

Digital transformation of the textile process chain – state-of-the-art

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ABSTRACT

New digital technologies, the internet age, and ever-increasing customer expectations are changing industries worldwide. Companies in the apparel industry must digitally transform to remain competitive. Traditional approaches will no longer work in the face of change because digital transformation is inevitable, irreversible, enormously fast, and unfortunately marked by challenges in implementation and uncertainties in execution. However, it also brings many benefits for which it is worth striving for the complete digitization of the value chain. This research paper aims to clarify the benefits and challenges companies face in digital transformation. For this purpose, it shows a report on the current state of digitalization in the apparel industry. The article ends with an approach on the implementation of digitization in the apparel companies.

Keywords

digital transformation,
digitalization,
apparel industry,
new technologies

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1 Introduction

The digital transformation caused by advanced information technology and the globalization through the internet has affected all industries, including the apparel industry. The ever-increasing technological possibilities have not only driven the digital transformation of apparel companies, they have made it a necessity. Digitization can enable apparel companies to progressively improve performance. The challenging situation created by COVID 19 has also shown that there is an urgent need for digitization in the garment industry worldwide. The pandemic is therefore often seen as a driving factor of digital transformation. Accordingly, the transformation process from analog to digital processes has been accelerated enormously since that.

This paper will examine digital transformation in more detail. What are the characteristics, advantages and the enabling technologies? It will also analyze the current state of digitalization in apparel industry and highlight the potential opportunities and challenges for the value chain. A recommended course of action on how companies can embrace digital transformation will be outlined in the end.

2 Digital Transformation

Before delving deeper into the extent to which the apparel industry is digitally transformed, the term digital transformation must first be clarified. Since the phenomenon of “digital transformation” is comparatively new, there is not yet a generally applicable definition. “Digitization” and the “Digital Age” are often used as synonyms. The PWC definition will serve as the basis for this paper and states as follows: “Digital transformation describes the fundamental change of the entire corporate world through the establishment of new technologies based on the internet with fundamental effects on the entire society.” [1]. The digital transformation is thus not only profoundly changing our economy, but also society. Therefore, a distinction can be made between macro and micro levels in the transformation processes. The macro level implies the company as an individual player in the market. The micro level is described by the authors G. Oswald and H. Krcmar with the following four characteristics, which are characteristic of the digital transformation processes: inevitable, irreversible, tremendous speed and uncertainty in execution. These four characteristics state clearly that digital transformation is a process in economy and society that is unstoppable. Companies consequently need a strategy and digital agenda to maintain or even prosper in competition. Within this context, companies are supported in this transformation by enablers such as digital data, automation, digital customer access and networking [2].

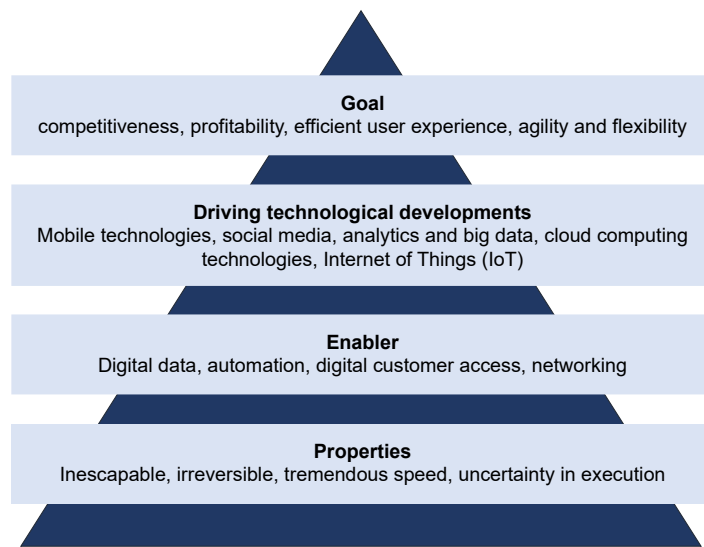


Fig. 1: Digital Transformation – goal, driving technological developments, enabler, properties (own illustration based on [2]).

