Università
Ca'Foscari
Venezia

Master's Degree Programme –
Second Cycle (D-M. 270/2004)
in Economia e Gestione delle Aziende,
Curriculum International Management

–
Ca' Foscari
Dorsoduro 3246
30123 Venezia

Final Thesis

Technological innovation as solution for the fashion e-commerce gap: 3D body scanners and smart measuring tapes for size optimization

Supervisor
Prof. Giovanni Vaia

Graduand
Alberto Bagarello
828252

Academic Year
2014/2015

Acknowledgement

I would like to thank my Supervisor, Professor Vaia, for guiding me in this thesis.

I would like to dedicate my thesis to all the people that have supported me during these years in which I attended the University and in particular in this last period in which I conducted this study.

I would like to deeply thank my girlfriend Camilla, my parents Francesca and Ivo, my grandparents Gianni, Lina, and Anna, and all of my friends, which gave me the support to go on through these years and which gave me the possibility to become the person I am today.

Abstract

The most important gap, that the world of apparel e-commerce still has to deal with, is the difficulty that customers face in taking their own measurements. This is a fundamental issue to solve both for users, in order to decrease the risk perceived in the the online buying experience, since they need to choose the right size and fit of garments, and for e-tailers, which have to deal with high return rates and low conversion rates. In a world in which online shopping is already widely spread and is growing faster year by year, this problem has been taken into consideration by several firms that, through technological innovation, are developing different solutions.

Index

List Of Figures

List Of Tables

Chapter 1: Introduction

Online shopping is a business in continuous growth all over the world; its value has reached 1.316 billion dollars in 2014 and is expected to reach 1.600 billion dollars in 2015.
According to Baeva (2011), driven by ease of transaction, widening markets and decreased overheads, e-commerce is increasingly viewed as a key business modality of the future for every type of entity, from governments to multinational companies to start-ups (Baeva, 2011).

In Italy apparel represents only the 2% of shopping online, in an industry in which the spare time (gaming, gambling, others) and tourism collect on their own the 79% of revenues from e-commerce (Casaleggio e associati, 2015). In U.S., in 2015, apparel e-commerce has represented the 17.2% of shopping online and has grown by the 14.9% with respect to 2014 (emarketer.com, 2015).
In terms of target, young people, in particular college students from 20 to 29 years, are, according to Baeva (2011) "the prime source of current and future growth in online sales", representing the most involved target and market for e-commerce (Baeva, 2011).

Comparing sales online with those offline, Hirt (2012) found that only 10% of clothes are sold through e-commerce with respect to other sectors like computers and books, in which online sales represents respectively 50% and 40% of the whole sales (Hirt, 2012).
It is clear that online shopping for apparel, though rapidly growing, still has a huge room for improvement. According to Song and Kim (2012), since apparel and accessories are experience goods, meaning that customers know their attributes only through direct experience, customers have to face a big limitation in buying them online, since they do not have any chance to interact with them and to know their attributes, like color, size, fit, design and fabric (Song, Kim, 2012).

Bhatnagar et al. (2000) state that apparel can be considered a high-risk product category, since feel and touch are extremely important when buying clothes, and that, for this reason, customers are uncertain in buying them on the web (Bhatnagar et al., 2000).

For customers these factors lead to a high degree of perceived risk, which has deep and

direct consequences on their willingness to buy clothing online. Without the possibility of trying clothes, customers often face uncertainty in purchasing apparel on the web (Park, 2002). These factors do not affect only customers, but have deep and direct consequences also on e-tailers. In fact customers' dissatisfaction and hesitancy in purchasing clothes online produce high abandonment rate of online transactions (Dai et al., 2014), low conversion rate and also high product return rates (Cordier et al., 2003).
As the survey of Samadi and Yaghoob-Nejadi reveals (2009), customers still feel unsatisfied and uncertain in online shopping and are still more comfortable with real shops and cable rooms (Samadi, Yaghoob-Nejadi, 2009).
This thesis aims at investigating and describing the solutions led by technological innovation, on the market at the moment, that are affecting and trying to solve one of the main issues of shopping online, the problem of size and fit faced by customers, with the aim to reach size optimization.
In chapter 2 we will describe e-commerce, in particular in the sector of apparel, analyzing its characteristics and components, and the issue of returns, which is one of the main problems e-tailers have to deal with. We will also analyze the concepts of fit and sizing and the actors of the market, which are important subjects for conducting our study. Chapter 3 will be a literature review in which we will highlight the theories connected to the topic that we will discuss in this thesis, like customer hesitancy and perceived risk; the review will proceed with the description of apparel choice criteria, with the analysis of the decision making process of customers, with the Technological Acceptance Model, and with the definition of the concept of technological innovation. In chapter 4 we will present some solutions that the apparel industry may adopt to help customers in choosing the right size, like the international standardization of sizes, the improvement of the elements of the product pages in e-commerce websites and Home Try On. In chapter 5 the analysis will go further into the solutions, aiming at size optimization through technological innovation, that the market present, like robot mannequins, systems based on algorithms, garment comparison and the digital tape; a deeper analysis will be made on 3D technology, with the study of the several solutions that are connected to and based on 3D body scanners, and we will see how this technology is permitting the establishment of mass customization. We will present also

some relevant case studies of firms which are developing or have already developed these solutions through technological innovation. Chapter 6 will be a discussion on the solutions presented in Chapter 5, in which the advantages and the limits of each solution will be highlighted; a final discussion will be dedicated to the topic of mass customization. In Chapter 7 we will conclude our discussion summarizing what has emerged in our study.

Chapter 2: E-Commerce

2.1 Introduction

E-commerce, which stands for Electronic Commerce, has been defined by Chaffey (2009) as the process of “electronically mediated information exchanges between an organization and its external stakeholders” (Chaffey, 2009). Golletz and Ogheden (2010) define e-commerce as the process of “selling and buying products or services over electronic system like the Internet, replacing physical business transactions with electronic business transactions” (Golletz and Ogheden, 2010).

Nowadays e-commerce has become a valid alternative to shopping in-store. More and more people purchase products and services online, instead of physical stores (Sarkar, 2011). This is mainly due to convenience in shopping online, having the possibility to consider a broader selection of alternatives and prices, and to save time, since by shopping online people can do everything on their devices, in any place they want (Bhatnagar et al., 2000).

E-commerce is so widely spread that in 2013 has counted the 1.34% of the Global Gross Domestic Product, with an increase of 23.6% with respect to the previous year. In the same year the region with the higher turnover for B2C e-commerce was Asia-Pacific region (567.3 billion dollars), followed by Europe (482.3 billion dollars) and North America with a turnover of 452.4 billion dollars (Ecommerce Fundation, 2015).

By the point of view of customers, the main advantages of e-commerce are that it offers to customers a wider selection and variety of products and convenience in terms of cost and time saving (Golletz, Ogheden, 2010). Also according to Bhatnagar et al. (2000), purchasing online gives customers the advantage of saving money and time. In fact through e-commerce the time to buy products is reduced both directly and indirectly (Bhatnagar et al., 2000). Other advantages of shopping online with respect to shopping in-store are 24/7 accessibility, consistency in the service, and a wider variety in the choice of products (Lim, 2009). From the e-tailers' point of view, according to (Golletz, Ogheden, 2010), e-commerce gives them “the possibility to fulfill demand for products, services and information of each customer individually” and also the opportunity to connect their business to customers, vendors, suppliers and employees all over the world (Golletz, Ogheden, 2010).

2.2 Web Experience

Baeva (2011) defines web experience as a bundle of elements “like searching, browsing, finding, selecting, comparing and evaluating information as well as interacting and transacting with the online firm. The virtual customer’s total impression and actions are influenced by design, events, emotions, atmosphere and other elements experienced during interaction with a given web site, elements meant to induce customer goodwill and affect the final outcome of the online interaction”. Constantinides (2004) defines web experience as “a combination of online functionality, information, emotions, cues, stimuli and products/services, in other words a complex mix of elements going beyond the 4Ps of the traditional marketing mix”.

From these definitions we can understand how the customer that wants to purchase clothes online is influenced not only by products, brands, etc. but also by the elements that compose an e-commerce website; starting from structural factors of the website, through the steps that lead to the end of the transaction in a simple, secure and efficient way, to more emotional factors related to the good design of a website, that give positive feelings to the customer.

According to Agnelli-Fernandes (2015), e-commerce websites should first of all build credibility with potential first time customers, providing them with assurances, in order to make them complete the transaction and also by using design to create an extension of brands' physical stores (Agnelli-Fernandes, 2015).

Several interventions are applied by web designers and user-experience experts to e-commerce websites in order to improve customers' web experience, like ways to reduce the number of clicks necessary to conclude the transactions (Flanagan, 2014).
According to Evans (2014), brand-appropriate design and well-structured navigation are key elements to attract customers and building loyalty (Evans, 2014).

Porat and Tractinsky (2012) have used the Mehrabian and Russell's model (1974) to study web experience. As we will see later in detail, it resulted that the reactions to usability and aesthetics of an online store affect the emotions and attitudes of consumers in the decision of buying products from an online store (Agnelli-Fernandes, 2015; Porat, Tractinsky, 2012).

In particular, in the field of apparel, web designers are trying to bring web experience to a superior level, trying to reproduce the texture, the feel and the fit of garments on e-commerce websites, leading customers towards an online shopping experience as similar as possible to the one they have in physical stores (Flanagan, 2014).
In detail, there are some principles which compose the websites that must be followed in order to improve customers experience on e-tailers' websites and in order to increase the conversion rate, which is the index of the number of sales with respect to number of views. Several scholars have tried to define the key elements of web experience, we will see, and define where necessary each element.

According to Baeva (2011) the factors that constitute the web experience, are the following:

1. *Usability*: which is defined as "the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standartization (ISO) 9241 norm, Guerrero et al., 2007; Baeva, 2011). In the opinion of Baeva (2011) usability directly affects the willingness to buy of customers and the probability of their return on the website to purchase other products in the future. She highlights site navigation, accessibility, payment process and delivery procedures as the most important elements of usability (Baeva, 2011). For Constantinides (2004) the most important components of usability are convenience, site navigation, information architecture, ordering and paying process, search process, site speed and accessibility (Constantinides, 2004);
2. *Interactivity*: in order to be successful, online stores should facilitate interaction with customers, also building communication and providing assistance to them (Merrilees, Fry, 2002), and this has been developed also through social

communication between customers through comments, ratings and feedbacks (Baeva, 2011). For Constantinides (2004) the key elements of interactivity are customer service, interaction with the company personnel, customization and network effects;

3. *Web design*: it represents the visual presentation of a website and, according to Childers et al. (2001), it increases the hedonic value perceived by customers through the provision of an aesthetically stimulating environment. The factors belonging to web design that affect the customer experience are presentation quality, style and atmosphere (Constantinides, 2004), color combinations, type and size of fonts, animation, sounds effects and clarity and readability of the text (Madu, Madu, 2002).

