 2006). In digitization processes, computers are used to convert analog ideas into digital information. This digital information can easily be shared and disseminated throughout the online network (Xiong & Yin, 2006).

The digitization of manufacturing is spreading rapidly, and some manufacturing industries have already successfully digitized their entire manufacturing process. For example, Boeing successfully developed the Boeing 777 using digital prototype technology, which reduced the development time by more than 40%. It also reduced

production costs by 25% and the rework rate by 75%**.** It is worth mentioning that the digitization process also resulted in greater user satisfaction. In addition, General Motors has successfully applied digitization to car production, reducing the development cycle of new cars by 50% (from 48 months to 24 months). Moreover, digitization reduced the number of new cars' bump tests[4] from over 100 times to 50 times (Xiong & Yin, 2006). These examples represent only a small fraction of the manufacturing potential of digitization.

Increased digitization is usually a consequence of various engineering breakthroughs. For example, the evolution of the CAD software enabled manufacturers to create digital models of products. These models can be tested as virtual prototypes before they are sent to the factory floor for production. With this approach, significant costs will be avoided, and the delivery time of the products to the market will be reduced (Campbell, 2013).

Digitization first started in product development. However, it now extends to the factory floor and to the service environment through applications such as augmented reality.[5] According to expert analysis, digitization is expected to spread through the entire manufacturing process within the next five to ten years (Campbell, 2013).

In a survey conducted by Manex (*The Global Community for Manufacturing Leadership)*, 94% of the respondents said they expected the manufacturing industry to be completely digitized in the next 10 years. However, only 63% of them anticipated that their own firm would be largely digitized in that time. The responses for the electronic integration of the design and production processes (the digital factory idea) are notably similar. 92% of the respondents assumed a high degree of integration would happen in the industry within the next 10 years, whereas only 38% said that their own companies would be completely digitized within that time (Chiappinelli, 2013). Despite this well-recognized need for digitization, the average manufacturing business has yet to start this process. In a recent survey conducted by Capgemini Consulting, only 12% of

4 A bump test is a method for monitoring gas in automobiles. In the bump test, sensors and alarm indicators are assessed to ensure that the best performance of sensors and monitors is fulfilled before use (EnviroMe).

5 Augmented reality (AR) is a type of virtual reality in which a physical object in a real-world environment is duplicated in a virtual environment by computer-generated sensory input, such as audio, video, graphics, or GPS data (Graham et al., 2013).

the manufacturing companies were “Digirati” (see Figure 7; Capgemini Consulting, 2014).

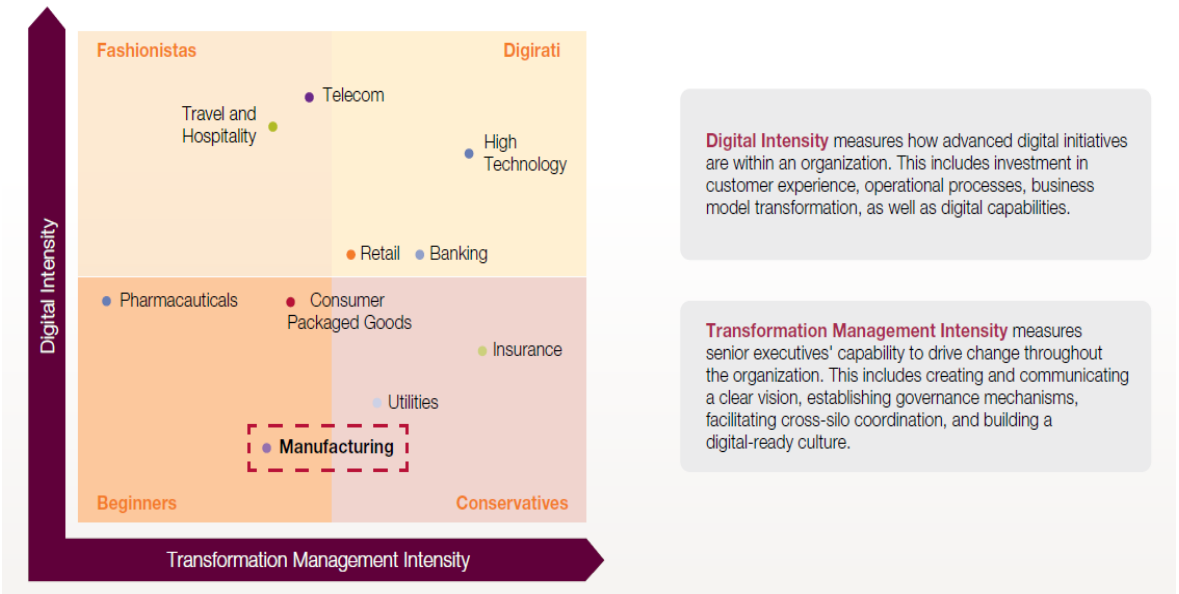


Figure 7: Digital maturity by industry (Capgemini Consulting, 2014). This figure compares the position of the manufacturing industry with that of other industries in two dimensions (digital intensity and transformation management intensity).

Most manufacturing companies have yet to evolve beyond the early stages of digitized transformation. However, a small group of manufacturing companies has progressed across all the business domains of digitized manufacturing and has grown rapidly by tapping into this profitable manufacturing strategy. It seems that there is still widespread uncertainty, and many manufacturers lack a vision for digitizing their work (Capgemini Consulting, 2014). However, Capgemini’s study anticipates that more companies will transition toward digitized manufacturing in the near future (Capgemini Consulting, 2014).

In this section, I have shown that integrated servitization, going green, and digitization pave the way for new types of manufacturing initiatives.

2.1.4 Changes in the value chain

Michael Porter first proposed the value chain concept in his book *Competitive Advantage* in 1985. In this book, Porter stated that a value chain disaggregates a firm into the strategically relevant activities that the firm performs to design, produce, and market, deliver, and support its product (Porter, 1985). Porter divides the activities involved in creating a value chain into two major groups:

• "Primary" activities include inbound logistics, operations, outbound logistics, marketing and sales, and services in the core value chain that create direct value;

• "Support" activities include procurement, technology development, human resources, management, and firm infrastructure, which support value creation in the core value chain (Porter, 1985).

Figure 8 illustrates Porter's value chain.

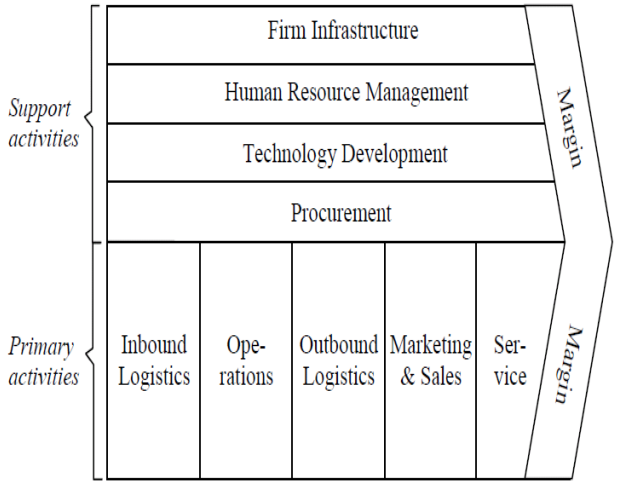


Figure 8: Porter's value chain (Porter, 1985). This figure shows the primary and support activities specified in Michael Porter's value chain.

A value chain is a useful tool that shows interlinked activities and value creation processes within a business from beginning to end. It is appropriate for traditional industries, particularly traditional manufacturing.

However, in recent years, products and services have dematerialized, and their value chains are not solely connected to their physical dimension. Consequently, the value chain has lost its perfect applicability and has turned out to be incapable of analyzing the value sources of many industries (Normann & Ramirez, 1994; Parolini, 1999; Hakansson & Snehota, 1989; Campbell & Wilson, 1996). To resolve this problem, some researchers have suggested using the term 'value network' instead of 'value chain' (Peppard & Rylander, 2006). In a value network, different economic players, such as suppliers, partners, and customers, collaborate to co-produce value.

In the manufacturing context, shifting from a value chain to a value network led to the creation of a new manufacturing structure, called "Networked Manufacturing". In networked manufacturing, different manufacturing centers connect together to enable efficient operation management and control among diverse manufacturing centers. Each of the manufacturing centers can be an external business (e.g., an external supplier, subcontractor, or designer) or an internal center (e.g., a production cell, marketing and sales department, or engineering department) (Montreuil, 2000). Figure 9 illustrates a networked manufacturing structure.

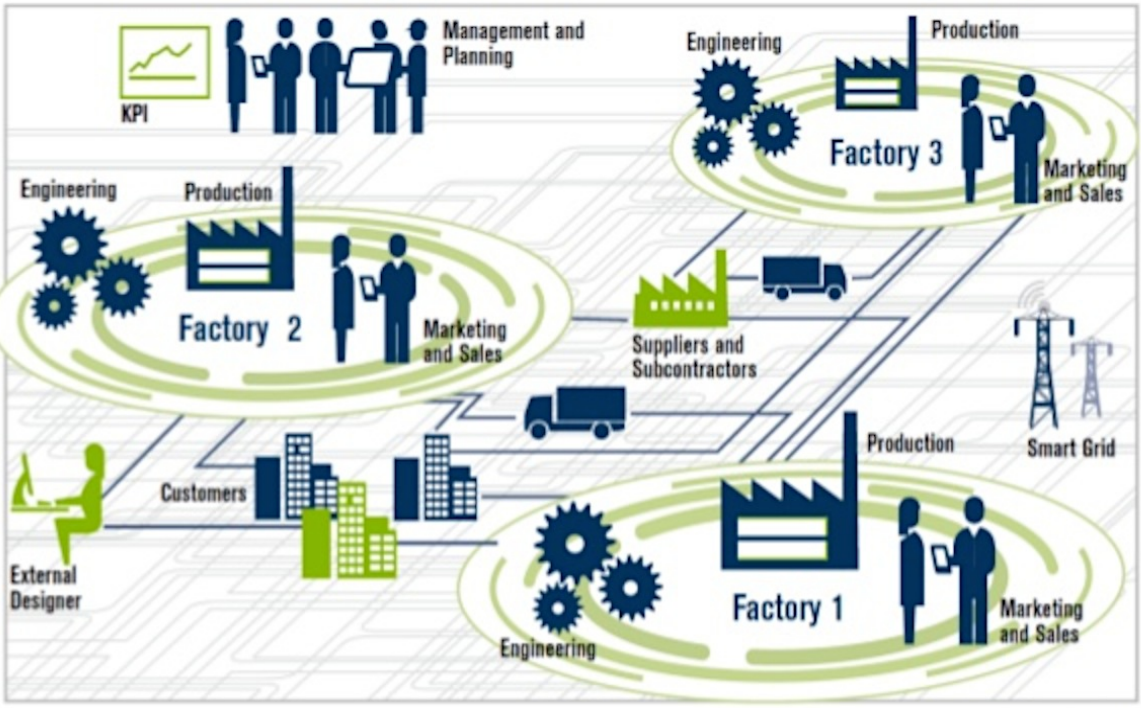


Figure 9: Networked Manufacturing Structure (Acatech, 2013).

In this section, I highlight four domains that can be used to develop the value chain to better adapt to new circumstances. These domains are globalization, customer behavior, social media, and end user power.

Globalization

Globalization is currently an important strategy for every enterprise. Firms constantly investigate international landscapes and seek to exploit opportunities and leverage resources across borders. Furthermore, business rules and legislation have been dramatically influenced through the process of globalization (Czinkota & Ronkainen, 2005). Multinational firms connect themselves to a variety of global and local suppliers to make worldwide contracting agreements (Gereffi et al., 2001). Scholars have studied the effect of globalization in different areas. Globalization strongly affects the conventional model of the value chain. Gereffi et al. (2005) add the notion of

globalization to make a new model for the value chain. They propose a new framework called the global value chain (GVC).