3 Analysis of the current state of the apparel industry

The Corona pandemic has accelerated the digitization of the apparel industry, as the lockdown has clearly forced companies to embrace and utilize new technologies. As a result, the benefits of new digital technologies were finally brought to the attention of companies and companies continue to engage with them. Online shops in particular for example were enabler to ensure that businesses continued to generate revenue despite social isolation.

Through online channels such as social media, fashion businesses were able to engage with customers through livestreaming, video chats or digital fashion shows. This rethinking of customer interaction was imperative, as consumer behavior and demands have changed dramatically in recent years. Consumers are more active, want to interact with clothing companies and influence the products. They now predominantly use digital channels to buy products. Trend setting in particular is undergoing a

transformation and relies on flexible processes. In the past, trends were set through advertising campaigns by clothing companies. This means there was more lead time for the production of the clothing. Social media have altered this “push” model. Trends “pop up” through social platforms such as Instagram, TikTok or YouTube and are particularly influenced by individuals such as celebrities or influencers. Furthermore, the trend is evolving from mass delivery towards personalization and sustainability. The value of information, data and analysis is therefore increasing. Only through data-driven insights, companies are able to meet these new customer demands [3].

This development requires digital solutions within the entire value chain. However, only a few fashion companies have fully digitized their value chain, from planning to the customer. “Many fashion brands take a fragmented approach to digital transformation, focusing on digitizing singular process steps or isolated functions. Digital transformation is often restricted to individual programmers or projects that affect only a small number of departments.” [4]. In Germany, this is also made clear once again by the Digitalization Index 2020 of the German Federal Ministry for Economic Affairs and Energy. The index indicates the status quo and the development of the digitalization of economy in Germany and compares different sectors. The most advanced sector is the information and communication sector with 273.0 index points or 273 percent of the sector average. Other manufacturing, including production of textiles, is less digitized, with only 66.7 index points [5].

“The whole of this end-to-end transformation is greater than the sum of its parts” [6].

It is important to digitize every step in the value chain because individual areas can complement and support each other. This is one key factor to success. For example, a 3D simulation of a garment can be used during the product development and subsequently as a 3D visualization of clothing, it can be used for product presentation in e-commerce and thus have a cross-process benefit. Increasing efficiency through digital processes at only one stage of the value chain alone will not significantly contribute to improvement. Only if there is sufficient linkage and interaction with the entire value chain, companies can benefit from digital transformation [6].



Fig. 2: Value chain.

Even within the garment industry, the level of digitization has only been classified as mediocre for a long time. Hans-Peter Hiemer, Managing Director of Assyst GmbH, sees 3D technology in the context of a 5-step model on the middle level of maturity. One level below, he sees the integration of 3D technologies within fashion brands.

The area of 3D simulation and virtualization is currently in the focus for many brands. Many companies are developing small collections exclusively digitally as part of pilot projects. Thus, computer-aided product development with three-dimensional visualizations is at the top of the agenda for many fashion brands when it comes to the topic of digital transformation. There are already some experiences and learnings of pioneers from which industry can benefit [7].

But fashion brands are not only focusing on the digitalization of the product development process, but also on the digitalization regarding the whole sale experience including customer interaction. Tommy Hilfiger, e.g., launched their digital showroom in 2015 [8]. In 2020, the PHV Group explained how their star-ups connect the digital product development process with the digital sales process. Also OLYMP launched their digital showroom in 2021, including 3D Styles [9].

As mentioned before, online shops contributed to business during corona pandemic significantly. In this context, customers are expected to also demand for individualized shopping experience. The technology “PICTOFIT” allows companies to bring the in-shop experience into their online shop. The customer is now able to virtually fit the whole product range of the company [10,11]. Integrating such technology into

online shops enables customers to digitally interact with products and it also can help to increase revenue [12].

Thus fashion industry becomes more digital every day, but the main challenge still is to integrate different technologies into a seamlessly connected, entirely transparent value chain [13]. A remedy is provided by PLM-Systems (product lifecycle management), which allows to digitally connect nearly all steps of the supply chain [14]. But often there are interfacing issues, companies struggle with. This makes it difficult to transform the supply chain [15].