Instead, according to Lorenzo et al. (2009), the websites through which e-tailers sell their products and services should be aligned with the following four variables:

1. *Usability*: composed by elements like how information is provided, clear and simple site navigation, site speed, easy checkout process, etc.;
2. *Trust building*: it is important that customers perceive credibility and reliability from the website and the brand communication;
3. *Marketing mix*: composed by product, price, communication;
4. *Aesthetics*: design and style of the website, presentation of products (Lorenzo et al., 2009).

According to Porat and Tractinsky (2012), the key variables of web experience are the following two:

1. *Usability*: aimed at helping the user in accomplishing tasks in an easy way. According to her the two most important elements of usability are the store layout, which must be user-friendly and efficient in order to avoid frustration of the user, and the ease of navigation and searching, in order to avoid confusion, waste of time and to provide a sense of control in the user;
2. *Aesthetics*: composed by classical aesthetics, in terms of legibility, simplicity

and clarity of the website, in order to reduce users' uncertainty, and expressive aesthetics, which represents the creativity and innovation of a website that stimulate users' interest.

According to the Mehrabian and Russell's model (1974) used by Porat and Tractinsky in their study (2012), the consequences of these two elements are the following emotional states, which web design should aim at:

1. *Pleasure and arousal*: which are positive attitudes rising from aesthetics and the interaction provided by the online store;
2. *Dominance*: the sense of control perceived by the user (Agnelli-Fernandes, 2015; Mehrabian, Russell, 1974; Porat, Tractinsky, 2012).

According to Constantinides (2004), web experience is composed of three main factors:

1. *Functionality factors*: they affect web experience by the point of view of good functioning, easy and fast exploration of the website, web interaction. These factors are considered to be the determinants of the success or the failure of a website, since they directly influence customers' web experience. They can be divided in elements who belong to “usability” and to “interactivity”;
2. *Psychological factors*: in order to provide a good web experience, websites must communicate trust and credibility to customers. In particular customers are afraid of providing personal information and need that the transaction happens in complete security. By the provision of credibility, customers will be less hesitant in exploring the website and in conclude a transaction;
3. *Content factors*: these factors can be divided into two categories: “aesthetics” and “marketing mix”. This type of factors affects the web experience of users by the point of view of design and style but also by the point of view of communication to customers, which should be as clear as possible in order to enable customers' trust (Constantinides, 2004).

Table 1 collects all the factors that compose web experience according to Constantinides (2004).

Table 1: Web experience and sub-categories

Functionality factors		Psychological factors	Content factors	
Usability	Interactivity	Trust	Aesthetics	Marketing mix
Convenience Site navigation Information architecture Ordering/paymen t process Search facilities and process Site speed Findability/ accessibility	Customer service/after sales Interaction with company personnel Customization Network effects	Transaction security Customer data misuse Customer data safety Uncertainty reducing elements Guarantees/return policies	Design Presentation quality Design elements Style/atmosphere	Communication Product Fulfillment Price Promotion Characteristics

(Source: Constantinides, 2004)

2.2.1 Utilitarian And Hedonic Experience

In order to understand the different nature of customers, it is important to divide them in utilitarian and hedonic shoppers, just like offline shopping. The main characteristics of utilitarian customers are: seeking for convenience and variety, searching for quality of products, for reasonable price, for ease of shopping, etc. Hedonic shoppers are led by an enjoyable and interesting shopping experience (Bhatnagar, Ghosh, 2004). So, while the first ones are much more practical, hedonic shoppers go beyond the bare functionality of products and services, and e-commerce is seen by these customers through a pleasant, playful and ludic perspective. For this reason, as Childers et al. (2001) state, there would be positive consequences on e-commerce if websites could provide an interactive and entertaining shopping experience, since consumers purchase for both convenience and enjoyment (Childers et al., 2001).

2.3 Apparel E-Commerce

The reason for which apparel e-commerce still is not widely spread as other e-commerce sectors is that it has less benefits and more constraints with respect to online stores that sell other typologies of goods and services (Cai, Cude, 2008). Due to the fact that clothes are experience good, the process is more risky and inefficient, due to the lack of some fundamental information on products that customers need and to the amount of time required to choose the right size of garments (Hirt, 2012). For Baeva (2011) buying clothes online lacks two fundamental features required to buy clothes: touch and try.

About this last issue e-commerce websites of apparel are considered unable to provide enough information on the attributes of products, like color, size, fabric, fit. These attributes are considered by customers as essential information for making decisions in the moment of the purchase (Hammond, Kohler, 2002).

On the other hand, according to Baeva (2011), purchasing clothing online gives customers the opportunity to compare a wide variety of products selecting between various online e-tailers and thus finding the best deals online. Furthermore customers have the possibility to buy clothes from brands that do not have physical stores or that have a physical store far from them; and these are factors that lead also to time saving (Baeva, 2011).

In the last years this sector has seen continuous investments from e-tailers, in particular in the field of visualization tools aimed at the provision of more accurate means to create a virtual experience of products directed to customers, due to the impossibility to examine them before the purchase (emarketer.com, 2012). Technological innovation is the driver of the development of technologies aimed at reducing the risk perceived from customers in shopping clothing online and at providing a virtual experience of clothes to customers (Lee, 2014). According to Lee et al. (2010), tools like 3D virtual models and interactive features on the websites have a positive impact on consumers' purchase decisions (Lee et al., 2010).

2.3.1 Benefits And Constraints Of Apparel E-Commerce

As we said before, one of the main benefits of shopping online is that customers have the possibility to save their time, without the necessity to travel to several stores, and concluding the transaction in the place they prefer, with a wider selection of products and full access to information (Bhatnagar et al., 2000). According to Baeva (2011), the most important advantage of online shopping is that it allows both companies and individuals to reach the global market without geographical restrictions. Through e-commerce in fact there are no time limits and geographical restrictions, since the purchase is possible at any hour, every day, in any place and the transaction can be concluded also with brands that are not present with their stores in the country (Baeva, 2011).

Kanttila (2005) highlights the following factors as benefits that e-commerce provides to customers with respect to offline shopping: "convenience, speed of process, ease of finding what I want, time savings, freedom from hassles, latest information, comparison shopping (price/product), variety of product/brand choice, 24/7 open times, international markets" (Kanttila, 2005).

In any case the "price" of all these benefits, which is made of two of the most important constraints of e-commerce, is to make choices under a condition of uncertainty (Bhatnagar et al., 2000) and of perceived risk, which we will discuss more deeply on Chapter 3 (Samadi, Yaghoob-Nejadi, 2009).

According in fact to the research of Horrigan (2008), even though the continuous growth of online shopping, 58% of Internet users describe online shopping as a frustrating, confusing, and overwhelming activity (Horrigan 2008). Madu and Madu (2002) state that customers are hesitant and uncertain when they shop online because they do not want to disclose personal information.

Analyzing the constraints of e-commerce, Masoud (2013) states that, with respect to in-store shopping, in online shopping consumers have to face the following disadvantages: "consumer's inability to value the quality of the product directly, the lack of personal contact with a salesperson, the costs of learning how to use the internet or site, the change from other channels to the electronic one, the generation of anxiety and stress for consumers who don't feel comfortable using the internet, the absence of interaction and social contact with other people, and security of payment and personal" (Masoud, 2013; Salo, Karjaluoto, 2007; Zhou et al., 2008).

Hirst and Omar (2007), through their survey have summed up benefits and constraints of apparel e-commerce as can be seen in Table 2.

Table 2: Advantages and disadvantages of online shopping

Advantages for Online buyer	**Disadvantages for Online buyer**
Wider product availability	Concern with transaction security and privacy
Customized and personalized information and buying options	Lack of trust for unfamiliar websites/non branded products
Ability to shop 24/7	Inability to touch and feel products before purchase
Easy comparison shopping	Unfamiliar buying process using electronic money
Quick delivery of digital products	Complicated legal environment
One-to-one relationship with seller	Return policies that are difficult to understand

(Source: Baeva, 2011; Hirst, Omar, 2007)

Another important limitation of e-commerce, which is one of the reasons of customers' uncertainty, is the inability to observe, touch or try clothes before purchasing. Park (2002) also found other constraints of purchasing online that generate hesitancy for customers, like the risk of losing privacy and the level of security of customers' information. Returns are another constraint of online shopping: the process is seen by customers as difficult and time-wasting (Park, 2002).

The issue of returns is not only due to the nature of clothes as experience goods, but is also related to the body image that customers have of themselves. This psychological factor is proper of clothes and does not affect decisions when shopping other types of goods like books, electronics, flights, etc. (Hammond, Kohler, 2002).

2.3.2 Returns

We already took into consideration returns as a constraint by the point of view of customers, but they are considered an issue also by e-tailers, since they limit the profitability of their business. According to Martinez (2010), beyond their cost, returns represent a form of inefficiency, since they do not only involve e-tailers' profits, but they affect an entire process that comprehends distribution, warehouse operations, storage, customer service, finance, sales and marketing (Martinez, 2010).

In the opinion of Golletz and Ogheden (2010), e-tailers need to decrease their return rate, and this is possible only understanding the reasons for which customers return products, the different behavior of consumers, patterns and demands. The motivations they have found for which customers return the products they have bought are the following:

1. Changed mind (or customer's remorse);
2. Wrong size or color;
3. Item looked different on the website;
4. Purchases items in multiple sizes or colors and returned what did not want;
5. Order type (Internet, phone, email, etc.);
6. Damaged item or item with imperfections;
7. Delivery issues (like late in shipment);
8. Took too long to receive the product due to the leadtime (inventory not available/backordered);
9. Assembly challenge;
10. Competition;
11. Years on market;
12. Culture (Golletz, Ogheden, 2010).

As we see the first reason is an unavoidable issue for the e-tailers, since it depends only on the customer's decision. About the second and the third points, these reasons mostly depend on the e-tailer, since on the website the garment may look different with respect to the product in the reality. About size instead, the e-tailer affects this issue only through the provision of information (which can be efficient or not), but it certainly depends on the experience nature of clothing, for which to have the correct size and fit it is almost fundamental to try products. Also the fourth point cannot be directly related to the e-tailers, since customers will always have the possibility to order different colors and sizes of products in order to find out which fits them the best. In particular this problem arises when customers have the possibility to return products without costs, which leads to order more and not necessary products with respect to what they need (Golletz, Ogheden, 2010).

According to Golletz and Ogheden (2010), factors like competition and years on the market are factors that influence returns. They state that companies which entered the market recently usually have higher return rate than those companies which are present in the market for a long time. And this is due to the fact that customers still do not have the experience with the products of the brand that has just entered the market. About the last point, different culture means different consumer behavior and so different criteria in the choice of returning or of not returning a product (Golletz, Ogheden, 2010).

According to Singh (2015), the issue of returns is extremely important to solve, due to the huge losses it brings to e-tailers, considering that just the handling of returns costs them between 6 and 18 dollars per item. According to him, lenient return policies, combined with free shipping, has provided a boost to online retailing (Singh, 2015).