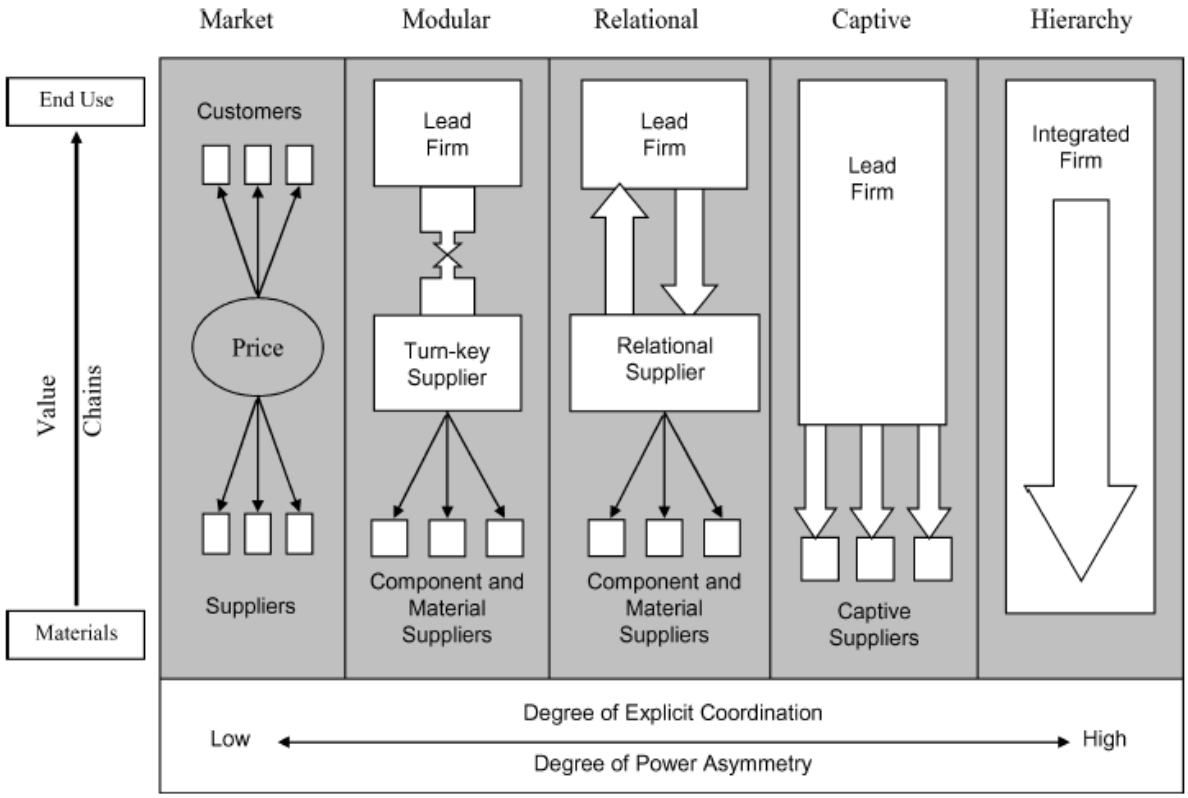


Figure 10: Five types of global value chain governance (Gereffi, Humphrey, & Sturgeon, 2005: 89). This figure shows the different power structure scenarios in a global value chain between customers or the lead firm and suppliers.

The global value chain framework investigates the global expansion of supply chains and underlines the way in which value is created and captured through the connections among firms on a global scale. The focal point in a global value chain is the nature of the dynamic connections between buyers and suppliers.

We can see insightful results by observing the two ends of the value chain in Figure 10. The power asymmetry between suppliers on the downstream side and end users on the upstream side may create different scenarios. At the downstream end, component and

equipment suppliers can deploy a great deal of power if they enjoy a monopoly or a duopoly in the business or if their offering is significantly different from that of other suppliers (in terms of, e.g., price and quality). For instance, in the computer business, Apple and Microsoft usually set policies to which most of the other value chain actors have to adjust. The same story applies to firms in other industries, such as Shimano in the bicycle industry or Applied Materials in the semiconductor industries. At the upstream end of the value chain, customers can define the characteristics of products and services, particularly early adopters and highly knowledgeable customers (i.e., elite users) (Gereffi et al., 2005).

Customer behavior

In today's competitive business environment, keeping customers satisfied and loyal is a critical challenge for many companies. Companies that build their products in a closed system and do not listen to the voices of their customers will face various problems, such as profit loss or customer dissatisfaction. Many firms have realized these negative consequences and have started to shift their focus from increasing internal efficiency to leveraging external resources. The core part of this change is associated with increased co-creation with customers and with transforming customers from external players to internal partners. Accomplishing this strategic change gives firms new competitive advantages in the new economy (Lovelock & Young, 1979; Prahalad & Ramaswamy, 2004; Zhang & Chen, 2006; Prahalad & Krishnan, 2008).

In service-dominant (S-D) logic, every product derives its value through use, which means that every product makes sense through the service it provides (Vargo & Lusch, 2008). Thus, manufacturing companies should pay attention to how their customers experience the services that their products provide. Elaborating the services that a product may provide is therefore crucial for value creation and should be eagerly pursued (Verhoef et al., 2009). The creation of a positive service experience requires co-creation with customers.

Companies that pay attention to the co-creation issue can achieve higher customer satisfaction (Wikström, 1996). Pine et al. (2010) explain how co-creation is linked with

richer communication with customers and with a better understanding of their needs. As a result, co-creation with customers improves a firm's customization capabilities (Zhang & Chen, 2008). Furthermore, attention to co-creation with customers develops a firm's operational performance. Additionally, during the co-creation process, firms often realize which activities have higher perceived values from the customer's perspective and then develop these activities further. Likewise, firms may discover which activities do not create value from the customer's perspective and then discard these activities (Whiteley & Hessan, 1996). Consistent co-creation with customers leads to a win-win result. Customers get their favorite products and services and are satisfied with the quality; firms acquire new competitive capabilities and gain customer loyalty.

Social media

The term "social media" refers to highly interactive platforms through which individuals and groups communicate, co-create, share ideas, and modify user-generated content (Kaplan & Heinlein, 2010). There are various types of social media, each connected with different applications. Online social media can be categorized into blogs (Blogger, Wordpress), microblogging (Twitter), collaborative wiki projects (Wikipedia), forums (Harley-Davidson user groups, Microsoft MSDN), professional networking sites (LinkedIn, Xing), and social networks (Facebook, Google+) (Kaplan & Heenlein, 2010). Firms often utilize social media to improve their internal operations and to collaborate in new ways with their customers, business partners, and suppliers.

Table 3 presents different applications of social media in business.

Table 3: Motives for companies to engage in social media applications (Culnan et al., 2010)

Activity	Motive
Marketing (advertising, PR)	To attract traffic, viral marketing, customer loyalty, and customer retention
Sales	To increase revenue
Customer service/support	Cost savings, revenue, and customer satisfaction
Product development	To increase fit with market and cost savings

Piller et al. (2012) studied the use of social media in product development and found that social media can boost both the effectiveness and efficiency of the co-creation process. This improvement is achieved through the reduction of transaction costs and interaction costs between participants and through the increase in the numbers of participants or potential co-creators. Thus, social media generates additional and diverse ideas for the firm (Piller et al., 2012), which will increase the firm's value and generate a network effect around the firm, respectively.

Additionally, social media may result in new types of research and development (R&D). Ideas for innovative products often come from lead users who create these ideas before the manufacturers do (Von Hippel, 1988; 2005). The importance of lead users is particularly pronounced in highly turbulent markets. Lead users can utilize social media to improve the innovation process in two ways.

First, social media can enhance collaboration among autonomous lead users by sharing information quickly and by making the feedback process easier. Social media can enhance the trial-and-error process throughout the R&D phase. For instance, lead users can use YouTube videos to show a prototype's applications. The main outcome is learning new lessons quickly (Churchill et al., 2009).

Second, social media enables lead users to cooperate easily with each other and discover complementary ideas. As a result, lead users are able to achieve larger innovation outcomes when others contribute new elements that together comprise the entire innovation (Churchill et al., 2009). Manufacturers are just getting started with leveraging the power of social media platforms, such as Facebook and Twitter. Companies that use social media earlier can benefit from the early-start advantage. They are able to find new groups of customers and suppliers more quickly than their competitors. However, it should be noted that the sporadic and ad hoc use of social tools cannot build strong networks with customers or suppliers.

The power of end users

Engineering, R&D, and operational excellence were long the focus of many organizations. As time passed, the role of end users became much more emphasized. Currently, end users increasingly demand personalized service in addition to the core product. This change requires understanding the (end) user's experience and rethinking the role of and relationship with users in the manufacturing process in general.

Many companies have already started to align their strategies with their customers' experiences. American Express, Oracle, and Nikon have made successful organizational changes by introducing a customer-centric culture (Ramble, 2014). In this regard, user experience (UX) is a concept that has increasingly gained attention among many companies and business executives. Companies observe their customers' journeys and leverage several technologies, such as social media, to make these journeys more pleasant and smooth. Concentrating on just the transaction or one part of the customer experience is no longer a good strategy (Sorman, 2014). Hence, companies have to develop different techniques and pay greater attention to customer relationship management (CRM). They should determine how to impress their customers from the starting point by drawing their attention to the final point of customer advocacy[6] (see Appendix 2). Nevertheless, many companies are still far from truly understanding the

[6] Customer advocacy is a type of customer service where companies focus on what is best for the customer.

necessity of customer experience strategies. Bodine et al. (2013) examine this issue in their study.

Figure 11: Adoption levels for customer experience strategies within companies (Bodine et al., 2013).

In addition to the increased power of end users, the trends in globalization, social media, social networks, and customer co-creation imply that the value chain of the current manufacturing model needs to be reshaped. In the next chapter, we will discuss how apparel companies can redefine their entire value chain.

Table 4 summarizes the literature review of this study. Four trends and fifteen sub-trends are identified in the current manufacturing paradigm. Their degree of newness and expected impact on social manufacturing are also presented.

Table 4: Summary of literature review: trends and sub-trends in current manufacturing.

Trends	Sub-trends	Degree of newness	Expected impact on social manufacturing
The transformation of business models	The sharing economy	Very high	Very high
	Crowdsourcing	Moderate	High
	Open innovation	Low	Moderate
	Mass customization	High	Very high
The transformation of manufacturing technologies	Lean manufacturing	Low	Moderate
	3D printing	Moderate	Very high
	Cloud computing	High	High
	Smart and wearable technologies	Very high	Moderate
The transformation of manufacturing strategies	Integrated servitization	High	High
	Going green	Moderate	Moderate
	The digitization of manufacturing businesses	Very high	Very high
Changes in value chain	Globalization	Low	High
	Social media	Moderate	Very high
	Customer behavior	Moderate	High
	The power of end users	High	Very high

In sum, this chapter has provided an extensive overview of changes in the manufacturing context. I have identified macro and micro trends in the current manufacturing paradigm and classified them into four groups.

3 Constructing a model concerning the paradigm shift to social manufacturing

In the previous chapter, I studied major trends in manufacturing industry and classified them into four groups: the transformation of new business models, the transformation of manufacturing technologies, the transformation of manufacturing strategies, and changes in the value chain. These groups provide a chance to shift from current manufacturing to what I call social manufacturing. In this chapter, I suggest a model for this paradigm shift.

3.1 Identifying the gap in social manufacturing

There is a need to clarify how far one should progress to enable social manufacturing. As I have discussed in the previous chapters, the transition toward social manufacturing has recently gained strength. However, these transitions have yet to reach their full maturity; the manufacturing stage is still far away from what could be called social manufacturing. I demonstrate this gap in Figure 13, marking it with a delta (Δ). Some gap-related questions arise. For instance, what is the level of sophistication required to achieve social manufacturing, and what is the current level of sophistication? These questions determine the size of the delta. The next question refers to the level of importance of each manufacturing trend to reaching social manufacturing. There are also other questions. How can the current level of sophistication be measured for each manufacturing trend, and what level is required for social manufacturing? Which one of the trends being discussed should be taken into account more for reaching social manufacturing? These questions are intriguing. However, seeking to answer them is beyond the scope of this study and will be proposed for future studies. Instead, this study explains that the gap is shrinking daily, which indicates that social manufacturing is becoming increasingly possible. Figure 12 presents a schematic illustration of the gap between current manufacturing and social manufacturing.