In a study of the Foresight project “Perspectives 2035”, the Institute for Innovation and Technology comes to the following conclusion: “By the mid-2020s, experts expect a strongly accelerating spread of digital processes along the entire textile process chain. [...] Accordingly, around 80 percent of textile production could be automated by 2025.” [16]. Another conclusion of the study refers to the period between the years 2030 to 2035, where the remaining automation gaps are to be closed. The reason for this is the reduction of investment costs for digital key technologies [16].

4 Benefits and challenges of the digital transformation in the apparel industry

In the previous chapters, it became clear that there are still significant gaps in the apparel industry with regard to the digitization of the process chain. What advantages and challenges does the apparel industry face within the digital transformation?

4.1 Benefits

According to the Boston Consulting Group, end-to-end digital transformation can shorten the timeline by 40%. 3D-Simulation of textile products, for example, can shorten the cycle time for design and prototyping and greatly simplify the process that was previously based on physical samples. The software company CLO3D states that 3D simulation of apparel can reduce sample lead time from 37 days to 27 hours [6,17]. The shortened time to market enables companies to generate competitive advantages and respond significantly to fast-changing trends [18].

Digitalization also leads to benefits during the product development process. By collecting, processing and analyzing digital data, better predictions and decisions can be made [19]. Additionally, 3D helps to gain more flexibility for the designers. It is easy to change color, fabrics, prints or the patterns, without sewing any physical prototype [20,21]. This also creates security in the product development process. The designer is now able to send a digital prototype to the supplier, which can have an interactive look to the garments. The manufacturers can respond faster and more efficiently to potential manufacturing errors, or even avoid them through predictive maintenance [15,22,23].

Moreover, digitalization changes the entire supply chain from an isolated step-by-step process into a connected, integrated, and fully transparent process for all actors. With transforming the supply chain, the processes will be more stable and less susceptible to errors [13].

The supply chain is not only more integrated, but also digital processes such as 3D simulation and 3D visualization make it possible to increase sustainability within the supply chain. Through digital samples, changes can be made directly to the prototype. Thus, no new patterns have to be sewn, but can be changed at the click of a mouse. Physical models can thus be significantly reduced or even eliminated [22,24,25].

Furthermore, through digitalization a decentralized work organization can be established; designers and product developers no longer have to travel to factories or fly in physical samples [22]. Everyone involved in the product development process is able to have a look to the samples from their office or home office [26]. Also using the digital samples in a digital showroom or with a virtual fit app makes it possible for the customer to place orders in the comfort of the office or home office as well [10,27].

Looking at other industries, a further urge of customers is becoming clear. Customers are demanding for more individualized products. This, for example, can be seen in the automotive industry. But also in

fashion industry, customers increasingly demand for individualized products [15]. By changing existing processes and approaches to digital manufacturing, individual customer requirements can be realized in the future [28,29]. Digital transformation thus leads to better integration of the individual steps of the value chain and satisfies the demand for individualization, providing new opportunities to interact with the customer during the process.

4.2 Challenges

The benefits make it clear why it is worth digitizing the supply chain and the associated processes. Nevertheless, digital transformation faces challenges that need to be overcome.

One of the key factors in digital transformation is the employees [30]. Philippe Ribera explains that transforming the product development process into a digital process is a "... fundamental shift in the mindset ..." [31].

The first thing to do here is to create a culture of digital transformation within the company [23]. This is the most important aspect to raise the desire for digitization within the company. In retrospect for many years, work was dominated by hands on and analogous processes [32] such as design, physical sampling, on-site meetings, physical salesmen samples. Now these processes need to be broken up, changed, and transformed for the digital future [32]. This means not only winning over employees for digital transformation, but also aligning management behavior within the company with digital transformation [27,30]. Digital transformation begins from the top of the management and should include all employees and processes [13].