2.4 Online Customer Loyalty

Customer loyalty is an important matter for all the types of business. It is based on the value the customers receive, which affects the possible return of a customer in a store or in an e-commerce website. In order to develop customer loyalty, organizations continuously try to satisfy their customers in order to develop long-run profitable relationships with them (Anderson, Swaminathan, 2011). According to Reichheld, (1995) in fact, “Customers remain loyal, not because of promotions and marketing programs, but because of the value they receive. Value is driven by a full array of features, such as product quality, service, sales support, and availability.” (Reichheld, 1995).

Customer loyalty is particularly important in shopping online because e-commerce is highly competitive with respect to in-store shopping; due to price transparency and the presence of competitors few clicks away, customer loyalty is elusive (Anderson, Swaminathan, 2011). For these reasons for apparel brands it is fundamental to understand the key factors that bring to customer satisfaction and loyalty in shopping online in order to obtain and retain profitable online customers. According to Anderson and Swaminathan (2011) the key factors are the following eight:

1. *Adaption*: adaption is the ability of an e-commerce brand to recognize each customer and tailor the choice of products, services and the online shopping experience to each customer;

2. *Interactivity*: “Interactivity can be defined as the availability and effectiveness of customer support tools and the two-way communication of the e-business with its customers.” (Anderson, Swaminathan, 2011);

3. *Nurturing*: this factor refers to the post-purchase information, education, training and service the brand provides to its customers, in order to provide value to their shopping experiences over time;

4. *Commitment*: is the strength of the ongoing relationships between the e-commerce brand and its current or potential customers. This factor relates mainly to the service provided to customers in terms of assistance, problem solving, etc.;

5. *Network*: represents the extent to which customers have the opportunity to share opinions among themselves through comment, product reviews, buying circles, and chat rooms provided by the brand, creating a sense of community and letting them compare products and experiences;

6. *Assortment*: it represents the ability for the e-tailer to offer a broad variety of products and services, so providing customers with money, time and energy saving;
7. *Transaction ease*: it refers to the simplicity of the transaction process in a website, so that customers may perceive it as a simple, intuitive and user-friendly procedure;
8. *Engagement*: engagement represents the brand image and personality that customers perceive on the website. On their side, e-tailers create the engagement through attractive, vivid, interesting, and exciting visuals, illustrations, formats, and content that may please and attract the customers in their shopping experience (Anderson, Swaminathan, 2011).

As the study of Martinez (2010) revealed, there is an important correlation between returns and customer loyalty. Through the study it was found that if the returns processes were not convenient, 85% of the online customers declared that they would not buy again from that brand. Instead with a convenient return process, 95% of the respondents stated that they would buy again (Martinez, 2010)

Boyer et al. (2007) have proposed a model of three variables which have direct and positive influence on customer loyalty on the issue of returns:

1. *Perceived value of the returns offering*: represents the perception of customers on the entire returns management system, including the policy and the process;
2. *Return satisfaction*: it specifically relates to the customer's experience with a specific return;
3. *Previous service experience*: which affects the future returns the customer will make, deeply affecting loyalty intentions of customers (Boyer et al., 2007).

Due to the impact that returns have on customer loyalty, according to Golletz and Ogheden (2010), e-retailers should treat all the returns made by customers as a service recovery opportunity, which means that a firm has the possibility to fix a customer complaint due to a service mistake.

2.5 Fit And Sizing

Berry (1963) defined fit as the "correspondence in three dimensional form and in placement of detail between the figure and its covering to suit the purpose of the garment, to provide for activity, and to fulfill the intended style."

According to Sohn (2012) fit is the relationship between the body and clothing and it involves the comfort and the appearance of a garment worn on a body.

Analysis of fit of clothing is a process to assess the relationship between the human body and clothing in order to understand how a garment apply to a set of requirements (Ashdown et al., 2004). Fit analysis happens by assessing the appearance of a garment on the human body and is fundamental in order to reach customers satisfaction. For its analysis, fit can be divided in the following four elements based on the concept of comfort:

1. *Physical comfort*: this element represents the interaction between a garment and the body, relating to body size, dimension, posture, and movement;
2. *Physiological comfort*: similarly to physical comfort, it represents the mechanical interaction of the garment on the body by the point of view of the feel of clothes on the skin;
3. *Psychological comfort*: this element depends by the garment appearance on the body by the aesthetic point of view. It includes the style, proper fit, fashion, suitability, and the body image deriving from wearing the garment;
4. *Visual fit*: is a judgement based on fit criteria, according to the comfort preferences of individuals that wear the garment (Sohn, 2012). The fit criteria are ease, line, grain, balance and set (Erwin et al., 1979). Among all the criteria, the concept of ease is of particular importance, and is defined as the extra fabric which permits physical comfort and ease on movements (Sohn, 2012).

Good fit is a concept that depends according to individuals tastes and preferences. On the theme of fit study, Sohn (2012) defines good fit as "clothing that provides a neat and smooth appearance and maximum comfort in an intended style of garment" (Sohn, 2012).

According to Ashdown et al. (2004), a garment can be assessed to have a good fit if it "hangs smoothly and evenly on the body, with no pulls or distortion of the fabric, straight seams, pleasing proportions, no gaping, no constriction of the body, and adequate ease for movement. Hems are parallel to the floor unless otherwise intended, and the garment armscyes and crotch do not constrict the body" (Ashdown et al., 2004).

The concept of fit is strictly linked to the concept of size, since with the spread of mass production fit is more associated to the creation of sizing systems, so that garments may have a good fit for everyone, and less linked to the interaction between a specific body of an individual and a garment (Sohn, 2012).

According to Beazley and Bond (2003), size can be defined as "the dividing of average body or garment measurements artificially into categories to form a range of sizes". In mass production, ready-to-wear clothes are produced in standardized sizes in order to provide apparel to a wide spectrum of body shapes and so to a larger amount of customers (Rzepka, 2011).

Manufacturers are free to follow the sizing system they prefer, and this fact has led to a variety of different sizing systems, which had also led, as a consequence, to the disorientation and confusion of customers in finding the right size of garments according to different apparel brands, making the sizing system unreliable and inapplicable (Rzepka, 2011). According to Lee (2014), the absence of a standardized sizing system has increased the risk perceived by customers in shopping apparel online.

The freedom apparel brands have on the choice of sizing systems has also spread the use of marketing tactics on sizes: vanity sizing is a marketing tactic for which apparel brands create sizes of apparel so that customers fit into smaller sizes with respect to their actual ones. In this way customers will feel thin and brands will create brand loyalty and a target niche (Rzepka, 2011).

According to Beazley and Bond (2003), the development of size chart, which are at the basis of sizing systems requires five steps:

1. obtaining body measurements
2. statistically analyzing the measurements
3. adding ease allowance
4. formulating the size charts
5. fitting the trial garment to test the size charts (Beazley, Bond, 2003).

2.6 Actors In The Apparel Industry

In order to analyze the solutions the apparel industry has developed in order to solve the problem of size and fit in online shopping it is important to outline the actors involved in the industry which are actively developing the solutions or can likely benefit from them. For the purpose of our research the actors we need to define are three:

1. *Customers*: they are also known as clients, purchasers, and buyers, and they can be organizations or parts of it; customers are considered the most important external stakeholder in product development (Christ, 2009; Majava et al., 2013).
2. *Apparel firms*: for the purpose of this research, the distinction of the several parts and roles which compose the concept of "apparel firm" is not perceived as fundamental, since it will not be analyzed each single role in the value chain. We will refer to apparel brands, manufacturers, retailers, e-tailers etc. with the only purpose to define the part of the apparel firm involved in each specific situation, but the aim of the research is not to see how the technological innovative solutions affect each single character of the apparel value chain, but apparel firms in their whole. Instead of apparel firms we will often use the term e-tailers, which has been already used by several authors, like Agnelli-Fernandes (2015) and Hirt (2012), to define the retailers that act in the web through an e-commerce website.

3. *Suppliers of solutions*: are those firms which are developing and supplying those solutions, which imply technological innovation, aimed at solving the problem of finding the size when shopping online. As we will see, these firms are mainly start-ups.

Chapter 3: Literature Review

3.1 Customer Hesitancy

Notwithstanding the increasing diffusion of apparel e-commerce, customers are still hesitant to purchase clothes online, or they feel unsatisfied due to their online shopping experience. This phenomenon is called consumer hesitancy (Beck, 2000).

In particular Beck (2000) highlighted as causes of consumer hesitancy these issues related to online shopping of apparel: problems with fit and in finding correct size, problems in returning products, inability to evaluate product attributes, difficulty in obtaining information and problems in navigating the website (Beck, 2000). All these issues, that bring customers to hesitancy in buying online, directly affect e-tailers; consumer hesitancy leads to low sales, since consumers prefer buying their clothes in physical store, to high return rates and costs, due to the impossibility of apparel examination, and to lost brand loyalty, which affects the business in the long term.

3.2 Perceived Risk

3.2.1 Introduction

The concept of perceived risk was introduced in 1960 by Bauer and it has been then used to describe the uncertainty customers feel in purchasing behavior (Hirt, 2012).

Later it has been defined by Cox and Rich (1964) as "[...] the nature and amount of risk perceived by a consumer in contemplating a particular purchase decision". They also defined this topic using the concept of buying goals: the risk is perceived due to the uncertainty a consumer feels when he/she wants to reach the buying goals (Cox, Rich, 1964). Masoud (2013) defines this risk as "the potential for loss in pursuing a desired outcome from online shopping" (Masoud, 2013).

Since perceived risk can be considered a personal belief, the uncertainty in buying online differs from customer to customer (Sheth, Parvatiyar 1995).

3.2.2 Perceived Risk In Apparel E-Commerce

The concept of perceived risk has been taken as a fundamental starting point to understand consumer behavior and in particular the research for information proper of customers and their decision-making process (Masoud, 2013).

According to the research conducted by Samadi and Yaghoob-Nejadi (2009), consumers perceive higher risk when they shop on the Internet than when they buy apparel in store (Samadi, Yaghoob-Nejadi, 2009). Perceived risk has important implications on Internet shopping because it affects the purchase experience of customers; according to Bhatnagar et al. (2000), the risk and the uncertainty the customer perceives while shopping on the internet decrease the perceived benefit of the shopping experience (Bhatnagar et al., 2000). In their survey, Matic and Vojvodic (2014) found that the insecurity perceived in online shopping strongly influences online decision-making process (Matic, Vojvodic, 2014).