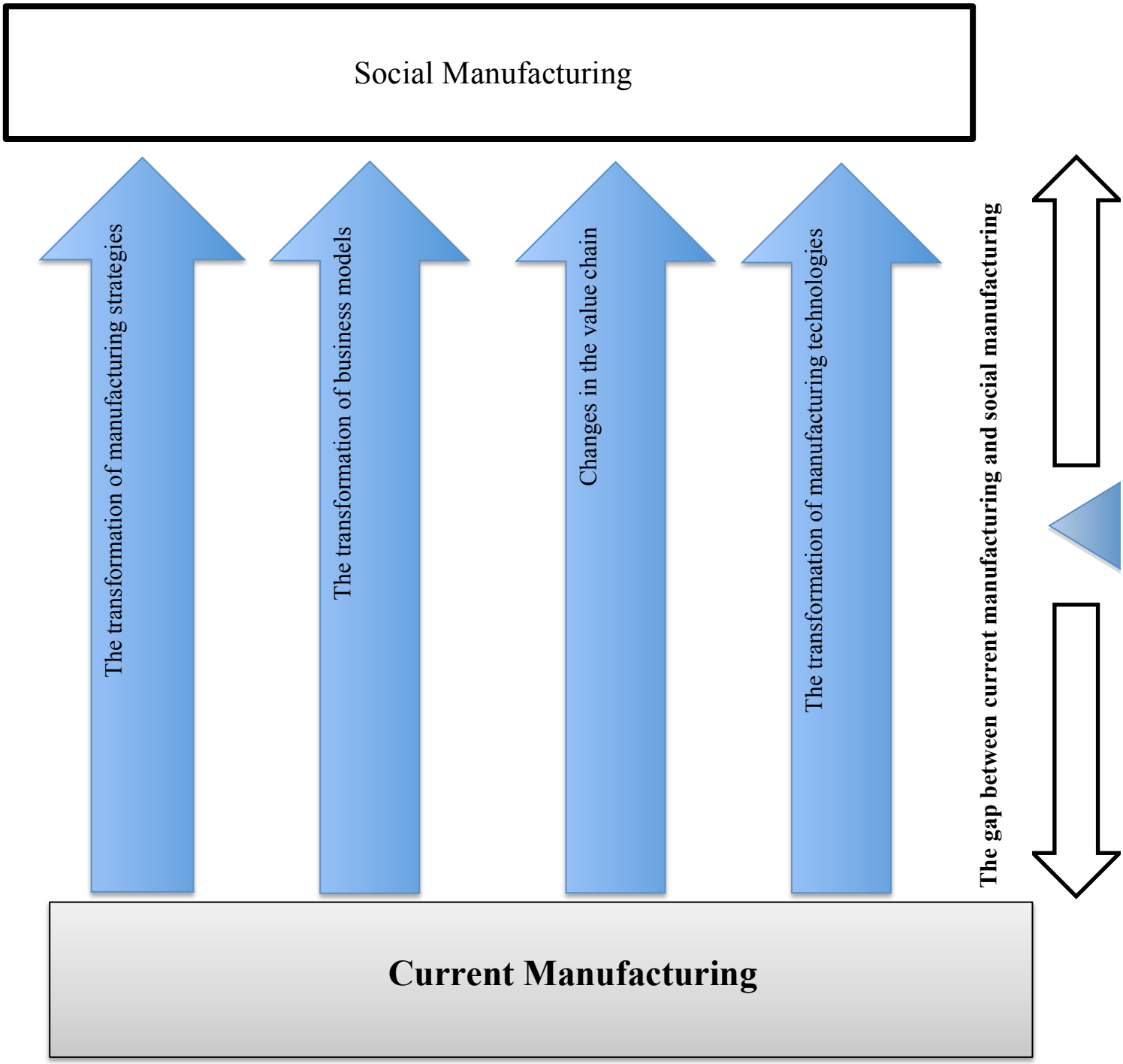


Figure 12: The gap to bridge in order to reach social manufacturing. This figure shows the gap between current manufacturing and social manufacturing.

This study suggests that the transition from the current manufacturing paradigm to social manufacturing will take place in two phases. The first phase is called the "intermediary phase of social manufacturing". In this phase, customers will become involved in the entire value chain of manufacturing (i.e., from design to services). However, manufacturers will still control the entire value chain. The benefit of intermediary social manufacturing is maximizing co-creation with customers. In other words, the intermediary phase of social manufacturing means an advance in mass customization. The first phase of social manufacturing is an incremental change from the current manufacturing paradigm.

The second phase of social manufacturing is called the "ultimate phase of social manufacturing". In this phase, all the manufacturing actors are connected through a worldwide platform in which everyone can receive and send on-demand manufacturing requirements. It means that the peer-to-peer (p2p) connections between the actors in manufacturing are increased; hence they can connect with each other at every time and in every place. In this phase, manufacturing is totally democratized through the people in the society. Thus, the ultimate phase of social manufacturing is a radical and disruptive change from the current manufacturing paradigm.

Unlike the first phase of social manufacturing, which is governed by established corporations, the second phase will lead to the emergence of new entrepreneurial producers.

In this regard, the second phase of social manufacturing represents a revolution in multiple dimensions. This revolution will happen in both the technological dimension and the social dimension of the manufacturing paradigm.

The concept of the "prosumer" (Ritzer & Jurgenson, 2010), who is a proactive consumer that participates in production, will be fully capitalized in the second phase of social manufacturing. Every consumer can utilize social media and suggest some product ideas in the design step, and he can then make a prototype and become involved in the production step. Finally, he can start selling the product exactly like a company (The Economist, 2013).

In the second phase of social manufacturing, consumers are more likely to become entrepreneurs as they can capture ideas and then make improvements to them and sell

them through their own business. This process enables what Shah & Tripsas (2007) called "accidental entrepreneurs." Figure 13 illustrates the two phases of social manufacturing.

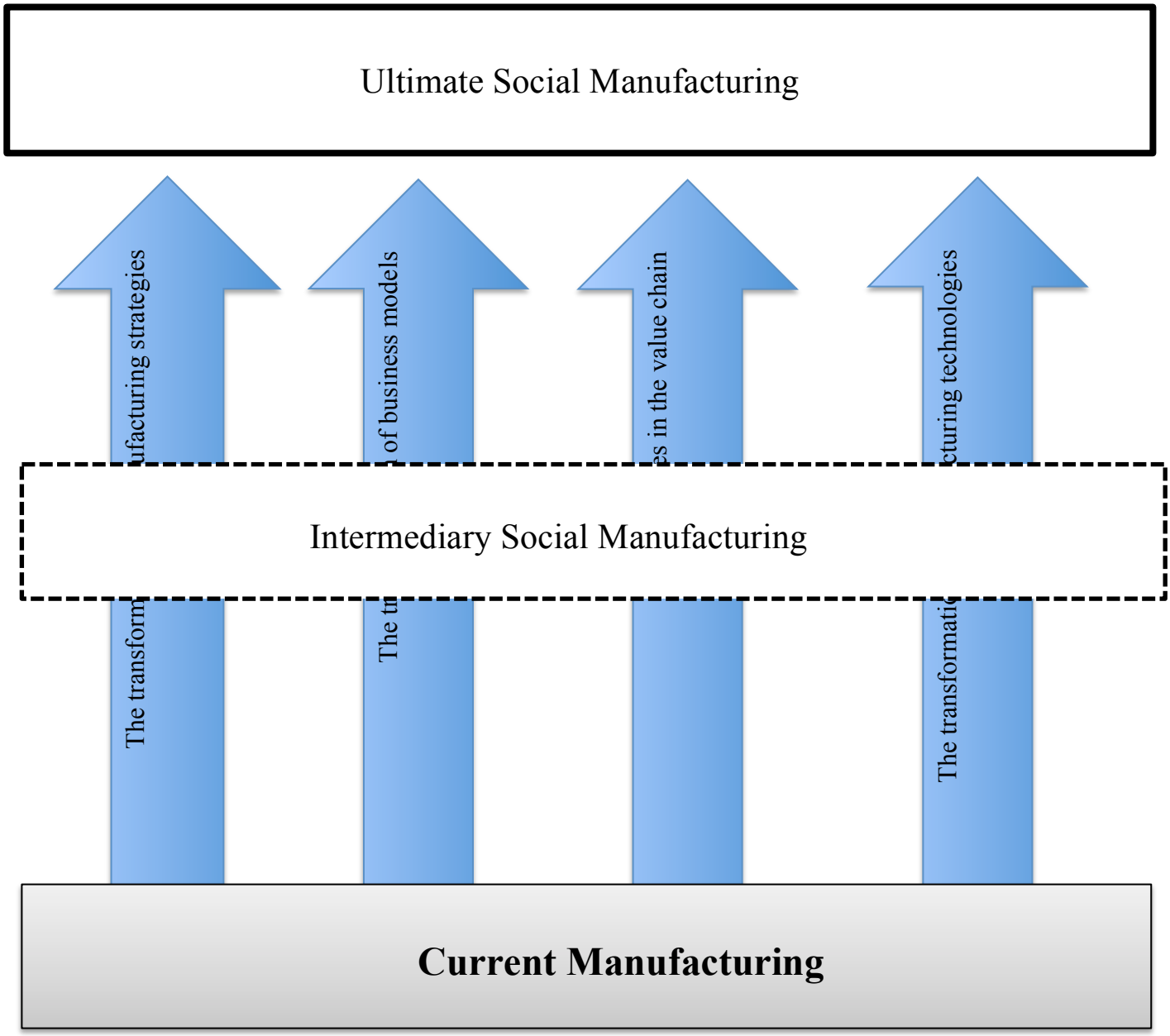


Figure 13: The intermediary and ultimate phases of social manufacturing. This figure shows the two phases of social manufacturing.

This study recognized and discussed the four trends in the manufacturing context in the previous chapter. I suggest that developments in these trends provide the chance for manufacturing companies to achieve the intermediary phase of social manufacturing.

The first trend relates to changes in the value chain. I expect that the effect of social technologies will grow steadily in the future. Many companies have already started to deploy and exploit them in their business. Furthermore, a new type of organizational behavior, empowered by social networks and crowdsourcing, has already been realized in some manufacturing companies (e.g., GE, Quirky, and Shapeways). However, these changes do not happen very quickly and require greater industrial adaptation.

The second trend is the transformation of new business models that are based on the sharing economy. Although this phenomenon is new, there are already successful examples, such as Uber and AirBnB.

The third trend in the change toward social manufacturing is the transformation of manufacturing technology. This field is developing quickly; many new innovations relating to 3D printing and wearable data are released every year. The prices of 3D printers are decreasing every day, making this technology more accessible for private customers.

The fourth trend is the transformation of manufacturing strategies, which includes digitization, servitization, and the go green principle in manufacturing.

All four developing trends are making the intermediary phase of social manufacturing more feasible.

The view of social manufacturing that was proposed by previous researchers merely looked at manufacturing inside out. In this regard, we can say the previous researchers mainly indicate the intermediary phase of social manufacturing. For example, Xiong et al. (2014) introduced the system component of social manufacturing (Figure 14) and Shang et al. (2014) introduced a social manufacturing model in high-end apparel, footwear, and hats (Figure 15).

The Economist (2012) represents this phase as follows: *"And the effects will not be confined to large manufacturers; indeed, they will need to watch out because much of what is coming will empower small and medium-sized firms and individual entrepreneurs. Launching novel products will become easier and cheaper."*

What is necessary, however, is to consider an overarching goal for social manufacturing. The final vision is to create a manufacturing paradigm in which the entire society can actively become involved. This vision is aligned with social manufacturing being referred to as the "third industrial revolution" (SoMa, 2014). In order to attain this vision, I present the ultimate phase of social manufacturing.

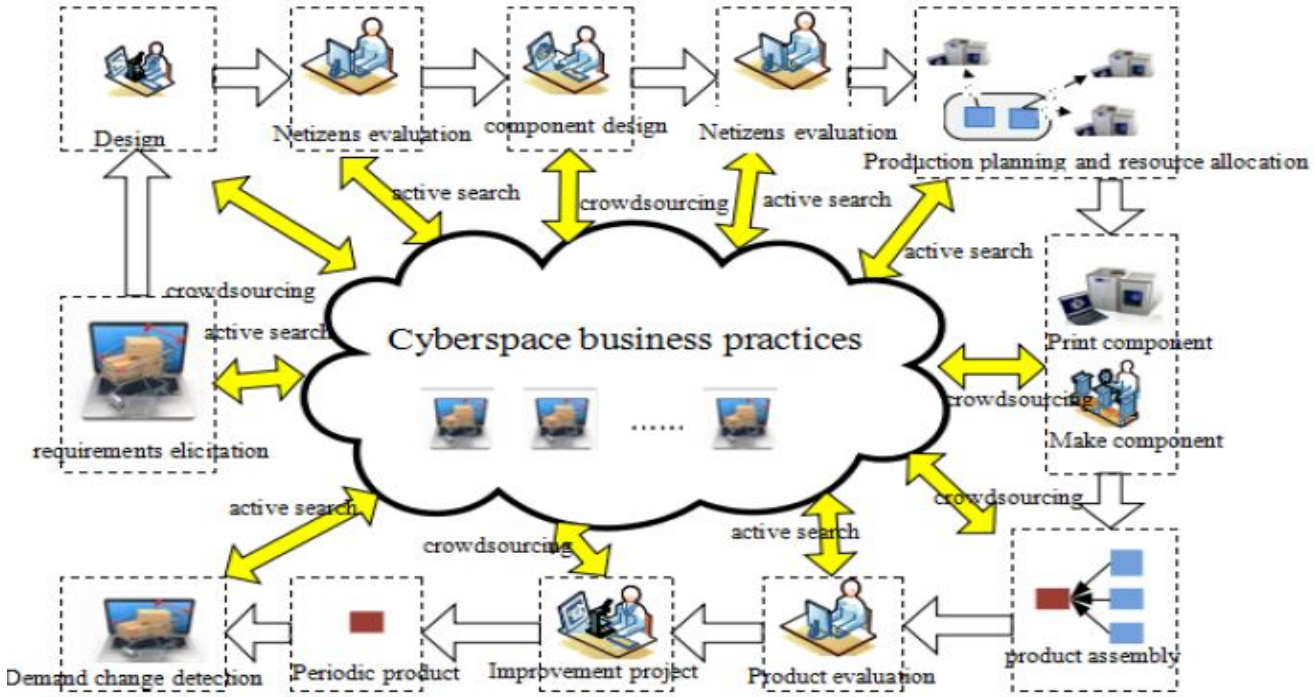


Figure 14: System component for social manufactuirng (Xiong et al., 2014)