It is important to establish a specific vision in the minds of all employees. Having only a vague vision of the transformed company will lead to inefficiency, mental barriers and the teams will not support the digital transformation [6]. Companies must also keep their corporate values and goals in mind during the digital transformation and consider whether corporate values are in line with the desired digital transformation or whether it needs to be adapted again [4].

Another challenge regarding the digitalization in the fashion industry is the emotional connection to the now digital samples or products. The emotionality and haptic of the product have still to be top goals in all stages of the supply chain and development process. This holds for designers as well as customers.

Deloitte names the isolated digital transformation as one of the challenges for fashion companies. As mentioned before one benefit is the transformation from an isolated step-by-step supply chain into an integrated and connected one. But therefore companies have to integrate all steps of the supply chain during the digital transformation and not focus only on singular areas [4,6]. A holistic approach to digital transformation means that silo investments can be avoided [33]. If we consider these statements, the digital transformation of value chain is also referred to as a transformation of the business model. Physical samples will be digital. Processes will be altered into software based processes and communication channels will be more digital [19]. Existing business models, which are successful at the moment, will become obsolete due to digital transformation [34].

The Boston Consulting Group mentions that digitalization should focus on long-term goals [6]. Digitalization causes costs – buying software (possibly annual service fees), training of the employees, investing time to find the right software and change the current processes. Focusing on short-term savings will lead to digital transformation not being established in the company at all, or only in small parts. Phillip Tettrou, VP Digital Creation at Adidas Shanghai, explains "First, digital transformation is a multiyear journey ..." [6].

A different challenge are the uncertainties that digitization brings with it. In addition to the short and long-term investments, there is also data security and the loss of brand identity [4,35]. Digital transformation also involves risks in data security. It is necessary to build up knowledge, make investments and analyze, evaluate, and transform the security structure of companies with respect to digitalization of the supply chain. It may seem unimportant, but data security begins with the sensitization of employees to passwords and firewalls as well as social engineering [35].

5 An approach to successful digital transformation

This section is intended to show an approach to implementing a digital process in a company. The literature gives different approaches to the digital transformation of a company. Esser, for example, shows a five-stage plan comprising analysis, development, and transformation [1,36]. PWC uses a six-phase model as the basis for a successful digital transformation. The first step is to determine the current position of the company, followed by the creation of a roadmap for the transformation. This is followed by the development and implementation of a business platform [1,37]. Finally, the new business models are operated, and continuous optimization is carried out through accompanying monitoring. In 2015, Roland Berger Strategy Consultants GmbH presented an approach consisting of three steps: analysis of the impact of digital technologies on the industry, comparison with the current position of the own company, development of an implementation map [1,38].

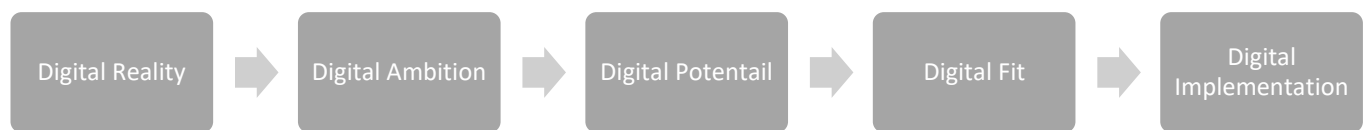


Fig. 3: Roadmap for the digital transformation (own illustration based on [1]).

Schallmo et al. use these approaches to develop a roadmap for the digital transformation of business models, which is used as the basis for the proposal in this article [1]. The authors divide the digital transformation into 5 steps: digital reality, digital ambition, digital potential, digital fit, and digital implementation. In the following, these 5 steps are briefly explained. For the scope of this article, the 5 stages of Schallmo et al. will be broken down and presented to the value chain of the company.

5.1 Digital Reality

Digital reality relates to the analysis of the existing business model, whereby the various dimensions of the business model are analyzed. Schallmo et al. name different dimensions of the business model that need to be analyzed. Broken down to the value chain of fashion companies, the areas are shown in Figure 2 should be analyzed [1].

The question to be answered is which steps are present in the value chain of the company and which actors are involved in these steps. The aim is to outline the current value chain including the actors. Within this step, digitalization is to be determined within the individual steps.