Risk represents one of the main concerns for people who want to buy products online (Samadi, Yaghoob-Nejadi, 2009), and the research of Matic and Vojvodic (2014) reveals that the uncertainty faced by customers has influences on their attitudes and intentions in purchasing on the web and also in online purchase decision itself (Matic, Vojvodic, 2014). Often customers are influenced so much by perceived risk that when they purchase products online they are more concerned in avoiding mistakes during the process than in maximizing their utility during the purchase (Mitchell, 1999). Furthermore, according to Jarvenpaa et al., (1999), consumers may prefer buying products from a store because of the low risk perceived in the transaction rather than due to the positive attitudes perceived towards the store (Jarvenpaa et al, 1999).

The risk perceived by customers is also strictly related to the availability of information provided by e-tailers on products, and the more the information provided, the more the customers will feel safe on buying products online (Hirt, 2012).

In terms of information required by customers, products can be divided into two main categories, according to Klein (1998): search and experience products. While search products are “those dominated by product attributes for which full information can be acquired prior to purchase", experience products "are dominated by attributes that cannot be known until purchase and use of the product or for which information search is more costly and/or difficult than direct product experience" (Klein, 1998).

Following this classification of products, it is clear that apparel can be considered an experience good, since consumers cannot have the possibility to examine, test and try garments (Park, 2002). Pastore (2000) states that the perceived risk in the market of clothes bought online is mainly driven by the inability of customers to try and feel the apparel before buying it (Pastore, 2000).

3.2.3 Types Of Perceived Risk

The subdivision of perceived risk into different typologies and aspects has been studied since the concept of perceived risk was born and many scholars have contributed to the study of this phenomenon (Bhatnagar et al., 2000; Dai et al., 2014; Forsythe et al., 2006; Jacoby, Kaplan, 1972; Simpson, Lakner, 1993).

We will take the broader, detailed and complete spectrum of typologies in which perceived risk can be divided, resuming and defining the concepts and the theories of several scholars.

Perceived risk can be divide in six different types (Masoud, 2013):

1. *Financial risk*: financial risk represents the fear of customers of losing money with the online transaction. This potential loss of money is seen as a deterrent that creates uncertainty in the consumer;
2. *Product risk*: since online shopping precludes the possibility of examining goods physically before the purchase, consumers are afraid that characteristics of products do not perform as expected. Information is reached by customers only through a screen and it is difficult to evaluate efficiently products attributes before the purchase;
3. *Time risk*: this type of risk is due to the potential loss of time in purchasing goods online and to the time necessary to receive the products bought. It

includes the difficulty of navigation and of completing the transaction;

4. *Delivery risk*: customers are worried also for issues bound to delivery. Receiving a damaged product, the delay of the delivery or the fear of not receiving the product bought are possible consequences that affect the decision-making process of consumers;
5. *Social risk*: products affect the way the society look at us, and this type of pressure affects consumers' purchases, also those they make online;
6. *Information security risk*: customers are also afraid of providing their personal information and data during registration or transaction process. They may doubt of the security of the website and be afraid of losing their privacy (Masoud, 2013).

For Jacoby and Kaplan (1972) and Simpson and Lakner (1993) the types of perceived risk are four: functional/performance (i.e. product risk), physical risk (fear that a product could harm the user's health), financial/economic risk and psychological risk (i.e. social risk). Instead, according to Bhatnagar et al. (2000) online shopping is mainly affected by product and financial risk:

1. *Product category risk*: Bhatnagar et al. (2000) state that this type of risk is higher for expensive products, highly technologically complex products, ego-related products (observable by others), and, in particular for apparel, it is strictly related to the right choice of size, fit, feel, color and fabric in purchasing clothes, since all these attributes cannot be examined by the customers before the purchase;
2. *Financial risk*: this type of risk is influenced by the uncertainty in completing the transaction in an effective way. The customer is afraid of losing money, of losing credit card information (Bhatnagar et al., 2000).

In the opinion of Schiffman and Kanuk (2009), the risk perceived for online shopping of apparel are six: functional, physical, financial, social, psychological and time risk.

According to Forsythe et al. (2006) the typologies of perceived risk in online shopping are three: financial risk, product risk and convenience risk. The last one concerns the technological difficulty consumers face when they shop online (Forsythe et al., 2006).

There is another subdivision of perceived risk proposed by Liang and Huang (1998): they state that there are two kinds of uncertainty which affect online shopping: product uncertainty and process uncertainty. Product uncertainty is related to the possibility of having bought a product which has a different performance with respect to what is expected (i.e. products risk). Process uncertainty happens when consumers are not confident with the transaction process, which is similar to the concept of convenience risk (Liang, Huang, 1998).

Another different subdivision comes from Park (2002). According to him, perceived risk is composed of two principal elements: uncertainty and consequences. The first element concerns the problems consumers have in identifying buying goals and in matching them with products. Consequences are instead associated with the following goals, which are similar to the types of risk described before:

1. *Functional or performance goals*: whether the product will satisfy the characteristics the consumer expected on that product;
2. *Psycho-social goals*: about the acceptance of society of the product the consumer bought;
3. *Efforts to achieve these goals*: in terms of time and money (Cox, 1967; Park, 2002).

3.2.4 Risk Reduction: Influence Of Experience

Sheth and Venkatesan (1968) state that consumers are more inclined to minimize the risk rather than maximize the expected positive outcome or the expected payoff (Sheth, Venkatesan, 1968); this is why experience is a variable that strongly affects the perceived risk of customers. According to Bhatnagar et al. (2000), risk aversion of customers decreases the more they get accustomed to shopping online. Through knowledge and experience, in fact, customers may perceive shopping online as a common way of buying products and services (Bhatnagar et al., 2000). In their survey, Moreno and McCormack (1998), found that if people already had a shopping experience on the web, their perceived risk is lower with respect to new users (Moreno, McCormack, 1998). Yoon (2002) found that familiarity and prior satisfaction in e-commerce transactions have high correlation with website satisfaction at the same level as trust.

The survey from Kim and Gupta (2009) demonstrates that, for potential customers, the decision-making process is more influenced by perceived risk rather than by the perceived price, while it is more influenced by the perceived price than by the perceived risk for repeat customers.

Previous experiences in shopping online not only affect future customers' intentions positively, but also negatively: Møller-Hansen (2013) states that each online transaction provides the consumer with online purchase experience, which can be for good or for bad. This thesis is supported also by Samadi and Yaghoob-Nejadi (2009): the survey they conducted reveals that the risk perceived affects, in positive or in negative, the future online shopping intention of customers, according to the experience they had. According to their research, it has been proven that customers' perceived risk is affected by previous positive shopping experiences and by the number of online purchases that customers have already made, such that positive shopping experiences tend to decrease the perceived risk users may feel in future transactions, and negative experiences increase the perceived risk for future online purchase (Samadi, Yaghoob-Nejadi, 2009).

Also the research made by Wolfinbarger and Gilly (2001) demonstrates that consumers online activity is affected by the online experiences they had previously. If previous online experiences had any sort of impact on the customer, in positive or in negative, this feeling will influence consumers' buying behavior (Wolfinbarger, Gilly, 2001). According to Baeva (2011), a bad shopping experience's harmful effect affects not only the future intentions of buying products online, but also the image the customer has of the online store and his/her buying behavior in that specific website (Baeva, 2011).

3.2.5 Risk Reduction: E-Tailers' Strategies

Several strategies aimed at reducing risk have been studied, in particular from the point of view of e-tailers, since their goal is to make consumers purchase their products.

For Gaal (1997), in order to decrease perceive risk, it is fundamental that e-tailers provide complete information on their products to customers.

According to the study made by Seitz (1988), the attributes of clothes like fabric, color, fit, size, style constitute essential information to give to customers in order to decrease the risk perceived by customers and affect in a positive way their purchase decision.

Kwon et al. (1991) state that information on products like descriptions of the item (both the way the item looks and its technical details) and brand name should be clear to customers to reduce risk.

Samadi and Yaghoob-Nejadi (2009) have selected in their research fourteen methods to reduce risk in online shopping: "Brand loyalty, store image, information from friends/family, past experience, visit/call local retailer, store recommendation, shopping around, well-known brand, money-back guarantee, price information, warranty quality, TV/print commercials, consumer reports, and internet newsgroups". In particular they state that brand reputation, product trial, and warranty are successful risk reduction strategies (Samadi, Yaghoob-Nejadi, 2009).

3.3 Apparel Choice Criteria

3.3.1 Introduction

As stated before, apparel goods, due to their nature of experience goods are perceived as highly risky products to buy online, since, when shopping on the internet, consumers do not have the possibility to examine and try them physically (Hirt, 2012). We will see how scholars have analyzed the purchase-decision-making process and which are the apparel choice criteria that are mainly considered by consumers.

3.3.2 Apparel Criteria

Apparel criteria are the attributes, the characteristics proper of apparel and they vary for importance from consumer to customer. In our study they are particularly important because they represent what customers need when they buy clothes, in particular when they buy them online. For this reason it is important to understand which are the attributes that customers need to know in order to buy without perceiving risk. Researchers have found different apparel criteria, divided by intrinsic and extrinsic ones (Kwan et al., 2004). According to Hirt (2012) both intrinsic and extrinsic criteria are fundamental to provide to customers in online shopping, in order to give them the information they need to purchase products on the web, reducing the risk they perceive (Hirt, 2012).

Kwan et al. (2004) define intrinsic criteria stating that "intrinsic product attributes are those that cannot be changed without altering the physical characteristics of the product" (Kwan et al., 2004). For this reason, dissatisfaction with intrinsic criteria is one of the main reasons of product returns (Hirt, 2012). Extrinsic criteria are instead attributes related to the product, they are not part of the physical product; they "are exerted by manufacturers or retailers and do not form the component parts of the product" (Kwan et al., 2004). In Table 3 we present the division of apparel choice criteria between intrinsic and extrinsic, according to Eckman et al. (1990) and Kwan et al. (2004).

For Park (2002) the most important criteria for apparel are size, color and fit, which are all intrinsic criteria.

According to the survey made by Uzan (2014), the mostly applied intrinsic criteria are: print, color, material, natural fibers and fit. The mostly applied extrinsic criteria instead are: spring/summer, simple, match with specific garment, wear on specific moment, something to have in wardrobe and the picture with the model. According to his research, these attributes are important both online and offline for customers to evaluate products; the only difference is that, for online purchase, intrinsic criteria cannot be physically examined (Uzan, 2014).

Table 3: Extrinsic and Intrinsic Clothing Choice Criteria

Extrinsic criteria	Intrinsic criteria
Price	**Product composition**
Brand	Style
Country of origin	Color and design
Store (store image)	Fabric
Coordination with wardrobe	Appearance
Salesperson's evaluation	Fibre content
Department in store	**Product performance**
Approval of others	Care
Warranty	Fit and sizing
	Durability
	Comfort
	Safety
	Colourfastness
	Quality
	Construction and workmanshop
	Physical
	Fabric
	Sex appropriateness

(Source: Eckman et al., 1990; Kwan et al., 2004)

3.4 Decision-Making Process

As we stated before, product attributes are a fundamental factor in the decision-making process, in particular when customers want to buy clothes online. For e-tailers it is fundamental to provide the information on product attributes to customers, so that they can evaluate product notwithstanding they can't physically examine them, in order to decrease the hesitancy and the perceived risk before the purchase and returns on the post-purchase phase.