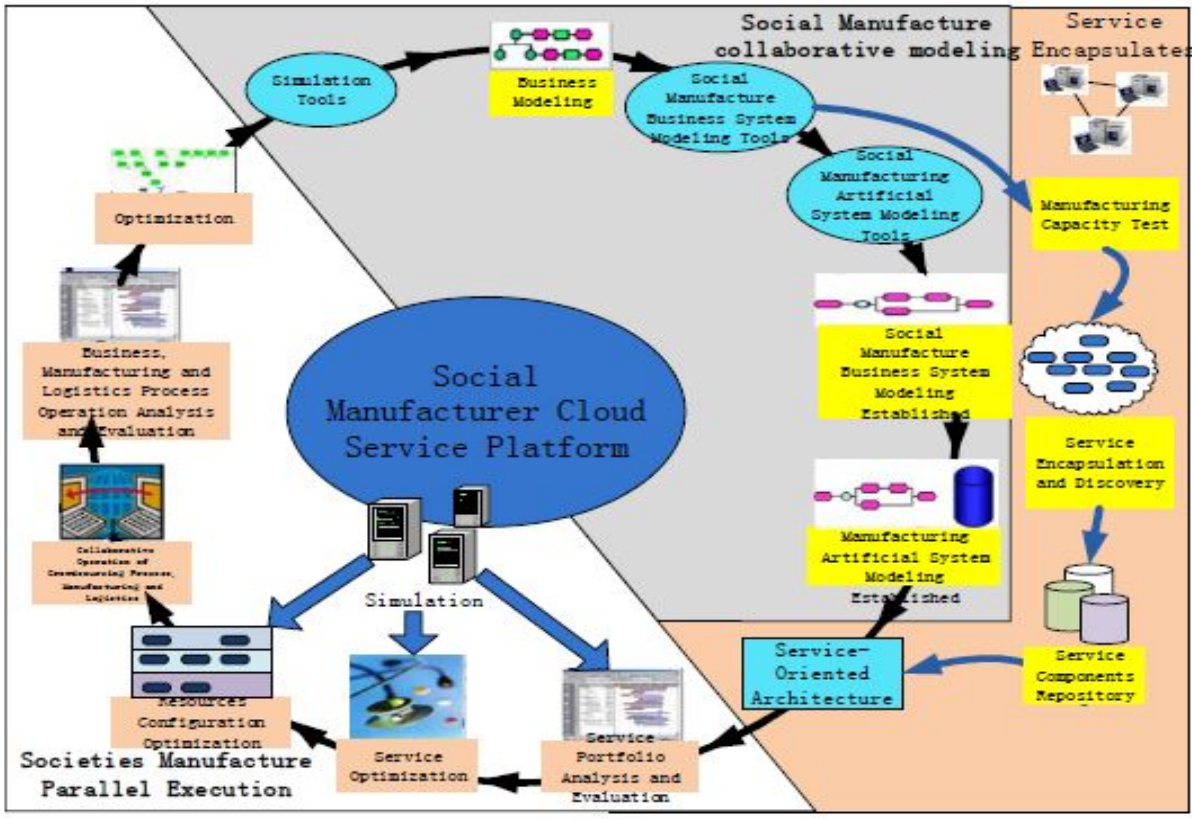


Figure 15: Social manufacturing modeling and collaborative mechanism for high-end apparel, footwear, and hats (Shang et al., 2104)

3.2 The ultimate phase of social manufacturing

If we compare manufacturing industry with the IT industry, we can observe that the trends that have happened in the IT industry can be mimicked in manufacturing industry. Before the existence of the World Wide Web (WWW), connecting computers and networks to each other usually took place through intranet networks. An intranet makes it possible to share information, operational systems, or computing services within organizations. However, after the emergence of the Internet, many intranet services were replaced with the Internet. Although the intranet is still used to manage intra-organizational tasks, many intranet services have been replaced with on-demand and proprietary cloud solutions. Cloud solutions have also affected customers' behavior. For example, customers seek virtual cloud storage, instead of physical hardware disk drives.

The result was the development of many cloud storage services, such as Dropbox, Google Drive, and so on. The world of entertainment has also been affected by on-demand cloud solutions. For instance, Netflix and other on-demand TV solutions have dramatically changed the business model of the entertainment industry.

Now the world of manufacturing is going in the same direction, although at a slower pace.

The intermediary phase of social manufacturing as discussed before resembles an intranet service. The intermediary phase of social manufacturing aims to improve co-creation with customers, involve customers in the entire value chain, and enable customers to become manufacturers in the end. However, the boundary in the intermediary phase of social manufacturing remains at the level of the particular organization or the industry. In the intermediary phase of social manufacturing, the manufacturing company manages the entire value chain and customers play the role of co-creators. The manufacturing company controls the upstream level and customers change to prosumers (Ritzer & Jurgenson, 2010). However, prosumers still stay at the downstream level. Some companies, such as Shapeways or Thinkgivers (see www.shapeways.com and www.thingiverse.com), are developing something like the intermediary phase of social manufacturing. But the intermediary phase of social manufacturing has not been applied to the whole of the current manufacturing paradigm and many issues still need to be solved before it can be deployed thoroughly.

To respond to this need, I envision a new manufacturing paradigm that I call “the ultimate phase of social manufacturing”. It is basically an on-demand manufacturing platform, which is controlled by the public (like the Internet). Everyone can share and receive cyber, physical, and social requirements to/from the platform. For instance, if a customer wants to manufacture a product, he only needs to look it up on the platform and gets any solution from R&D to services on demand. Meanwhile, if he has any input on any level of manufacturing, he can share it temporarily or permanently on the platform.

In the ultimate phase of social manufacturing, peer-to-peer connections increase and finally all manufacturing industries will be democratized.

Figure 16 presents a model that constructs a paradigm shift from current manufacturing to social manufacturing. The ultimate phase of social manufacturing is illustrated at the

top and the intermediary phase of social manufacturing is illustrated in the middle. This model demonstrates that in the first step toward social manufacturing, a platform is designed by manufacturing companies to involve their customers in the entire value chain. This will help customer creation to evolve and customers can be manufacturers. However, the overall governance of manufacturing is still conducted by the manufacturers. The manufacturing companies could build this platform earlier and would benefit from the new co-creation with their customers. In this phase, manufacturing might focus on building a platform and shift attention from operational efficiency to engaging the customer in the co-creation process.

In the second phase of social manufacturing, a global manufacturing platform will be created. In this phase, unlike the previous step, the public owns the manufacturing platform and everyone can contribute to it. All requirements (including hardware, software, manpower, social, etc.) will be available on this platform. The end result will be an on-demand global manufacturing paradigm that I call the “ultimate phase of social manufacturing”.

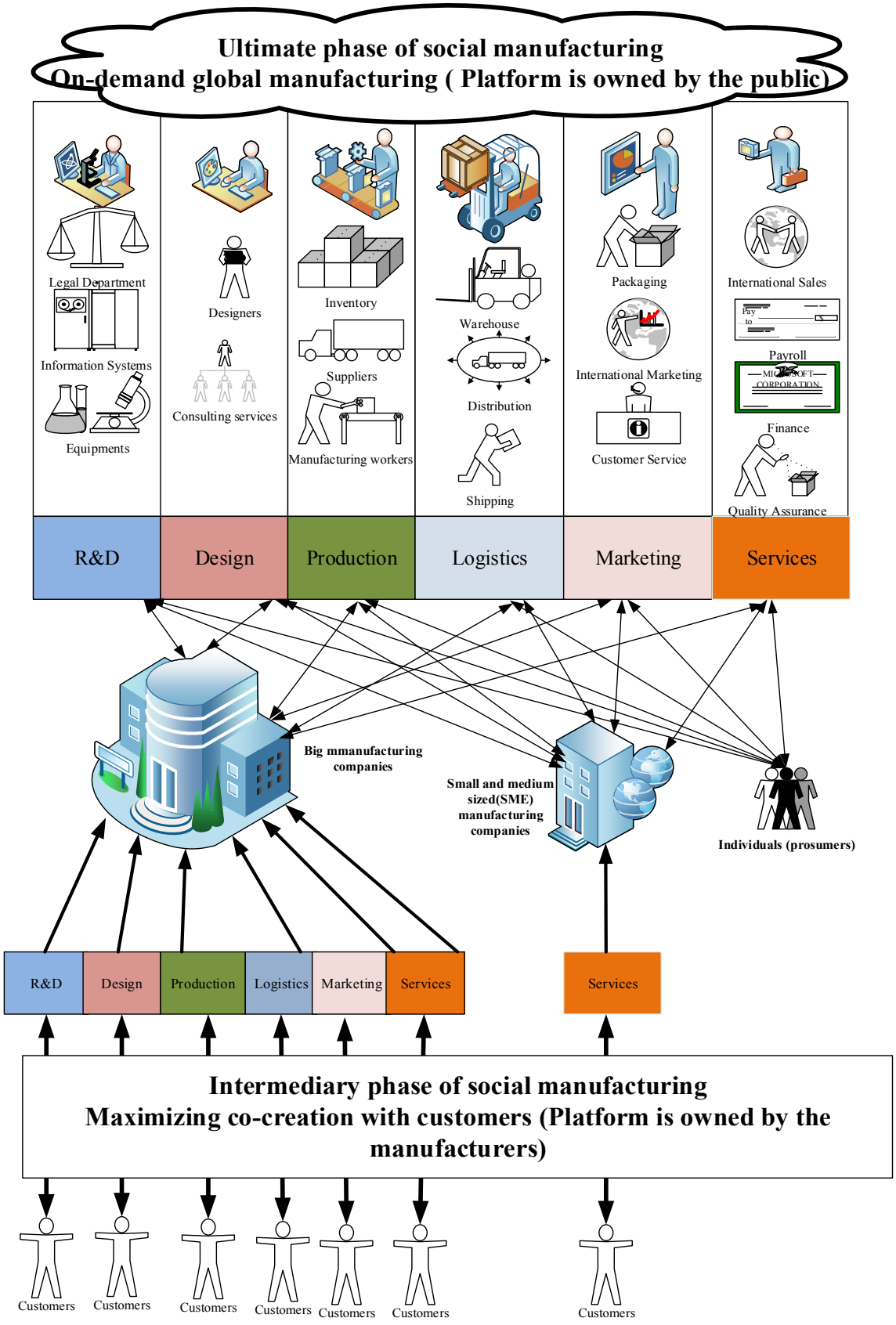


Figure 16: Proposed model concerning a paradigm shift to social manufacturing

The ultimate phase of social manufacturing envisages a utopian world for manufacturing. Someone might claim that this phase remains far in the future; however, I believe that the trends in manufacturing provide a chance to make this dream world come true. It needs global tenacity to move the manufacturing paradigm ahead. However, the first goal is accomplishing the intermediary phase of social manufacturing. For this reason, I concentrate on the apparel industry and suggest how these two phases of social manufacturing can be achieved in the apparel industry.

4 Changing the value chain model of the apparel industry to reach social manufacturing

In this chapter, I apply my model to a particular industry. I have chosen the apparel industry because several changes have occurred in this industry that make it an ideal research object. The major changes are as follows.

First, the structure of demand in the apparel industry is changing from mass production to personalized products. Apparel manufacturers should use mass customization and create niche markets to meet the diverse and fragmented needs of customers.

Second, the apparel industry is confronted with tough competition, which makes resource management more challenging, and apparel manufacturers should consider even small costs. The products in the industry are also becoming increasingly similar, and apparel manufacturers are searching for ways to differentiate themselves. However, differentiation is costly (Shang et al., 2013). These two trends can clash with one another and make it difficult for apparel manufacturers to choose a manufacturing strategy.

The third major change in the apparel industry is that sustainability, particularly social and environmental sustainability, has been receiving increasing attention across the entire industry. Table 5 presents the changes that already are happening in the apparel industry.

Table 5: Current changes in the apparel industry (Vurro et al., 2014)

Empirical contexts	Changes
Supply chain	The popularity of offshoring, delocalization, and outsourcing
Manufacturing strategy	The shift from product orientation to consumer orientation
Market segmentation	Geographical dispersion in offering semi-finished textile products, manufactured products, and related services
Market expansion	Choosing new target markets based on sustainability (e.g., natural and ecologic fibers) and speed to market

I see great potential for the social manufacturing model to resolve the issues of resource management, sustainability, and personalized production offerings.

4.1 The apparel industry: opportunities and challenges

The global apparel and textile market has changed considerably since 2005. On the one hand, the market has expanded in value; on the other hand, a relatively small group of companies has gained market dominance. Marketing attention has shifted toward developing countries, such as China and India. There have also been changes on the supply side. In 2011, the top ten developing country suppliers accounted for 58% of the global apparel exports. Of this proportion, Asian suppliers represented approximately 90%, which represented 52% of the entire market (OECD, 2013).

Before 2005, each country had its own import and export rules, and the garment manufacturers had to manage their outsourcing case by case. However, the Agreement on Textiles and Clothing (ATC) by the World Trade Organization (WTO) turned a new page in this industry by setting global rules for the international textile trade. This change enabled garment manufacturers to outsource their production networks overseas to emerging economies with cheaper labor forces and larger market sizes (Gereffi & Frederick, 2010).