For the fashion industry, digital ingredients, digital fabrics, surfaces, or scans can represent possible digital steps in the value chain [39-42].

5.2 Digital Ambition

Digital ambition is concerned with setting goals and prioritizing digital transformation. Schallmo et al. base this on four categories: time, finance, space, and quality [1].

The aim of this step is to clearly define and prioritize the goals. For example, the following lines can be defined for the value chain in the fashion industry:

Time: e.g.: reduction of time to market by 40% and lead time for samples from 37 days to 27 hours; more efficient sales process through a digital showroom.

Finance: long-term reduction of costs using digital samples and digital fittings; cost reduction through a reduction in time to market increase in sales by creating an emotional and digital shopping experience

Space: indicates automation or networking in the value chain. Here, there are already the possibilities of digital area development by producers, or the scan of a textile area. There are also already manufacturers of ingredients who make them available digitally [39-42].

Quality: By clarifying production errors and difficulties in advance, both product and process quality can be significantly increased, and trend research can be more reliably carried out by collecting and analyzing customer data.

5.3 Digital Potentials

The digital potential phase is aimed at analyzing which potentials or best practice models could be considered as options for the future digital business model. In doing so, it is important not to limit oneself to one's own industry, but also to consider other industries and their problems, issues, results, and approaches. It should also be examined how these options can be used to shape the new digital business model. In addition to the potential, it is also important to examine how they can be implemented. Schallmo et al. cite digital data, automation, digital access to customers, and networking as enablers for digital transformation [1].

Looking at other industries suggests that better decisions can already be made in the development process. For example, the online giant Amazon suggests possible products for purchase based on the customer's order history. Applied to the fashion industry, this would mean that based on collected click rates, the analysis of social media trends, the analysis of sales data, etc., planning can already be supported more digitally. Based on the collected data, future trends can be estimated, and thus customer-oriented designs can be determined.

The design process can be supported by a 3D library, so new ideas can be realized by mouse clicks on digital prototypes. In addition, digital avatars can be used to check and, if necessary, adjust fits.

For production, there is for example the possibility of digital textile printers and automated cutting machines. The digital printer prints the fabric design or the designed pattern pieces directly onto the fabric. The automated cutting machine can locate the individually printed pattern pieces and identify the cutting lines using QR codes previously printed on the fabric. This allows the patterns to be cut fully automatically. Another approach is robotic technology in the future, it can be used in sewing production. Another production concept that is welcomed by the industry is additive manufacturing. 3D printing technologies are already established, especially among sports goods manufacturers in the footwear sector. In the future, accessories, ingredients and spare parts can be produced quickly and directly on site with 3D printers. The advantage of the additive manufacturing is to simplify the supply chain, this leads to fewer suppliers, lower inventory and transport costs and a faster delivery. Robot technology is still used very cautiously in the clothing industry, but in the future it can be applied in sewing production and increase efficiency enormously [43]. However, the future goal should be not only to create individual partial solutions but to transform the entire production chain into a holistic automated production line. Through IoT technologies, all manufacturing machines in production, such as printers, cutters, and sewing machines, can communicate with each other and network [44].

The PLM systems already described providing actors in the textile supply chain with the ability to digitally network with each other and automatically exchange data with each other. Plausibility checks in the systems can already exclude sources of error and create secure processes. This makes it possible to integrate the individual steps of the value chain.

Digital access to the customer can be created through the use of social media – Hugo Boss, for example, is relying on a famous influencer in its current campaign [45]. The approaches of OLYMP and PVH also show that the wholesale customer can and must be reached digitally. On the one hand, this creates a new sales experience, but it also means that the sales process can be made more efficient and transparent [9].

5.4 Digital Fit

The digital fit must be examined from company to company on a case-by-case basis. This involves evaluating the options listed in 5.1, 5.2, and 5.3 and determining different combinations from existing possibilities, which must be aligned with the existing objectives of the digital transformation of the value chain and the corporate objectives as well as the company's business model [1]. This step aims to ensure that the desired goals of the digital transformation, and the measures envisaged to achieve them, are in line with the company's values.