In online shopping of apparel in fact the step of product evaluation, in which clothes can be tried on, comes after the purchase, instead of before, which is proper of in-store shopping. Hirt (2012) defines apparel online shopping using three phases: “surfing, buying and fitting”. In the phase of surfing, customers look for information on products' intrinsic and extrinsic criteria, in the buying phase they complete the transaction, and only in the end of the process, in the fitting phase, they can try on the clothes (Hirt, 2012). In this way the customer cannot easily change what he/she has bought just like in a physical store, in which customers have the possibility to change size, color, fit, model, etc., but it is necessary to start the procedure of return of the products. On this issue Hirt (2012) states that there is a post-purchase evaluation step that should be changed in order to decrease the perceived risk and the dissatisfaction of customers, returning to the formula of in-store shopping of “surfing, fitting and then buying” (Hirt, 2012).

The consumer purchasing process, as Dewey (1910) states, is made of five different steps: need recognition, search, evaluation of alternatives, purchase and post-purchase (Dewey, 1910). For Cai and Cude (2008) the purchase process is made of five stages: problem recognition, search, alternative evaluation, choice, and outcome evaluation.

According to Hirt (2012), the online apparel purchase process follows the same purchase-decision-making process, but is made of five different steps, and, with respect to online purchase of digital goods, there is one step more, which is purchase hesitance (Hirt, 2012)

Table 4: E-commerce purchase process for digital goods and apparel compared

E-commerce purchase process for digital goods	E-commerce purchase process for apparel
1. information search 2. product selection 3. purchase evaluation 4. purchase decision	1. information search 2. product selection 3. purchase hesitance 4. purchase decision 5. purchase evaluation

(Source: Beck, 2000; Hines and Bruce, 2007; Hirt, 2012)

As we see on Table 4, apparel can be evaluated only after the purchase, due to the impossibility of examining the good. Purchase hesitance also arise due to the impossibility to examine clothes before the purchase (Hirt, 2012).

According to Liang and Huang (1998), the process of online purchase is composed of seven steps:

1. *Search*: for products and related information on the web;
2. *Comparison*: of products of different types or of different brands, having the possibility of finding different prices, designs, attributes, etc.;
3. *Examination*: of the chosen product;
4. *Negotiation*: of terms like price, delivery costs and time, etc.;
5. *Order and payment*: from the shopping cart, through the checkout;
6. *Delivery*: after-payment step that ends with the physical acquisition of the product by the customer;
7. *Post-service*: like the need for customer service, returns, support, etc. (Liang, Huang, 1998).

According to Peter and Olson (1994) the decision-making process is made of five stages: need recognition, search, evaluation of alternatives, purchase and post-purchase (Uzan, 2014; Peter, Olson, 1994). In the need recognition phase the customer identifies his/her need and then starts the search of information phase (Baeva, 2011). Constantinides (2004) states that between the search stage and the evaluation of alternatives there is a further step in online shopping, which is "Building trust and confidence"; this step is necessary, according to him, in order to create a relationship between the brand and the customer. After the search stage, the evaluation of alternatives starts; in this step the customer compares different products of different attributes (Baeva, 2011). Apparel choice criteria are evaluated in this stage, in which criteria are determinants of the different products the customer evaluates (Uzan, 2014). After the evaluation of alternatives, the customer selects the products he/she wants to purchase, according to his/her criteria. With the post-purchase evaluation phase the customer has the possibility to evaluate physically the product he/she has bought. In case the product meets consumer’s expectations, he/she will feel satisfied. In case his/her expectations are not satisfied, the consumer will have negative opinions on the product and will, in case, start the return procedure (Baeva, 2011).

3.5 Technology Acceptance Model (TAM)

3.5.1 Introduction

Since purchasing is considered a socio-psychological behavior, it is fundamental to understand the psychological background with respect to the online consumer behavior. Many models have been developed around this topic; in particular we will analyze the TAM model, which represents the most useful model for our study. In fact, we will apply it where possible to understand whether the technologically innovative solutions in the world of apparel e-commerce are efficient for users in solving the problem of finding the right size and fit when purchasing clothing online.

3.5.2 The TAM Model

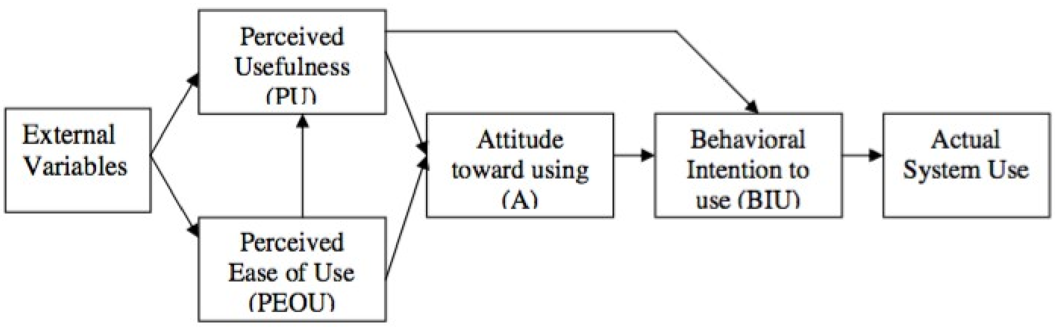
The technological acceptance model (TAM) has been created by Davis (1989) and it has been used from then to understand and predict the acceptance of information technology by users. Davis stated that the aim of TAM is “to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified” (Davis, 1989). The model was derived from the Theory of Reasoned Action (TRA) proposed by Fishbein and Ajzen (1975): while TRA explains general human behavior, TAM is specific to IT usage and explains consumer's acceptance of information systems (Baeva, 2011; Davis, 1989).

According to TAM, users' acceptance of a new information technology is based on perceived usefulness (PU), defined by Davis (1989) “as the degree to which a person believes that using a particular system would enhance his or her job performance", and on perceived ease of use (PEOU), which he states is "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). The logic explained through the Technology Acceptance Model is that the more the perceived ease of use of a technology by the point of view of a customer, the more useful it is perceived to be (Baeva, 2011).

Beyond the model of Davis, many factors have been added and included in Technological Acceptance Model. According to Çelik and Yilmaz (2011), over the years scholars have added to the perceived usefulness and perceived ease of use the following factors: TAM approach, trust, social personality and perceived enjoyment, personal characteristics (age, sex, income, education and culture), internet experience, normative beliefs, shopping tendencies, online experience, safety, system quality, psychological perception (the perception of risk and benefit), online shopping experience, availability, service quality and attitude (Çelik, Yilmaz, 2011). Çelik and Yilmaz, (2011), for their survey, presented an extended TAM model with the following five variables added to the original model: the perceived information quality, perceived service quality, perceived system quality, perceived enjoyment, and perceived trust.

TAM has been used in several studies to test user acceptance of different information technology applications: word processors (Davis et al., 1989), spreadsheet applications (Mathieson, 1991), e-mail (Szajna, 1996), web browser (Morris, Dillon, 1997), websites (Koufaris, 2002).

Figure 1: The Technology Acceptance Model



(Source: Baeva, 2011; Davis, 1989)

3.6 Technological Innovation

Damanpour (1996) has provided the following definition of innovation: “Innovation is conceived as a means of changing an organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment. Hence, innovation is here broadly defined to encompass a range of types, including new product or service, new process technology, new organization structure or administrative systems, or new plans or program pertaining to organization members” (Damanpour, 1996).

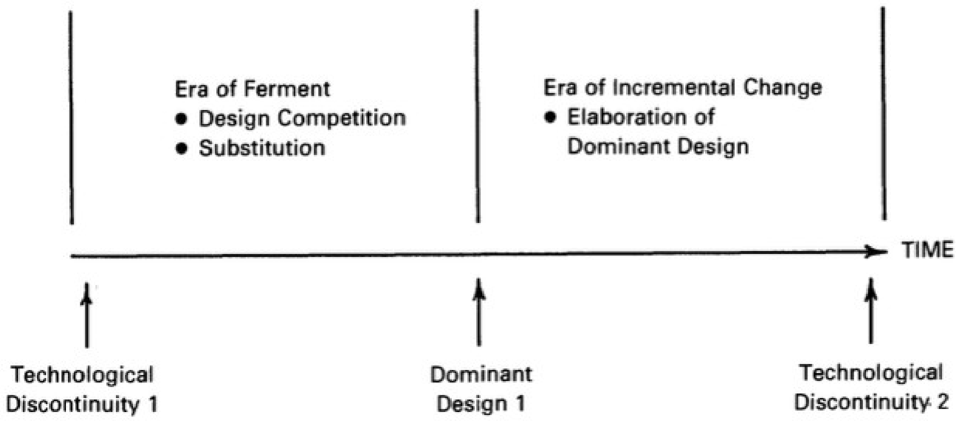
Technological innovation is defined by Schilling (2010) as “The act of introducing a new device, method, or material for application to commercial or practical objectives” and is considered one of the most important competitive drivers in industries.

According to Radu (2015), “Technological innovation represents the creativity implementation which gives rise to inventions. These concepts are found in different stages of the innovative process comprising the following steps: generate ideas, the development of the product or service and its trading.” (Radu, 2015).

According to Schilling (2010), the main part of innovative ideas does not become a successful product; in order to reach innovation success, a firm must formulate a well-crafted strategy aligned with resources, core competences and objectives. He also states that “A firm's new product development process should maximize the likelihood of projects being both technically and commercially”, this can be done by understanding the dynamics of innovation, the creation of a proper innovation strategy and of the right processes for implementing the innovation strategy (Schilling, 2010).

When an innovative product succeeds in the market and is adopted by a vast majority of firms, a dominant design emerges. In the industry dynamics of technological innovation, according to Anderson and Tushman (1990), a dominant design marks the end of the “era of ferment”, in which, after a technological discontinuity, the market is characterized by turbulence and uncertainty generated by firms that are involved in design competition through the use of technology. Once the dominant design has been established a new phase comes, the “era of incremental change”, in which firms focus on efficiency and market penetration in order to improve their technology rather than developing alternative designs. This phase continues until a breakthrough innovation (i.e. a technological discontinuity) starts again the era of ferment (Anderson, Tushman, 1990; Schilling, 2010)

Figure 2: The Technology Cycle



(Source: Anderson, Tushman, 1990)

It is particularly important for firms to develop the dominant design at the right time, since the firm gains the potential to create a monopoly and has also the possibility to shape the evolution of the industry. On the contrary, whether the firm is not able to develop the dominant design, it has to adopt the dominant technology, abandoning the investment it has done for its original technology and incurring the risk of remaining out of the market if it is not able to adopt the dominant design technology (Schilling, 2010).