Generally speaking, the global apparel retail market has been growing steadily and is expected to reach an estimated value of $1.348 trillion in 2016 (Thomasson, 2012). However, the apparel industry faces various challenges and complexities. The first problem arises from stock-outs, which are common for apparel retailers. Traditionally, many apparel retailers keep extra inventory to buffer the changes in customers' demand. However, because customers' needs change rapidly and the products' lifespans have become shorter, apparel retailers must be more agile. Harvard Business School studies indicate that customer bargaining power is currently highly significant in the clothing and apparel industry. When a customer looks for a product in a store and that product is out of stock, he is most likely to shop for the product in another store (checkpointsystems). Thus, suppliers need to realign their supply chains with real-time and integrated systems to control the merchandise levels in their stores and distribution centers (checkpointsystems). A delay in responding to a customer's needs may harm retailers in two ways; they lose the immediate chance to sell and lose the potential for

long-term sales, as a dissatisfied customer will be unlikely to return to the store. Because products in the apparel industry are more alike and differentiation is very hard, the importance of customer retention is garnering more attention (Ngai et al., 2014). Therefore, the entire value chain aims to foster a customer-oriented approach.

Another challenge in the apparel industry relates to the nature of the market, which is turbulent and unpredictable. New trends and consumer preferences for different styles and fashions emerge continuously. Apparel brand owners are confronted with the challenge of quickly fulfilling their customers' changing needs. They have to reconfigure their logistics to deliver the design to manufacturing and to distribute the final products to the store faster than ever. The retailers then must sell those products immediately because the customer demand stays at a peak level for a very short time (Martin, 2013).

Furthermore, the sustainability requirements have dramatically influenced the entire industry and present the next challenge. Sustainability can be studied in three dimensions: economic sustainability, environmental sustainability, and social sustainability (McKenzie, 2004). Economic sustainability relates to the profitability of the business over time. As I have discussed, the apparel industry has a promising outlook, and market growth is predicted to continue. Thus, economic sustainability is not a major concern in this industry. However, in terms of environmental sustainability, the green transformation of the global economy has obviously affected the industry. This trend has enforced new manufacturing policies in the entire production process of the apparel industry. Scrutiny of the handling of wastewater, accidental discharges, pollutants, and energy use has increased across the apparel industry. A global manufacturer should inspect its supply chain partners to ensure that they have the certifications required for environmental and social compliance. Such certifications include, for example, ISO and blueprint certifications (checkpointsystems). Regarding social sustainability and workers' well-being, the apparel industry faces major challenges. The requirements for social sustainability have become even more paramount than those for environmental sustainability and are now applied across the entire industry. Exporting apparel can bring economic progress to the country in which the production occurs. However, the apparel industry in developing countries is

burdened with poor working conditions and heavy pollution. Death tolls and health issues are among the major worries for many garment manufacturers that operate in developing countries. The Rana Plaza disaster, the deadliest garment factory accident in history, was the showcase for occupational health and safety issues within the industry. In April 2013, this accident killed 1,133 people in Bangladesh (Martin, 2013). The alarming number of casualties after this disaster reemphasized the importance of social sustainability in the apparel industry. In addition, there is increasing debate about the need to specify minimum wages for apparel workers in developing countries. For instance, in Bangladesh, the minimum wage for garment workers is the lowest in the world, only about USD 38 per month. There is currently a strong campaign by Bangladesh's garment workers to increase this wage and introduce free trade rules (Devnath, 2013).

In short, the apparel industry is facing the problems of unpredictable demand, short product life cycles, and sustainability requirements.

Despite all these challenges, there are also some promising and positive trends emerging in the apparel industry. First, manufacturing strategies are transitioning toward going green, servitization, and the digitization of apparel. Second, manufacturing technologies are transforming quickly. New manufacturing technologies have the potential to alter the entire industry and create new markets. We have witnessed substantial progress in the development of 3D technologies and smart clothing. Some companies have already introduced impressive achievements in smart garments, such as Nike+ running shoes and proximity sensing shirts (Macmanus, 2010). Third, business models in the apparel industry are moving toward mass customization and crowdsourcing. Middle-class customers are particularly involved in this made-to-order trend (Jacobs, 2013).

Although some positive developments are occurring, the promised land of social manufacturing is still obscured by uncertainty. As many experts have discussed, apparel manufacturers' corporate CEOs are very concerned about economic sustainability and do not seriously consider other emerging issues, such as social sustainability (Martin, 2013). The apparel industry has traditionally adhered to the idea of the status quo. However, to achieve social manufacturing, radical changes should be applied to the

market. The academic world should assist with this change. Within this study, I answer this call, which can be applied in general and in the apparel industry in particular.

4.2 The value chain in the apparel industry: the current model

The value chain in the apparel industry is currently fragmented. The value chain starts with the production of raw material. This step begins with the production of fiber that is processed into yarn, fabrics, and finally finished products. This process includes physical raw materials and textile designs. Next, the textiles are moved to places where they are cut/sewn. In this step, they are further processed for packaging. Meanwhile, national branding and licensing are acquired for products that include branding or licensing attributes. After the production process, the final products are transported to distribution centers. A brand marketer, who is the agent of the brand manufacturer, or a third-party distributor usually carries out the distribution of the products. Finally, the retailers sell the products to customers in their merchant stores or discount stores, or through similar channels (Gereffi & Frederick, 2010).

As shown in Figure 17, customers remain at the end of the value chain, which delimits the opportunities for achieving the best co-creation and producing customized products. By the same token, customers are not involved in the most value-adding steps, i.e., R&D, design, marketing, and services (Mohajeri et al., 2014).

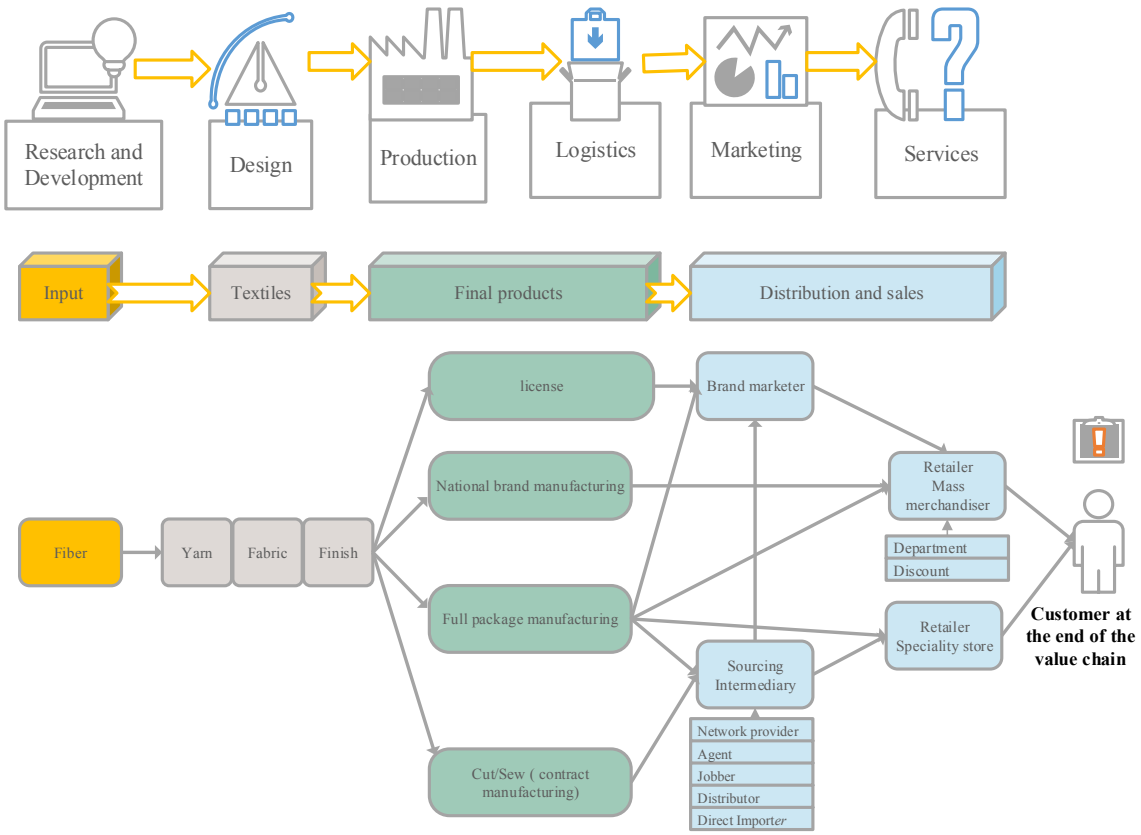


Figure 17: The apparel industry's value chain (Gereffi & Frederick, 2010). This figure explains the value chain of the apparel industry. The value chain starts with R&D in the production of fibers and ends in marketing and services, in which mass merchandise retailers or specialty store retailers sell the products.

4.3 The new value chain: an introduction to social manufacturing

In order to reach social manufacturing, I propose the improvement of the value chain of the apparel industry in three steps. In the first step, the current value chain of the apparel industry is improved on the basis of the current technology. As a result, customers are better involved in the value chain. This improvement means optimizing mass customized apparel manufacturing. In the second step, I am concerned with developments in the technologies to influence the value chain of the apparel industry since some modifications are implied in that value chain. The outcome of this step is the intermediary phase of social manufacturing in the apparel industry. In the third step,

directions are outlined that promote the value chain of the apparel industry toward the ultimate phase of social manufacturing.

4.3.1 Improving the current value chain of the apparel industry

The goal in this stage is achieving the total engagement of customers in the entire **va**lue chain of the apparel industry on the basis of the current technology**.** However, there are limitations in some phases of the value chain **(**e.g., production or logistics) that hinder the total engagement of customers in the entire value chain. Nevertheless, involving customers in all possible steps can significantly develop co-creation. I look at every phase in the current value chain and investigate how the engagement of customers should be encouraged.

- **R&D and Design**: these two phases are very closely interlinked in the apparel industry. Customers will be able to use an online platform, which is provided by the manufacturer, to upload their own designs or tailor their favorite clothes (Mohajeri et al., 2014). Other customers can look at previous designs on the online platform and benchmark their favorite styles. Thus, customers can co-create in the research and development phase, as well as the design phase.

- **Production**: current technology does not provide a chance to involve the customers in this phase. 3D printing technology is not yet advanced enough to print textile material. Nor is it economically viable to print clothes for selling to the stores. It is not aslo economically viable to distribute other technologies, such as cut-sew machines, among customers.

- **Logistics**: currently, it is much more cost-effective to manage the logistics in a centralized manner. In centralized logistics, manufacturing companies can buy bulk orders, which reduce their inventory purchasing costs. In addition, it is easier to integrate logistics activities via a centralized logistics system. Therefore, it is not economically viable to distribute the logistics among customers.

- **Marketing**: it is very effective to engage customers in this phase. In the marketing phase, real-time customer consumption data (online and in physical

store suppliers) will be collected and disseminated among suppliers and manufacturers, allowing them to analyze these real-time data. A prompt analysis enables them to adapt rapidly to customers' needs through proactive offerings. Currently, several apparel manufacturing companies are running new sales and marketing channels such as Omni-Channel[7] to combine the benefits of both online and brick-and-mortar sales channels.

- **Services**: it is quite feasible to involve customers in this phase. The retailer's service quality will be improved by combining online and brick-and-mortar sales channels. Through this combination, the stock will be reduced and inventory can be minimized. Thus, inventory-keeping costs and outbound logistics costs will be reduced, allowing companies to deliver customized services to customers. The new services will meet the customers' various motivations (Mohajeri et al., 2014).

Table 6 summarizes the feasibility of the engagement of customers in different phases of the value chain of the apparel industry.

7 Omni-Channel is a multichannel approach to sales and marketing which combines the advantages of both in-store (brick and mortar) selling with those of online selling. It allows the customers to choose among different sales channels, including in-store and online selling channels (Newman, 2014).

Table 6: Feasibility of engagement of customers in the value chain of the apparel industry

Phase	Feasibility
R&D	Yes
Design	Yes
Production	Not technically feasible or economically viable
Logistics	Not economically viable
Marketing	Yes
Services	Yes

4.3.2 Intermediary phase of social manufacturing in the apparel industry

As identified before, two major bottlenecks to reaching the intermediary phase of social manufacturing in the apparel industry are the production and logistics phases. Nevertheless, this study believes that new technology provides opportunities for the engagement of customers in these two phases. In other words, this study considers that in the near future it will be both economically viable and technically feasible to use social manufacturing in the production and logistics phases in the apparel industry. This speculation is built on the following reasoning.

Production: the major driver in this phase is the development of 3D scanning and 3D printing technologies. The price of 3D printing is declining every day. At the same time, the ranges of 3D printable materials are increasing. Likewise, applications for 3D printing are developing very fast. There are groups of companies that have already started to use 3D printing in the apparel industry. The N12 bikini from Continuum

Fashion 3D is the world's first ready-to-wear, completely 3D-printed article of clothing (continuumfashion, 2012).