Questions that should be clarified in this part of the digital transformation are:

- How do the digital options fit into the current business model?
- What does the digital solution contribute to improving the value chain of your own company?
- Does the digital solution contribute to the achievement of the set goals? And how?

Regarding the objectives presented in 5.2 and the potentials in 5.3, it can be said for a company such as PVH that a digital showroom for wholesale certainly offers the opportunity to digitize the sales process and make it more efficient. However, if we look at a label like Zara, a digital showroom for wholesale would not offer any added value for the company. For this label, other options must be chosen for the business model, such as the virtual fit "PICOFIT" which was already explained in section 3.

If we take up the goal of reducing time to market and cost savings through digital sampling, the digital product development, and digital fit inspection presented in 5.3 contribute to the goals of digital transformation. Additionally, as mentioned in 4.1, it leads to designers being able to work much more creatively and quickly without slowing down the value chain, as samples can be changed much faster and at almost no cost.

Therefore, the chosen changes must be in line with the existing supply chain and business model.

5.5 Digital Implementation

This phase is the final phase of the 5-step plan according to Schallmo et al. [1]. The aim here is to finalize the new digital supply chain and implement it in the company's business model. In this step, it is determined at which point in the digital transformation the individual digital solutions are to be integrated into the value chain. It is examined which projects are necessary for this. The question of necessary knowledge and resources must also be conclusively clarified here [1].

A step-by-step plan must be generated that can ensure a successful digital transformation. The following steps of digital implementation emerged during the research for this article.

Step 1: Define strategy, specific goals, vision, and current problems. Digital transformation requires a profound shift in thinking throughout the organization. It requires a clear vision and concrete goals. The strategy, concrete goals, and vision can be derived from the results of the previous analysis of the company and its current position [6].

Step 2: Find partners with the necessary qualifications. IT expertise and infrastructure, for example, are particularly important for digital transformation [46]. Here, in particular, it is important to find external partners with experience as part of the digital transformation [6].

Step 3: Train employees and make knowledge available. Employees are crucial to the success of a company and also to digital transformation. Make information and knowledge available to your employees. Create a culture of digital transformation in your company [23].

Step 4: Cleanse data and create technological conditions. Data must be cleaned up and put into shape because it is the most important foundation of digital transformation. Analog information, such as old paper cutting patterns, must be cleanly digitized and prepared so that there is no loss of information [6].

Step 5: Start a pilot project. To begin with, it makes sense to start with a pilot project. In this way, initial experience and challenges in implementation can be gathered. In the best case, this is a project in which the entire value chain is digitized, not just parts of it [6].

Step 6: Redefinition of the strategy and rollout. The pilot project is a very important basic building block for the digital transformation, so the individual steps, successes, weaknesses, etc. must be recorded in detail in writing. The results from this project should be analyzed, improved, and redefined for further projects and the rollout to the entire company.

6 Conclusions

Digital transformation is no longer a topic for the future; it is one of the central components of the entire industry, including the fashion industry. Companies have to rethink; proven processes are no longer sufficient to meet the new challenges of the market. In addition to the industry, the customer is also undergoing a digital transformation. The smartphone is irreplaceable in today's world, making it one of the most important sales channels for companies.

This paper shows, on the one hand, the core of the digital transformation; on the other hand, it explains the current state of the fashion industry. It also makes clear that there are still some to-dos in the industry that need to be worked out. On the one hand, the benefits and challenges presented make it clear what potential there is for companies in the digital transformation of the entire value chain. In the last chapter, the article shows at a high level which steps companies can take to successfully implement the digital transformation of their value chain. The article does not provide a holistic approach to digital transformation but offers an overview of the possible steps for the digital transformation of the value chain.

Author Contributions

Nafz, R.: conceptualization, methodology, investigation, writing – original draft preparation; Schinle, C.: conceptualization, investigation, writing – original draft preparation; Kaiser, C.: writing – review and editing, Kyosev, Y. K.: writing – review and editing. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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