3.7 Mass Customization

Mass customization was identified by Davis (1987) as an oxymoron concept deriving from the combination of “mass production”, characterized by the production of large numbers of identical products, and “customization”, for which each item is produced as unique one for each customer (Davis, 1987; Lim, 2009). Later Pine (1993) defined the concept of mass customization as a new business strategy in which products and services are customized to meet customers' individual demands in a cost-effective way (Lim, 2009; Pine, 1993).

Thus the concept of mass customization represents the antithesis of mass production: mass production in fact assumes an homogeneous market, in which customers are at the end of the of the value chain and can choose only among highly engineered long-run standardized products; on the other side, mass customization assumes an heterogeneous market in which customers are at the beginning of the value chain, in the product development phase. The organization of mass customization, characterized by short product development and manufacturing cycles, permits the customization of products according to the specifics required by customers (Anderson-Connell et al., 2002).

The market turbulence represented by the customer demand of customized products is, according to Pine (1993), an indicator of potential benefits of mass customization as a competitive strategy (Ulrich et al., 2003; Pine, 1993).

According to Dong et al. (2012), mass customization combines the advantages of mass production and customized production: mass customization enables the possibility of customers to buy customized products, which provides customer with satisfaction and awareness of quality and functionality, at low costs and short lead times (Dong et al., 2012).

While in mass production the only input provided by customers is their purchase behavior and the demand of customers is not integrated in the manufacturing and in the design process, anticipated by the choice of suppliers and retailers, in mass customization customers have a role in the creation of the design of products (Senanayake, Little, 2010).

Salvador et al. (2009) state that mass customization is a process to align an organization to customers' needs and that, in order to reach this goal, an organization has to develop organizational capabilities, that in the long-term will supplement and enrich the existing business. The organizational capabilities require organizational changes according to the specific business of the firm and, according to them, they will provide long-term competitive advantages. They identify three fundamental capabilities that must be developed in order to reach the goal:

1. *Solution Space Development*: it is fundamental that the organization that wants to apply mass customization understands the product attributes along which customers' needs diverge, understanding customers' needs and the "solution space" which represents what the firm can offer to its customers in terms of customization;
2. *Robust Process Design*: the organization needs to have the capability to reuse or recombine existing organizational and value-chain resources, in order to be efficient and reliable, which means that the firm needs to have a robust process design. This can be reached through flexible automation, process modularity, and by investing in adaptive human capital;
3. *Choice Navigation*: the organization has to help customers to identify problems and solutions minimizing complexity and the burden of choice, and so limiting the possibility of choosing among a big number of different options, which would lead to high costs (Salvador et al., 2009).

Beyond a flexible manufacturing, in order to apply mass customization, the application of information and manufacturing technology is fundamental (Lim, 2009).

The technologies already emerged allow direct communication between the retailer and the customer for the creation of customized products. However, according to Anderson-Connell et al. (2002), new information technologies need to be developed in order to make mass customization possible (Anderson-Connell et al., 2002).

CAD systems are already used for design, pattern-making, grading and marker-making, since they provide the flexibility to create and modify the design of products, which is fundamental to enable mass customization (Ulrich et al., 2003).

Other technologies, like virtual reality, multimedia technology and 3D body scanners are enabling the possibility to fulfill mass customization (Berman, 2002; Lim, 2009).

Apparel industry is one of the application fields for mass customization. According to Senanayake and Little (2010), in this industry mass customization will continue to provide competitive advantage due to the fulfillment of customers' demand through flexibility and quick responsiveness (Senanayake, Little, 2010).

Apparel mass customization is supported by the following technologies: 3D body scanning, CAD systems, single ply cutters, digital printing, and modular production. In particular 3D body scanners are important substitute of manual measurement, since they provide precise body measurements that enable the creation of a garment that perfectly fits the customers' body (Lim, 2009).

Chapter 4: Solutions without Technological Innovation

4.1 Introduction

In order to find out the ways in which it is possible to decrease the perceived risk of customers in shopping apparel online, in this chapter we analyze those solutions (possible in the future or already taken) which can be applied by e-tailers or by the apparel industry without the implication of technological innovation.

4.2 International Standardization Of Size

Size, together with fit, is considered one of the main criteria of apparel which makes difficult for users to buy clothes online. Problems in choosing the right size lead to high perceived risk for customers and high return rate for e-tailers (Beck, 2000). The source of problems with sizing can be attributed to the absence of a standardized sizing system, which has led to a higher risk in shopping apparel online (Lee, 2014).

Hirt (2012) proposes that some available brands could start aligning their sizing systems; in this way complications in choosing the right size would decrease almost completely (Hirt, 2012).

In fact the problem of sizes is related to the lack of a common sizing system for all the brands. Since the beginning of the 20^{th} century the sizing system started its transformation: from a unique sizing standard, born in the mid of the 19^{th} century with military uniform requirements, to sizing fragmentation, for bespoke and homemade services, towards ready-to-wear apparel and so to mass production. Different sizing standardization systems have been created according to different populations, and later by manufacturers for their own apparel to satisfy customers' fit (McNulty, 2015). Nowadays sizing systems, even though derived from the International Organization for Standardization (ISO), are used as marketing tactics by brands, that add the “preferred fit” to garments in order to differentiate their garments from those ones of their competitors (Cheruiyot, 2013).

Currently the following methods are used to create sizing and fitting systems Cheruiyot (2013):

1. basing on the measurements of one “ideal” customer, which represents the fit model of the system;
2. other sizes, smaller and greater than the fit model, are added by using grade rules to determine proportional increases and decreases with respect to the fit model;
3. the other sizes are evaluated with respect to the fit model both visually and in two dimensions by comparing linear garment measurements to linear body measurements.

Cheruiyot (2013) states that these methods are not adequate if we look at the complexities in the relationship between clothing and bodies, with an extremely wide variety of customers' body types.

These phenomena have led to a situation in which, according to different countries and to different brands, the size is a very difficult attribute to choose for apparel, in particular when it is bought online. According to Cheruiyot (2013), it has become necessary to create a standardized sizing system at least within each country, basing the sizing system on the target population. The return to a “one-fits-all” system would certainly reduce the probability of buying clothes with the wrong size but it is not a realistic scenario. Furthermore it could not provide a possible solution due to the diversity in the body shape of people of different nationalities across the world, and would create negative emotions for people dissatisfied with their body (McNulty, 2015).

4.3 Online Consumer Reviews

One of the main differences between buying apparel in physical store and online is that in the first case consumers have the possibility to be assisted by sales assistants or friends and relatives that can provide information, advice, and help in concluding the purchase. Instead on the web the consumer usually does not have this sort of assistance and has to conclude the purchase without any help.

The survey made by Bae and Lee (2011) reveals that online reviews made by other consumers may help users in receiving important information on the products they want to buy and in diminishing the perceived risk. Furthermore since the recommendation is provided by other consumers, users perceive the information contained in the reviews as reliable and credible, since they come from consumers that have already tried, examined and used the products (Bae, Lee, 2011). Moreover, since the recommendation comes from consumers, it is felt as more credible and relevant with respect to the recommendation of a sales assistant (Cheong, Morrison, 2008). In websites, reviews can be presented as a text (which may provide more information to the customer) or as grades given through numbers or “stars” (Golletz, Ogheden, 2010). According to Golletz and Ogheden (2010), recommendations and reviews are seen by customers as an advice on the products, in substitution to the advices of a relative or a friend which are common “assistants” in shopping in-store.

In the field of apparel, Amazon.com has implemented “fit as expected” review, so that customers that have already bought a garment may provide their feedback on the fit according to five different parameters. In this way potential customers may understand whether the garment fits on the body as expected, according to body measurements (Singh, 2015).

One disadvantage of customer reviews is the possible influence they may have on customers: according to Bae and Lee (2011), consumers are more influenced by a negative review with respect to a positive one. This possible consequence may discourage e-tailers in enabling reviews on their websites, since potential customers' intentions could be deeply affected by negative comments on products, which could lead to reduce sales.

4.4 Web Experience And Cognitive Computing

According to the research of Lorenzo et al. (2009), aesthetics and usability of a website have positive and significant influences on consumers in online purchase (Lorenzo et al., 2009).

For Park (2002) a well structured layout and a prominent store display in an e-commerce website positively influence customers' intentions in buying online (Park, 2002).

Cognitive computing is an approach to design and manage a website which is based on studying consumers' behavior, best practices and preferences when shopping online (Park, 2002). Through insights it is possible to understand consumer information processing styles, shopping patterns, storefront preferences, and related areas that yield insights into developing more attractive, friendly, and successful internet shopping environments (Park, 2002; Szymanski, Hise, 2000).

A well designed website leads to lower cost in terms of time for customers, less steps to the end of the transaction and so to conclude the purchase through an easy and straight procedure (Park, 2002).

Baeva (2011) states that one of the most important factors that influence the success of a website is customer experience, based on understanding the needs of customers and influencing them in their shopping behavior online. She also states that “a clear, easy-to-use and customer-centered web site can help garner better reviews and ratings, reduce the number of mistakes made by customers, trim the time it takes to find needed information, and increase overall customer satisfaction. Furthermore, customers who really like a website's content and quality of service are more likely to tell their family, friends, and coworkers, thereby increasing the number of potential customers” (Baeva, 2011).

4.5 Size Charts

Beazley (1998) defines size charts as “artificial division of a range of measurements”. Size charts are the main tool customers may use to find the right size of the garments they want to buy online. They indicate the sample coverage of body measurements basing on standard deviation values (Apeagyei, 2010) through a range which is usually aimed at being convenient both for e-tailers' production and for meeting customers' requirements (Ola-Afolayan, Mastamet-Mason, 2013). In order to provide an efficient tool to customers, e-tailers have to furnish effective information to customers, aiming at conducting them to purchase garments of the right size in order to avoid returns (Lee, 2014).

E-tailers have to help customers in finding the right size through size charts and information on how to take measurements of the body in a clear and efficient way (Golletz, Ogheden, 2010).

However many consumers feel frustrated due to sizing systems and to the incorrect use of them, since it is complicated for them to find clothes that fit the body (Cheruiyot, 2013). Sizing variations are mainly due to two reasons, according to Cheruiyot (2013): the first one is the so called “vanity labelling”, meaning that garments are labelled smaller with respect to their “real size” in order to flatter the customers, since in this way they will chose a smaller size than their actual size (Cheruiyot, 2013; Kinley, 2003; Ennis, 2006); the second opposite reason is represented by the production of only small sizes, marking anyway the sizes too large to get marketing advantage and selling clothes that should fit thin.

The development of a size chart, according to Beazley and Bond (2003), is made of five steps:

1. obtaining body measurements
2. statistically analyzing the measurements
3. adding ease allowance
4. formulating the size charts
5. fitting the trial garment to test the size charts

Sohn, (2012) recommends 21 measurements that should be included in size charts, which include both linear and girth measurements. Linear measurements are: height, waist length from center front, cervical to natural waist, cervical back to natural waist, cervical height, outside leg length, inside leg length, arm length, and shoulder width. The girth measurements are: neck girth at midway level, neck girth at neck base, bust, natural waist, intended/artificial waist, hip measured at 4 inch below the natural waist, hip measured at 6 inch below the natural waist, thigh, ankle, knee, upper arm, and wrist

(Sohn, 2012).