Picture 1: The N12 bikini – the world's first ready-to-wear, completely 3D-printed article of clothing (continuumfashion, 2012)

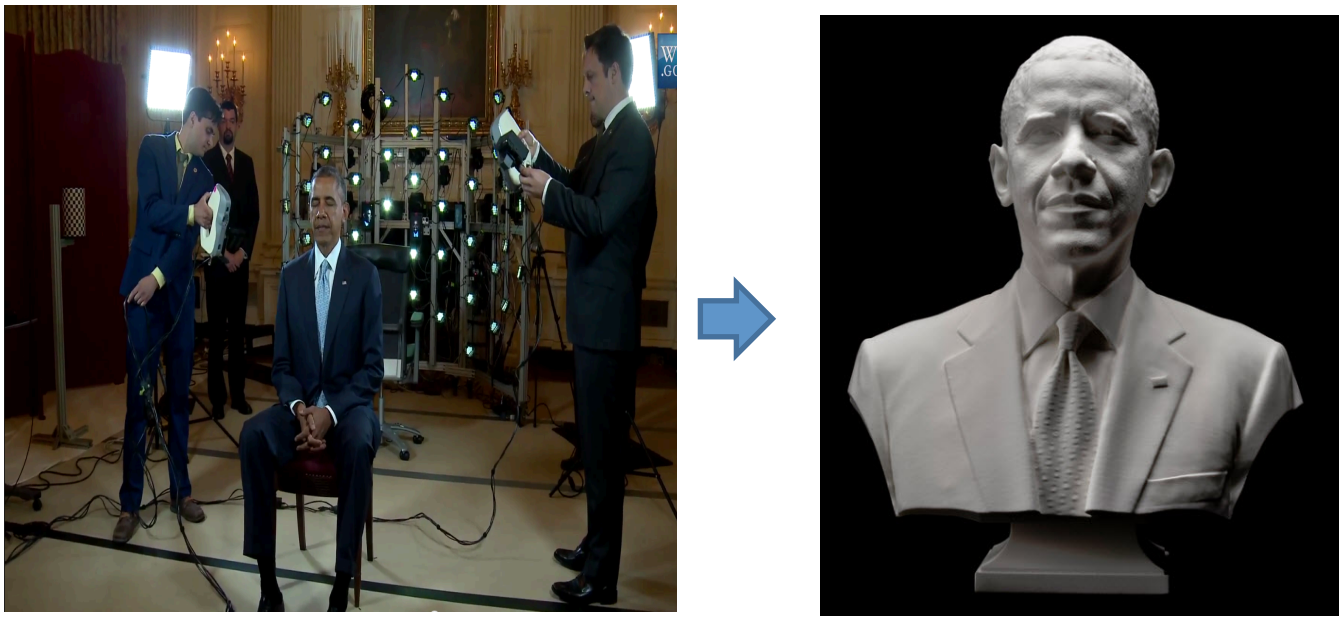
Meanwhile, Electroloom is working on the first 3D printer to print out fabrics for comfortable sets of clothes.

Picture 2: Electroloom is building the first 3D printer for printing fabrics (electroloom, 2014)

Currently, the focus for these types of companies is on the fashion market. However, as the feasibility and applications of 3D printing improve, 3D printers will be used for the consumer market in the future. Thus, customers will be able to 3D print various types of products and substantially co-create in the production phase at some point.

Meanwhile, 3D scanning technologies have developed very fast. 3D fitting rooms perform full body scans and enable customers to wear their favorite brand's clothes in a virtual environment. Customers can check the size, fitting, and shape of the clothes on their body in virtual fitting rooms. They can even virtually change the color of the cloth. It provides a wonderful opportunity to make better-customized products.

New 3D scanning technologies go even further. The Artec Group develops and sells 3D scanners which are handy, cheaper, work in real time, and are easy to use. They enable everyone to scan his body and make his own virtual fitting room at home (Artec, 2104).



Picture 3: President Obama in 3D (Artect, 2104)

Logistics: the development of this phase depends on improving the production phase or, more precisely, 3D technologies. If 3D printing evolves, the distribution of logistics activities will be more realistic. In this scenario, the size of stores will be minimized, while the number of stores will be increased. This strategy creates a flexible distribution model and allows customers to shop near their homes. Such an approach will save significant amounts of energy and money in both transportation and inventory keeping. In addition, online stores will potentially replace physical storefronts, which will also reduce logistical costs (Shang et al., 2013).

Some companies have already started initiatives in distributed logistics. For instance, 3D Hubs is a company that offers distributed logistics via an online 3D printing service platform (3dhubs, 2014). This company works with 3D printers in over 12,000 locations in 140 countries via a networked system. This company enables connections between 3D printer owners (Hubs) and people that want to make 3D prints. 3D printer owners are able to join the platform and offer 3D printing services. On the other hand, customers can locate available 3D printer owners via the platform and find the 3D printers for their 3D printed works nearby. This network provides access to a 3D printer within 10 miles

of their home to over a billion people (3dhubs, 2014). This is one example of pooling the production resources to improve the cost benefits of distributed logistics. Hence, customers will be able to participate actively in logistics activities in the future.

All in all, I expect that in the intermediary phase of social manufacturing, apparel manufacturers will be able to actively involve customers in the entire value chain of the apparel industry. Figure 18 presents the intermediary phase of social manufacturing in the apparel industry.

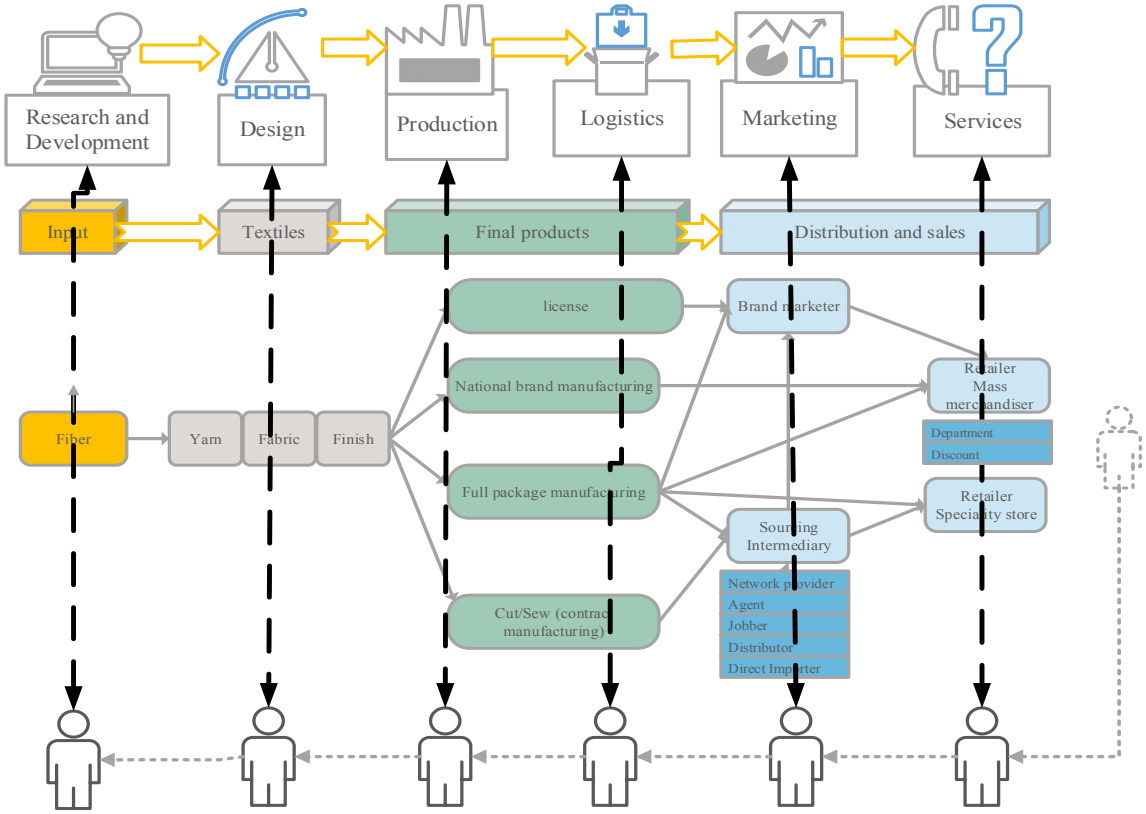


Figure 18: New value chain models in the apparel industry that are enabled by the intermediary phase of social manufacturing. This figure shows the intermediary phase of social manufacturing. In this phase, the role of the customer changes from that of a mere receiver of products and services to an active co-creator of value through the apparel industry's entire value chain.

The new value chain can lead to several outcomes. It may result in the increased power of end users who are co-creating throughout the entire value chain. This new model also enables customized products to be produced, as the customers co-create throughout the

entire value creation process. In addition, the customer's active role gives apparel manufacturers an opportunity to leverage the power of social media through brick-and-mortar sales and through online marketing. Apparel manufacturers can build an online platform for their businesses, replicating the best practices from other industries, as discussed in Chapter 2 through the examples of Shapeways and Quirky. The new value chain model would also optimize the use of local resources in value creation, as the size of the stores would be minimized and the stores would be moved close to the end customers. In the new value chain, the apparel manufacturer is able to gather immediate and quick feedback from its customers and to improve its marketing efficiency by reducing operational costs.

Eventually, the new value chain will foster social sustainability. In the conventional value chain of the apparel industry, the manufacturing department is given a subordinate position throughout the production process. Personnel who work in the manufacturing department have very little decision authority, and they often carry out orders that come from outside their department (e.g., from marketing, sales, and R&D). Consequently, blue-collar workers in the manufacturing department do not have much bargaining power to pursue their interests. They might be the first group to be laid off when business slows down. These blue-collar workers usually rely on trade unions and free trade rules to defend their rights. In developing countries, however, sufficient support for manufacturing workers is not available, and they can easily be exploited by the industry. Catastrophic accidents (e.g., Rana Plaza) reveal the significant difficulty that the current apparel manufacturing structure has in observing social sustainability.

However, the new value chain can contribute by increasing the attention given to worker-related social sustainability. Because workers are embedded in the production system, they partly own the production facilities. Additionally, workers are in direct contact with customers.

4.3.3 Ultimate phase of social manufacturing in the apparel industry

After the intermediary phase of social manufacturing in the apparel industry has been reached, I expect that this industry will shift to the ultimate phase of social manufacturing in the long run. Although the ultimate phase of social manufacturing is still far away, I provide an example of how this change may happen in the apparel industry. The example is as follows.

I expect 3D scanning rooms will be improved in the future and every customer will be able to 3D scan his body and register his unique body shape. Thus, every customer will have his own virtual identity for clothing. Then he will be able to upload his scanned file via social media. He can specify the types of cloth he would like to have, including color, style, material and so forth. He can keep his digital identity with himself and update it as needed since the exact information about the clothes for every customer will be on a cloud manufacturing system. Then it will be visible for everyone to see who needs what type of cloth, with which characteristics and which size. As a result, it will be possible for everyone to manufacture clothes for others. The ultimate phase of social manufacturing makes it very easy and straightforward for customers to be potential manufacturers in the apparel industry. All in all, in this chapter, I have elaborated the applicability of the new value chain model in the apparel industry through three steps. In summary, the new value chain concerns a paradigm shift from current manufacturing to social manufacturing in the apparel industry.

5 Discussion

In this study, I suggest that the status quo in the present model of manufacturing has been disturbed, and the field is heading toward a mindset revolution. This shift is visible in various manufacturing industries.

I have noted that social manufacturing is not only a technological revolution but also a social and economic transformation to retune production for the needs of human societies. In this study, I have shown that social manufacturing addresses different targets and various disciplines. I have focused on the development of a social manufacturing model and its application in the apparel industry. Meanwhile, scholars and researchers have started to explore the applications of social manufacturing in different industries. For instance, in the food industry, Lvert et al. (2014) investigate the sales and operations (S&OP) of four Scandinavian food producers and conclude that food manufacturers can improve their S&OP by adopting a consumer-driven model, which is supported by the notion of social manufacturing. In the software business, Kenandy, a cloud software company, has initiated a cloud-based enterprise resource planning (ERP) platform for modern global enterprises. This software aims to reshape the world of industrial manufacturing into the new world of social manufacturing (Takahashi, 2011). Sandra Kurtzig, CEO of Kenandy, describes this initiative as follows: "By building the core manufacturing applications on a social platform, we're providing the structure to use the new tools of social media and collaboration for greater efficiencies in global supply chain networks." In the energy industry, Solar City is offering customized solar energy solutions to its customers. These services include the installation of rooftop solar panels, maintenance, monitoring, the financing of solar PVs (photovoltaic), and sales of PVs. This has enabled the customers of Solar City to become producers of energy with their PVs (Solarcity, 2014).