According to Rzepka (2011) size charts are inefficient in being an instrument to find the right size of garments. This is due to the fact that size charts mainly use three measurements (i.e. the bust, waist, and hip circumference), with the assumption that the other parts of the body are proportioned on these measurements, while body shapes are different from individual to individual (Chun-Yoon, 1996; Ashdown, 1998; Rzepka, 2011)

4.6 Visual Product Presentation

Visual product presentation is one of the main tools used by e-tailers to show the products to customers online. Beyond the description, size charts and technical information of the product, photos represent a means for customers to understand if that is the product they want to buy. Furthermore, since through apparel e-commerce consumers have not the possibility to examine the clothes before purchasing them, detailed photos of products help them in having a "visual experience". Beyond the purpose of showing the product to customers, the display of products is used also to show customers different mix-and-match combinations and for marketing purposes, like the promotion of products, new fashion trends and ideas (Golletz, Ogheden, 2010)

To show the product in the better way e-tailers have adopted techniques like:

- *Zooming*: which permits a clear view of the details of a product;
- *360 degree view*: enabling the complete rotation of a product the customer can have a more complete view with respect to photos that show just a side of it;
- *Videos*: give the possibility to see the product at 360 degree and they are useful to understand how a garment may fit the customer;
- *Alternative views*: from different points of view or details of products;
- *Views of products together*: that enable the combinations of products with different colors, textures and fabrics (Beck, 2000; Song, Kim, 2012).

For Then and Delong (1999), presenting products by several angles and through zooming affects the shopping experience of customers, and most of all they influence their purchase intention (Then, Delong, 1999).

Song and Kim (2012) have conducted a research to find out whether visual product presentation may affect mental intangibility and interaction effect on customers, whether customers prefer small or large photos and whether it's better to show more or less views of a product. The result was that photos affect mental intangibility of products online, that there is no interaction effect of presentations on mental intangibility and that photos affect the perceived amount of information by customers. Furthermore consumers, in case of small photos, feel that more views are more effective, while for large picture it is better to have less different views (Song, Kim, 2012).

Then and Delong (1999) found a positive relationship between the amount of information provided to customers through the visual display of products and the intention of customers to purchase that apparel online. Furthermore through their survey they have found out that there are three aspects in visual presentation of products that provide efficient information to customers in online shopping: representation of products as close to the end use as possible, presentation with similar products, photos from different angles (Park, 2002; Then, Delong, 1999).

According to Khakimdjanova and Park (2005), e-tailers can exploit different types of visual presentation: the main presentation, in the list-view of products, can show different types of photo, like human model wearing the garment, mannequin, hanger, or flat; the techniques that can be used are two-dimensional, three-dimensional, rotation, enlargement, etc.; it is also useful to show the alternatives of color for a product through cross-presentation. Beyond these possibilities Khakimdjanova and Park (2005) state that customers prefer to see photos in which products are worn by human models, since this provide the customer with the closest "physical" experience possible.

4.7 Accurate Descriptions

According to the survey made by Kim and Lennon (2010), a detailed product description is a more efficient factor in influencing positively the decision-making process of customers than the size of the pictures through which the product is displayed, leading customers to higher purchase intentions.

Kwon et al. (1991) state that, together with the brand name, descriptions and technical details of products should be always presented to customers to reduce the risk perceived.

According to Golletz and Ogheden (2010), brands have to provide customers with good data about products and all the right information they need in order to make their customers satisfied; they should provide customers essential information on the product through a description of how to wear the garment and on color and fabric. They also state that information like product materials, wash care, shrinking percentage and a care guide should be provided to customers (Golletz and Ogheden, 2010).

Through product description consumers have the possibility to evaluate product attributes like material and natural fibers. The evaluation of these two criteria in case of in-store shopping happens through physical contact, but that are otherwise impossible to examine in online shopping (Uzan, 2014).

4.8 Home Try On

Home try on is a system which permits the customers to receive several products at home, without further costs, having the possibility to examine and try the garments and to return what does not meet their requirements.

Warbyparker.com, an eyewear brand, was the first to apply home try on for its e-commerce in 2010. Customers can choose five different glasses, receiving them with free shipping. From the delivery date they have five days to try them at home and understand which ones they really want to buy. Those glasses that consumers do not want to keep may be returned for free (warbyparker.com, 2015).

Drawing inspiration from warbyparker.com also AYR (ayr.com) have started a home try on program: hesitant customers may decide to receive different sizes of a specific model of jeans, being charged only for one dollar. In this way customers have a week to examine and try the products at home and choose the size they fit better and return for free the products they do not want to keep, being charged only for the product they have chosen (Byers, 2015).

Home try on permits the brands to decrease and, in a certain way, control the returns, providing the possibility to customers to choose the product that they prefer, in terms of tastes, size, fit, etc. (Burrows, 2014). Furthermore home try on programs make the brands expand their customer base (Byers, 2015), in particular for those customers who haven't bought from the brand before and for young customers, that otherwise could not afford to have a large amount of money charged on their credit card (Brooke, 2015).

Chapter 5: Solutions Implemented Through Technological Innovation

5.1 Introduction

In order to decrease the risk perceived by customers and the return rate, e-tailers have started to implement technologically innovative solutions, to give the possibility to customers to buy clothes online in an efficient way. On this issue, according to Hirt (2012), the tools developed can be of interactive, technical, sensory, explanatory or suggestive nature and are aimed at allowing the potential customer to examine and monitor the products in a more precise way, so that he/she can reduce the risk perceived and can be conducted to the purchase in a more efficient, quicker and simpler way (Hirt, 2012). Brands are trying to convert "touch-and-feel" attributes of clothes into "look-and-see" attributes through technological innovation (Weitz, 2010).

With respect to the solutions presented in Chapter 4, the solutions implemented through technological innovation connect the purchase step and the evaluation step. These solutions give the possibility to customers to have the evaluation step before the purchase step by letting them do the evaluation virtually, and, in this way, reproducing the structure of the purchase process of in-store shopping (Hirt, 2012). So, using the concepts of Hirt (2012), these tools permit the modification of the online process from "surfing, buying and fitting" to "surfing, fitting and buying", reproducing the same purchase process of in-store shopping. In this way customers can try in a virtual way the clothes they would like to buy, and since the problem of choosing the right size is solved before the purchase, considering also the other benefits of shopping online (like time saving, convenience, quantity of information), the online channel has more competitive advantage with respect to offline channel (Hirt, 2012).

The main goal of technologically innovative solutions is not only to achieve process optimization from the point of view of customers, but also of the e-tailers: in fact they should be easy to be adopted by customers but also easy to be integrated by e-tailers (Hirt, 2012).

These solutions provide support to customers in their online purchase process, with the aim of reducing the risk perceived by them. By reducing the perceived risk these technological tools lead also to higher conversion rate, lower return rate, and so lower costs and an increase in the reputation of the website and of the brand (Baeva, 2011).
We will describe now the main solutions developed for e-tailers and some related case studies, to see which firms have developed and in which way these solutions that facilitate customers in buying apparel online with the right fit and size, through permitting them to evaluate products virtually.

5.2 Robot Mannequins

Robot mannequins are tools developed for size optimization which are aimed at a personalized view of the product in the apparel e-commerce website. This tool is a bust that permits the simulation of the human body with the possibility of changing some parameters of the body according to different measurements, like the slope and the width of the shoulders, or the shape of the lower body (Abels, Kruusmaa, 2013). In the market can be found different types of solutions, like fix mannequins or fully articulated ones, and mannequins made of different materials (D'Apuzzo, 2007). The most important characteristic of the robot mannequin is in its structure: it is made in fact of several actuators which move the cover pieces to simulate the human body. According to different measurements of human bodies, the actuators can be controlled permitting a customized shape of the body (Abels, Kruusmaa, 2013).

Robot mannequins are used by e-tailers to show to customers how a garment fits according to different body shapes.

At first in the market only male robot mannequins were developed, since they are simpler to design and control, since for female it had to be developed also the breast region, which resulted a complex engineering issue but fundamental to solve in order to address also the female target (Abels, Kruusmaa, 2013).

In this field, one of the most important firms that developed robot mannequins for male and female customers is Fits.Me, which is presented in the following section.

5.2.1 Case Study: Fits.Me

Fits.Me is an Estonian firm founded in 2010 that developed "a shape-shifting robot mannequin", which, combined to data and information about users' bodies, lets customers find the right size and, in particular, the fit of the clothes they want to buy online in those e-commerce website that have implemented their technology (Hirt, 2012).

The robot mannequin (also called Fitbot) was developed by the University of Tartu in Estonia with the help of Human Solutions, a German firm specialized in body dimensions and ergonomic simulation. The mannequin is composed of small panels covered in Pedilin, which is a material that simulates real skin. The panels are pushed in and out by actuators that can be moved according to the combination of measurements in order to form different body shapes (Niiler, 2014).

In this way the robot mannequin they have developed simulates the human body and customers can recognize the shape of their own body in the mannequin and reproduce their body online, in the virtual fitting room.

Figure 3: Different shapes of the robot mannequin

(Source: fits.me, 2015)

The robot mannequin can be exploited in some product categories in the following e-commerce websites: hugoboss.com, thomaspink.com, prettygreen.com, hawesandcurtis.co.uk. The system is available only for English-speaking countries (hugoboss.com, 2015; thomaspink.com, 2015; prettygreen.com, 2015; hawesandcurtis.co.uk, 2015).

The process is made of the following steps (hugoboss.com, 2015; thomaspink.com, 2015; prettygreen.com, 2015; hawesandcurtis.co.uk, 2015) :

1. *The "try on" button*: the button is integrated in the product page or in the size chart section of the product page;
2. *Enter measurements*: the system requires height, neck, chest and waist measurements providing also the indications to measure the body in these specific landmarks, after entering them the system automatically calculates arm measurement (which can be slightly modified by the user);
3. *Virtual fitting room*: the virtual fitting room shows how different sizes of the garment may fit the customer; in this way the customer can choose the right size, according to the indications provided by the platform.

In case customers do not know their measurements, in step 2 they just enter height, weight, age and neck measurement. After this, they choose which size of specific landmarks (chest/bust, waist, hips) they have among small, medium, large. According to their choice, customers may see the robot mannequin changing in shape, leading to at a maximum of 27 different body shapes; in this way customers may understand whether this shape is similar to the one of their body.

In some stores, like thomaspink.com, instead of the virtual fitting room, in the last step customers choose the fit of the garment among close fit, regular fit, relaxed fit.