According to my literature review and the model I introduced in Chapter 3, I envision that the industries mentioned below can be affected by social manufacturing at different times. The basic purpose of this timeline graph is to identify the minimum requirements for introducing the idea of social manufacturing in each industry. For example, social manufacturing will probably affect the apparel industry or advanced manufacturing

more quickly than the energy industry or food industry. This time difference stems from the fact that in the energy industry and food industry, there are many technical and social barriers that would impede social manufacturing. However, specifying these barriers falls outside the scope of this master's thesis. Accordingly, within the SoMa project to be conducted at Aalto, my colleagues and I will study these barriers in more detail. The time division (i.e., one to four years or four to eight years) is only speculative at this stage, and the numbers are not yet fixed. I used these numbers because I merely wanted to show what I meant by short-term, medium-term, and long-term horizons. The apparel industry and advanced manufacturing are more easily influenced by social manufacturing. These industries are already fairly mass-customized. Conversely, the energy industry, healthcare, and the food industry are currently managed in a very centralized fashion, which means that a long time will be needed to implement social manufacturing. For example, in the energy industry, one opportunity to apply social manufacturing is using distributed energy resources (DERs) in renewable resources such as solar energy or wind energy (Hoffmann, 2012). Nonetheless, the energy industry is strictly regulated. In addition, it is not currently financially or technically feasible to democratize manufacturing in the energy industry (Hoffmann, 2012). The same story applies to healthcare and the food industry. Finally, in the long-term horizon, I envision that social manufacturing will take place in a grand landscape. Social manufacturing will ultimately influence smart houses, smart workplaces, and smart cities, while it has already begun to influence other industries (Letaifa, 2015). In this stage, we will observe the ultimate phase of social manufacturing.

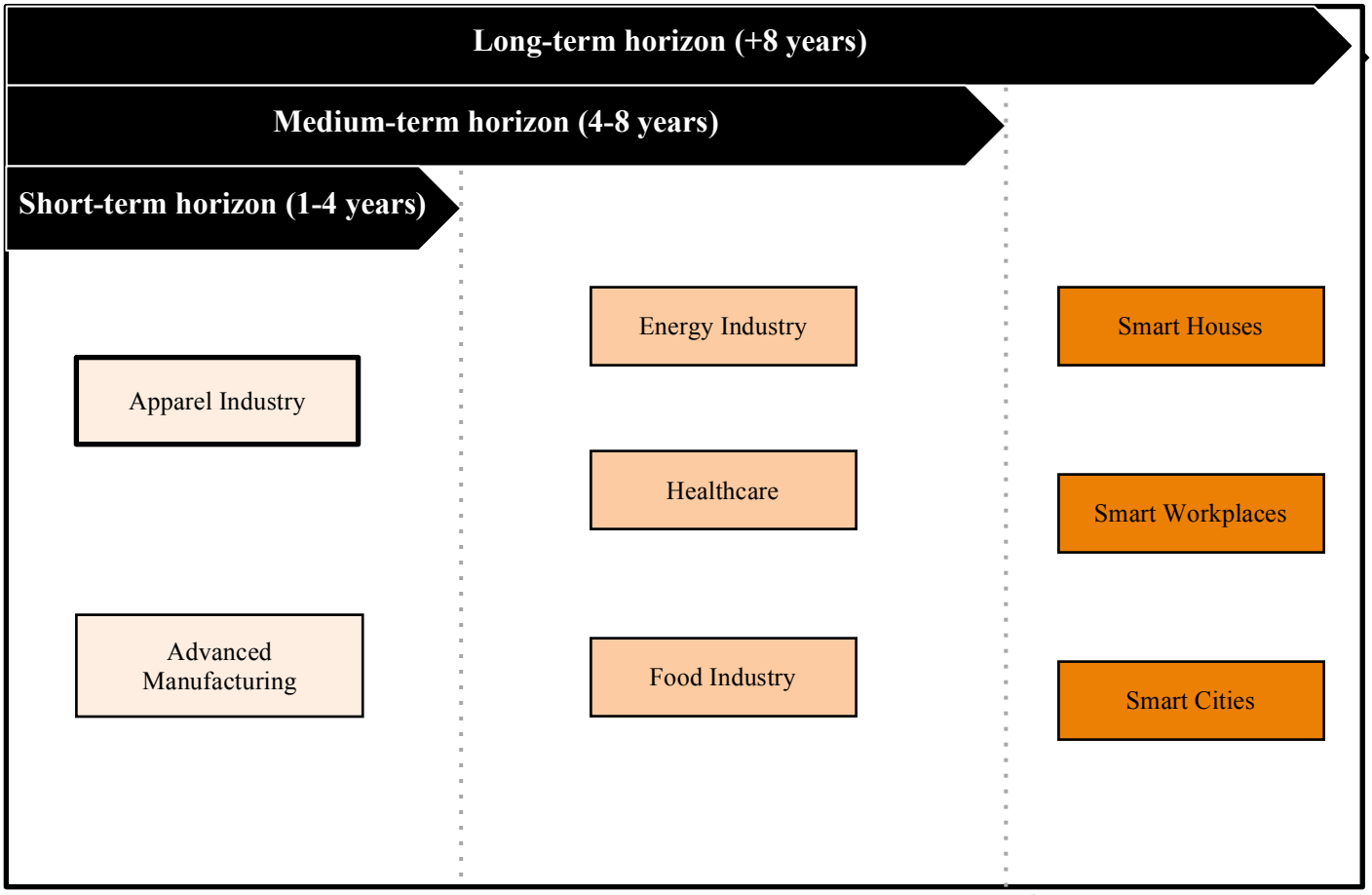


Figure 19: The effect of social manufacturing on different industries (with probable time frames).

In this study, I have suggested that social manufacturing might alter the current manufacturing paradigm. However, there are scenarios in which social manufacturing will face problems and obstacles along the way. I will now present these scenarios and perform a risk management analysis for each of them. More specifically, the risk of each scenario can be divided into two dimensions, "magnitude" and "probability". Magnitude refers to the effect that this scenario could have on the entire system, if realized. Probability refers to the likelihood that the risk will occur.

In the first scenario, manufacturers resist adopting social manufacturing. The term "manufacturer" here includes all suppliers, original equipment manufacturers (OEMs), contractors, and all players on the production side of the supply chain. The magnitude of this risk is huge because it can completely halt the shift toward social manufacturing. I

believe that this risk has a high probability. The reasons for manufacturers to resist social manufacturing relate to the fact that it may limit their influence over the supply chain. Even large manufacturers have to share their information and competencies with other players in the production process, and their short-term profitability may thus decline. For the companies that currently enjoy dominance or even a monopoly in their business, this change would be particularly painful. However, I consider that this risk will gradually be mitigated when new models of crowdsourcing and digital manufacturing are developed. In the long run, I believe that the benefits of social manufacturing will outweigh the short-term losses, and manufacturers will, in turn, acclimatize to this new system.

In the second scenario, customers become reluctant to participate in co-creation with manufacturers. The magnitude of this scenario is huge, as it might cause the entire social manufacturing ecosystem to break down. However, I assume that its probability is low. In the future, customers will continue sharing their ideas with manufacturers with greater interest. The importance of social networking and social recognition can amplify this sharing process. Furthermore, the success that crowdsourcing and open innovation models have already had will assist in attracting more customers to the co-creation process and also legitimize that process.

In the third scenario, the manufacturing field faces legal barriers, particularly relating to IPR, as social manufacturing has the potential to democratize counterfeit products. Furthermore, some nations may protect their national brands by imposing rules that may potentially prevent the dissemination of social manufacturing. Social manufacturing can minimize the perceived quality gap between national brands and retail brands, as the customers co-create in both brands from beginning to end. Moreover, global manufacturers might face practical issues, such as how to manage production taxes, as their products are designed, produced, marketed, and sold globally. Hence, this issue might lead to the modification of global trade rules and a uniform international tax system in the future. This scenario has a moderate magnitude but a relatively low probability. I support this assumption with the previous success of open-source regulations and the global tenacity with which the manufacturing business has been liberalized. This trend may indicate that the legal barriers to social manufacturing will be resolved in the near future.

These three scenarios are illustrated in Figure 20.

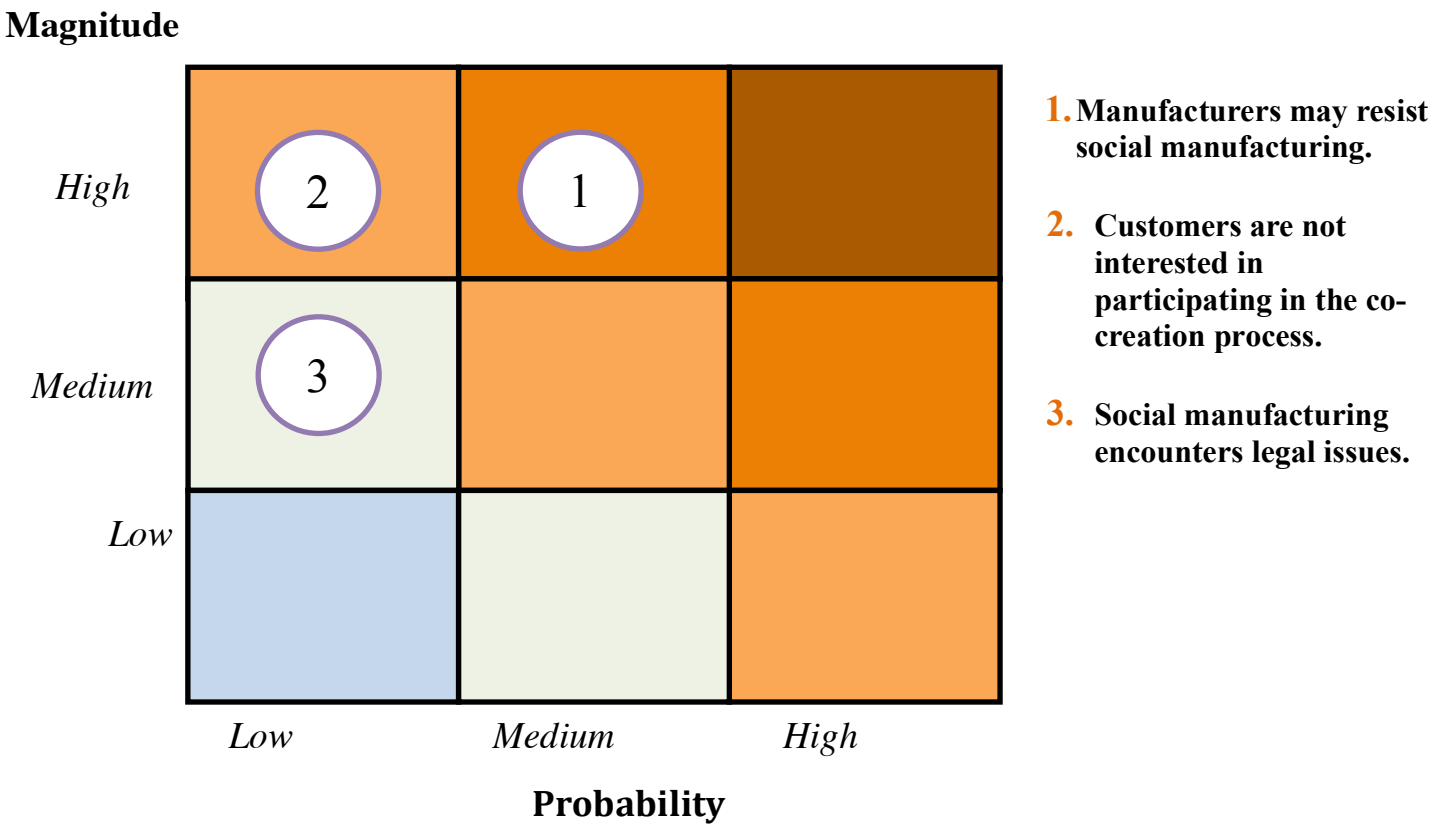


Figure 20: Risk analysis of the major obstacles that social manufacturing faces

There are other scenarios that might present barriers to the adoption of social manufacturing. I have already mentioned that social manufacturing represents a paradigm shift, which means it calls for a drastic reconfiguration of the entire current manufacturing ecosystem. Nonetheless, I see that the first steps toward this change have already been taken.

From a long-term economic perspective, social manufacturing may negatively affect outsourcing and off-shoring policies. New manufacturing techniques reduce the amount of work needed for production. As a result, reducing freight costs may become a more important factor than cheap labor costs. Instead of manufacturing products in developing countries, it could be cheaper and faster to produce locally. Therefore, the manufacturers may prefer to avoid extra shipping costs and build their manufacturing companies near their customers' market. This strategy would also improve the market responsiveness of

the manufacturers. Hence, the future may bring a new wave of localization that can occur globally or in certain clusters.

Another trend that may make localization strategies more popular is the digitization of manufacturing. New technologies (e.g., 3D printing, easy-to-use robots, and new collaborative manufacturing services) make the production of fewer products as economical as mass production. Manufacturing is moving toward more flexible production with much less labor input (The Economist, 2012).

Overall, I expect that future manufacturing strategies will embrace the mantra, “Think Globally, Act Locally”.

6 Conclusion

As Feiyue Wang (2012) has urged, the academic community should immediately start large-scale research and development in the field of social manufacturing. This study responds to this call. In sum, in this study, I first looked at ongoing manufacturing trends to create a general understanding of the present situation. On the basis of this understanding, I then constructed a model concerning the paradigm shift from current manufacturing to social manufacturing. In doing so, I contributed to the theoretical and managerial fields.

6.1 Main findings and theoretical contributions

This study investigated the concept of social manufacturing as a paradigm shift in manufacturing. Because of the novelty of social manufacturing, I chose a constructive methodology. The concept of social manufacturing was studied through a comprehensive literature review, which included material from the latest online resources.

The main contribution of this study is the creation of a model concerning the paradigm shift from current manufacturing to social manufacturing. This model helps readers to understand the characteristics of social manufacturing. This study unraveled two phases of social manufacturing.

Previous authors (see, for example: Wang, 2012; Xiong et al., 2014; Shang et al., 2013; Mohajeri et al., 2014) have paid considerable attention to the first phase of social manufacturing in which the manufacturing companies still control the manufacturing process. In this study, I elaborated on those studies and explained the second phase of social manufacturing, in which individuals become empowered to control the entire manufacturing process. This categorization brings a novel approach compared to the previous studies of social manufacturing. I examined how these two phases could be applied in the apparel industry (as an example). In the discussion chapter, I then

concluded my analysis by identifying opportunities for and threats to social manufacturing.

From a strategic management perspective, this study contributes as follows. Rumelt (2011) articulated that a good strategy usually has a specific structure, which he called "the kernel". The kernel consists of three elements. First, management can simplify complicated situations through dedicated analysis of the key issues presented by problems or challenges. Second, leaders can establish a policy to overcome these obstacles. Lastly, leaders must design a set of coherent actions that are coordinated with one another in accordance with the guiding policy. In this master's thesis, I covered the two first elements. I analyzed the concept of social manufacturing and suggested a model concerning the paradigm shift from the current model of manufacturing to social manufacturing. These two elements provide a direction for the implementation of social manufacturing, which would include the development of the third element in future.

6.2 Managerial implications

The major managerial implication of this study is instilling a sense of urgency about making the transition from the current manufacturing paradigm to a social manufacturing paradigm. I have introduced a model that helps managers to conduct their strategies to transform their model from current manufacturing to social manufacturing. I examined this model in the apparel industry and also included brief predictions for other industries. I explained two phases of social manufacturing: the intermediary and ultimate phases of social manufacturing. In the intermediary phase of social manufacturing, a corporate manufacturer becomes involved in dynamic co-creation with its customers and involves them in the entire value chain. In this phase, the manufacturing company owns the platform. In the ultimate phase of social manufacturing, on the other hand, the whole public owns the manufacturing platform. Manufacturing assets and intelligence are shared by means of a cloud and everyone can interact with the cloud according to his needs. This will lead to the creation of an on-demand manufacturing model.

Academic researchers and business managers share the view that manufacturing will make a complete shift from product orientation to customer orientation in the future. This anticipated change is based on rapidly evolving technology and increasing social networking. Feiyue Wang (2012) anticipated distinctive dimensions within this development. Future products will be freely variable, which means that customizing each product will not cost more than mass-producing it. The level of complexity will also be free, meaning that detailed and complex products with many components will be 3D printed as cheaply as producing a simple block of plastic. Furthermore, the level of flexibility will be free, which means that changing a product after the production has begun will be accomplished through a few tweaks to the system.

Within my study, I have highlighted how social manufacturing can help companies to align their manufacturing strategies with future manufacturing visions, as envisioned by Wang. I suggest that the new trend of the sharing economy will affect the manufacturing industry, and companies will move their production from the factory floor into their customers' homes. This shift means that in the future, manufacturers will not have to concentrate as much on capital expenditure (CAPEX); they should instead pay more attention to including customers in the entire manufacturing process. I have described how some companies have already changed their business models to incorporate such customer engagement. However, I assume that the manufacturing community is generally still unaware of the full potential of crowdsourcing in the process of "making the idea into a product". It is highly probable that many manufacturers doubt that social manufacturing will eventually pay off. Manufacturing managers might be too busy with other concerns, such as improving production planning and operational management; hence, they may consider social manufacturing a distraction from their work.

In addition, social manufacturing can substantially increase the number of entrepreneurs in the future because every customer can potentially be a micro-entrepreneur when given access to information disseminated via a distributed social manufacturing system. Thus, it is worth studying how social manufacturing will influence the world of entrepreneurship.

7 Limitations

This study has considered a new subject in the manufacturing field. Because of the lack of available data and the broadness of the topic, I have concentrated on the conceptual development without presenting any empirical results. In addition, I have focused only on the apparel industry in developing my propositions. These limitations arise from the fact that social manufacturing is not yet practiced on a large scale. Consequently, its real effects and characteristics can only be examined in the future. Accordingly, it will only be later that researchers will be able to conduct the necessary empirical studies to test the propositions of this study with real cases. It will also be important to analyze other industries in addition to the apparel industry for a better understanding of the full effect of social manufacturing. Other mechanisms should be used in addition to value chain analysis in order properly to judge the benefits of social manufacturing. The risks and opportunities involved in social manufacturing should be analyzed thoroughly and be quantified through case studies. The cost benefits of social manufacturing in different industries should be analyzed and acted on accordingly. The Cyber, Physical, and Social (CPSS) requirements of social manufacturing should be analyzed in general and in different industries in practice. Changes in regulation and policies that are needed in order to realize social manufacturing should be identified and analyzed. The benefits of social manufacturing for different stakeholders (e.g., manufacturers and customers) should be studied. Finally, solutions that enable the two phases of social manufacturing in society to be reached should be studied and implemented.

8 Future research

I suggest new avenues for future research regarding social manufacturing in different areas and disciplines.

Logistics and supply chain

- How can social manufacturing affect logistics and operational management in the future?
- How will social manufacturing improve the agility of supply chain management?
- What modifications to the supply chain are needed to improve the cost benefits of social manufacturing?

Law and order

- How can social manufacturing affect IPR and ownership rights?
- Which rules and policies should be modified in different industries to provide an ideal ecosystem for implementing social manufacturing?
- What are the legal threats posed by social manufacturing?

Strategic management

- How might social manufacturing influence corporate governance?
- How can social manufacturing be linked with entrepreneurial practices?
- How can social manufacturing change the manufacturing business structure, including the relationships between suppliers, manufacturers, distributors, and customers?
- How might the CEO's, team's, and employees' cognition influence the adoption of social manufacturing inside an organization?

Industrial evolution

- Which industries will social manufacturing affect most?
- How can social manufacturing affect different industries' life cycle?

Sustainability

- How can social manufacturing affect sustainability?
- How can social manufacturing assist cleaner production initiatives?

These questions only represent the tip of the iceberg in terms of what must be researched. Social manufacturing is a new phenomenon and a paradigm shift that inspires a wide range of topics.

All in all, social manufacturing appears to be a promising venture that will expand current manufacturing beyond its current characteristics. Technology already provides the tools for entering the era of social manufacturing. Social manufacturing will create a dynamic co-creation environment and benefit all the people in society. Eventually, social manufacturing will help to improve democracy around the world. As I have discussed in this study, social manufacturing is still a long way off. However, a journey of a thousand miles begins with a single step. Steps toward social manufacturing have already been taken, and I believe this study and other studies will shed light on the path toward social manufacturing.

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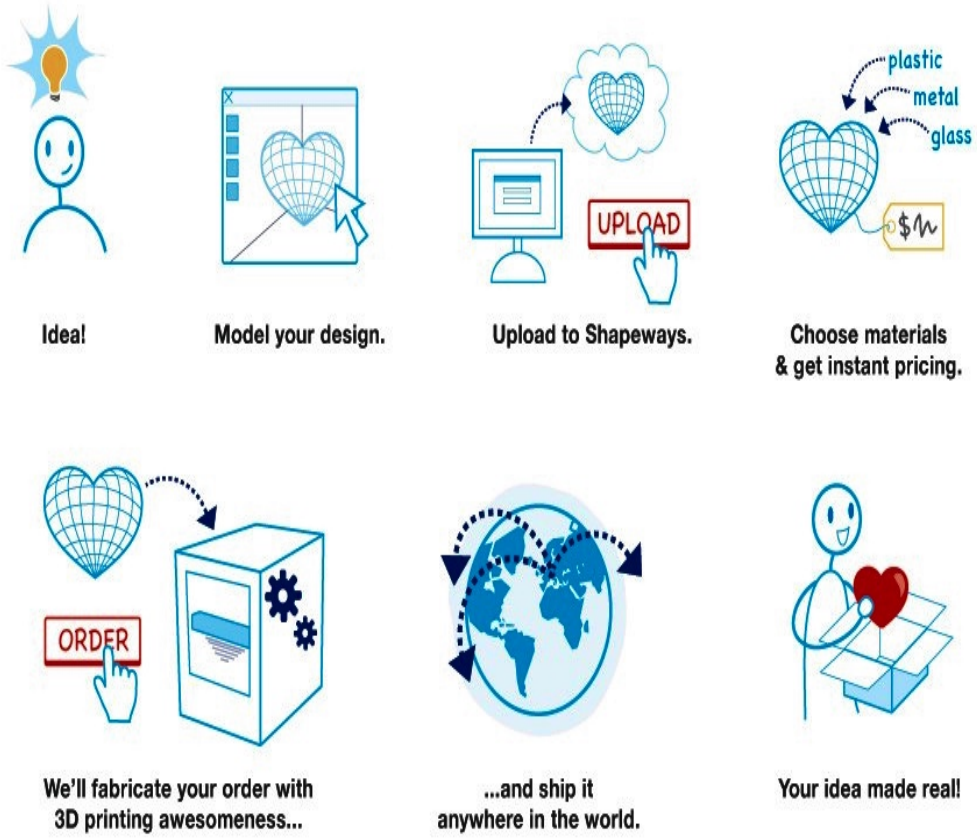
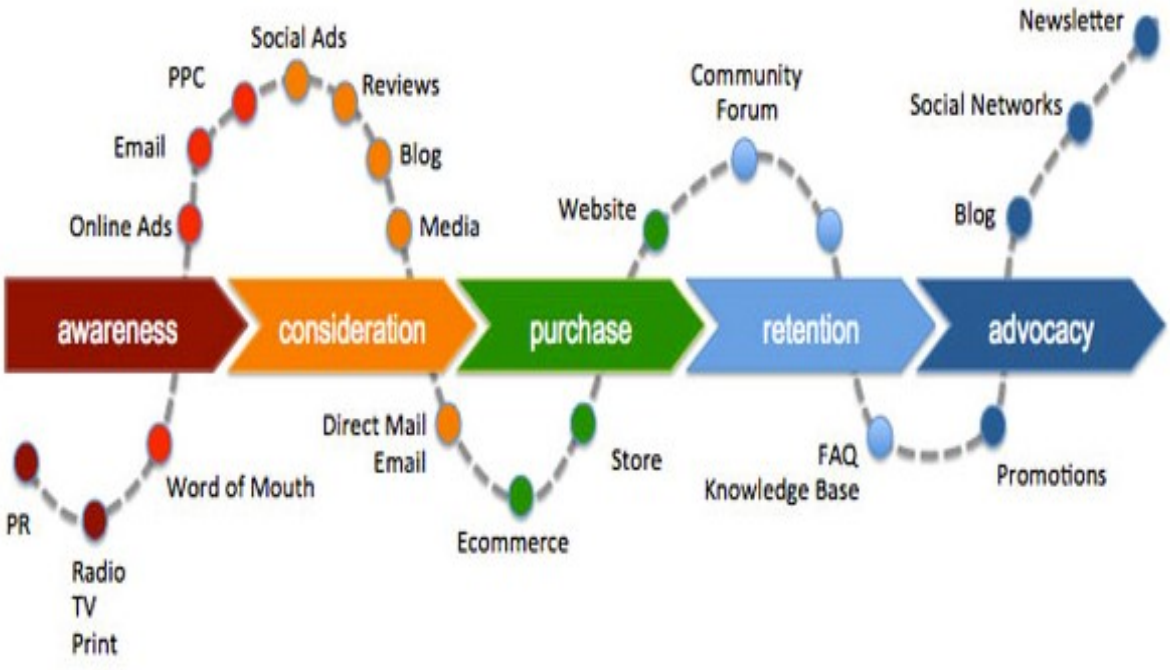
10 Appendices



Appendix 1: How Shapeways transforms an idea into a product (Shapeways, 2014)

Appendix 2: Quirky's pipeline visualizes a timeline for any idea from its birth until its realization. A tag or picture symbolizes each idea. If the idea completes a particular stage (e.g., design or prototype), its picture will be moved from that step and to the next. This process occurs for all offers that come to the company. In this way, Quirky can monitor its ideas as they are created and develop.

Appendix 3: Apple Watch view (digitaltrends.com)



Appendix 4: A schematic customer journey (Gary, 2013). This picture visualizes the steps that a customer takes during the purchasing process.