Figure 4: Different sizes worn by the mannequin in the virtual fitting room of hugoboss.com

(Source: hugoboss.com, 2015)

The use of this technology aimed at finding the right size and fit is available for men and women for the following types of garments: shirts, knitwear, jackets, dresses and skirts, excluding more complex garments like outerwear, trousers, shoes and accessories. The fact that the system is limited only to the upper part of the body may be considered as the main limit of this technology, since the simulation of the lower part of the body is not provided (hugoboss.com, 2015; thomaspink.com, 2015; prettygreen.com, 2015; hawesandcurtis.co.uk, 2015).

5.3 Systems Based On Algorithms

Several firms have developed algorithms aimed at advising customers on the choice of the right size of a garment according to their body measurements. The goal of these firms is to provide their services to customers or to e-tailers in order to implement their systems in the apparel e-commerce websites, so that customers, once registered in their platform and recorded their measurements in their personal account, can find the right size of the garments they want to buy. These systems are time saving, since, in this way, the platform automatically provides the right size and customers do not have to take measurements for each purchase.
We will see now the case of Fashion Metric and the case of Bodi.Me.

5.3.1 Case Study: Fashion Metric

Fashion Metric is an SaaS (Software as a Service) based on algorithms to provide customers with the right size of clothes. The system works also for bespoke tailoring services for which, due to the level of customization, it is necessary to have accurate data of customers (Piras, 2015).
Once an e-tailers has implemented Fashion Metric in its e-commerce website, the customer, by answering to few questions about his/her own measurements like chest, waist etc., has the possibility to find out the right size. After these few questions have been answered, Fashion Metric, through its algorithms, analyses data providing customers with the size they should buy for that garment (Piras, 2015).
Beyond the advantages this system can provide to fashion brands and customers in terms of return rate and of solution to perceived risk, e-tailers and brands have these data available for the creation of a database of customers which can help them to

understand their target and plan their future production and campaigns, also helping with inventory management (Piras, 2015).
The technology used by Fashion Metric is Virtual Tailor API, which provides a large amount of measurements from the few ones the customers provides (McNulty, 2015).
The service provided by Fashion Metric is licensed to their clients, which are apparel brands, retailers and customer clothiers. The cost of this service is an initial setup fee and a fee based on the API use (startupbeat.com, 2015).
Their system is already implemented in e-commerce websites like SecondButton (secondbutton.com, 2015) and Pacific Issue (pacificissue.com, 2015).

5.3.2 Case Study: Bodi.Me

In the field of the use of algorithm for size optimization, Bodi.me has developed a system to provide precise measurements to customers in a few minutes as a central solution for all the brands in the market (bodi.me, 2015).
As Lara Mazzoni, CEO of Bodi.me, stated in our interview, which can be found in Appendix A, the work on their project started in 2010, with the aim of helping customers in finding the right fit and size both offline and online. Through internal R&D, external partners, a team of fashion experts, programmers, UX experts and online marketing specialists, they developed an algorithm that allows to predict accurate size basing on body measurements which can be acquired by users in different ways: manually, through webcam and through 3D body scanners. They are trying to develop a system that allows operating at many different levels of the fashion industry, from a High Street fashion, through Uniform industry, up to Bespoke Tailoring. With respect to their competitors, Bodi.Me wants to focus only on a niche of the market; as Lara Mazzoni states: “No other size advisor provider is focusing on Uniform, eTailors and eFashion SMEs. Other competitors are focusing on large brands.”
They launched their service in 2013; the service provided to customers by Bodi.me is completely free, their revenues come from the service implemented by apparel e-tailers on their websites (Ingham, 2014).
They have developed an algorithm that permits customers to find the right size and fit of the apparel they want through three different types of measurement: manual

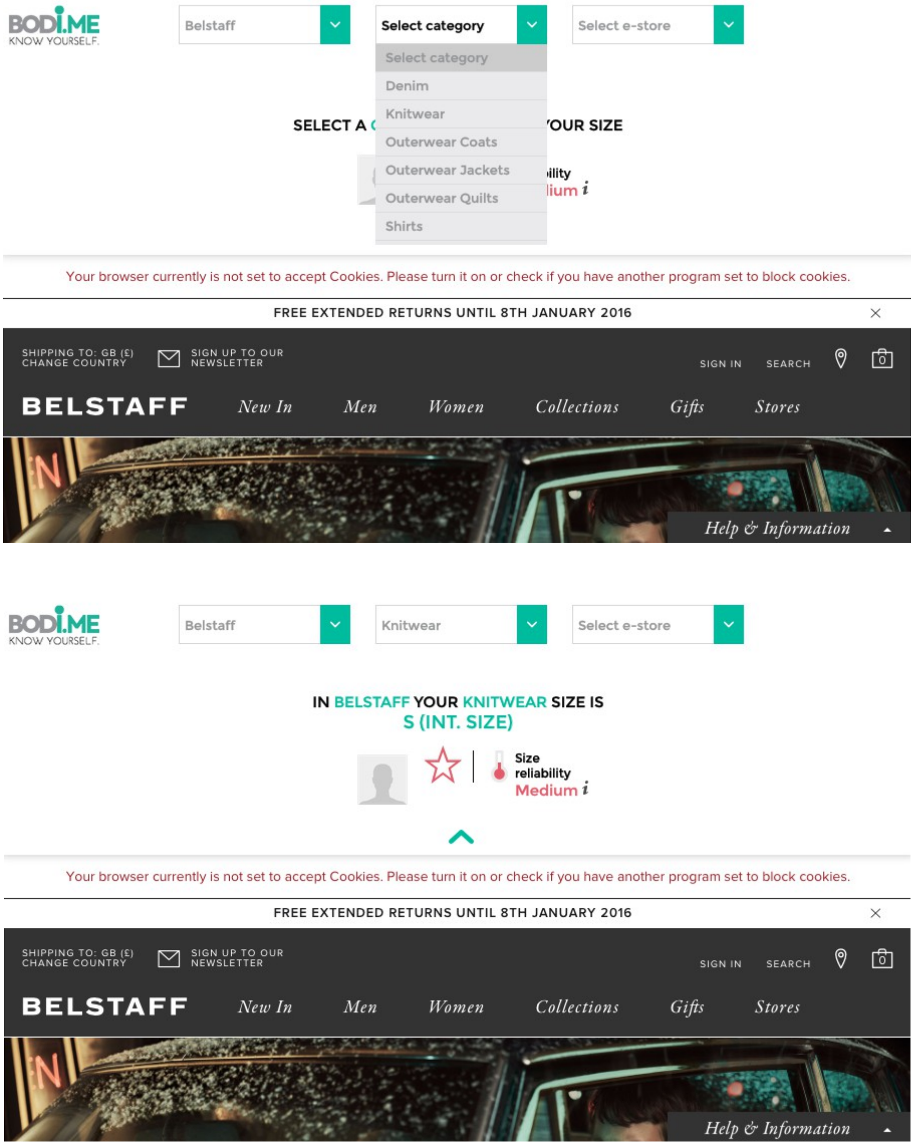
measurement, webcam measurement and 3D body scanners. We will try to describe their functionalities:

1. *Manual measurement*: customers have to take measurements of their body, create an account in the website of Bodi.me and enter their data in a form. These data will permit customers to have the database of their measurements on their account, with the possibility to update them and see also the change of their bodies over the time;
2. *Webcam measurement:* Bodi.me is developing a system to provide measurements of users only trough two photos made by the webcam;
3. *3D body scanners*: Bodi.me gives also the possibility to register 35 automatically customer's body measurements through body scanners installed in physical stores (bodi.me, 2015). Since this scenario is not common yet, Bodi.me has organized public 3D body scanner sessions in London and Barcelona to promote their technology (Maria, 2014) and also gives users the possibility to book a scan session (bodi.me, 2015).

Once the measurements have been entered in the personal account, customers can easily find their size of a specific category of garments for each e-tailer, since the size is suggested by Bodi.me, according to customers' measurements. This system gives the possibility to avoid to enter data in each e-commerce website and to have a central account which can be used for every brand. Notwithstanding the simplicity of the process, bodi.me declares to provide online “medium” reliability for the advice of the right size (bodi.me).

The business of Bodi.me has permitted a conversion rate higher by the 30% for its clients' e-commerce websites and some e-tailers that have implemented their system have increased it by the 60% (Ternent, 2015).

Figure 5: Bodi.Me system integrated in e-commerce websites



(Source: belstaff.eu, 2015; bodi.me, 2015)

5.4 Garment Comparison

A solution which is quite different with respect to the others presented in this paper is garment comparison. The garment comparison is the unique solution presented in this research which is developed without taking as a main reference the body of customers but the garments that customers already own. In this way the choice of the size and the fit of the garment desired is based on a garment that customers already own and that fit them well.

We present the case study of Virtusize, which is the unique firm that have developed a system based on garment comparison.

5.4.1 Case Study: Virtusize

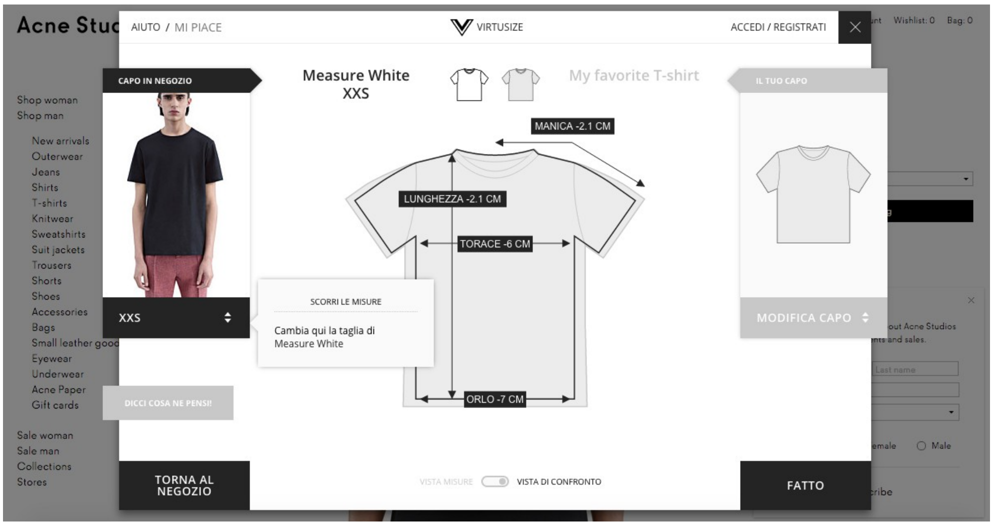
One technologically innovative solution to the problem of size that is quite far from 3D body scanners and measuring tapes is the one proposed by Virtusize, a startup founded in 2010 in Sweden. In fact, while all the other solutions involve the measurements of the human body, or have the human body as the reference of the system, Virtusize developed a B2B system which is not based on the body of the consumers but on the other clothes that they already possess. So, while for the other technologies discussed in this paper the fitting procedure is based on the human body, Virtusize's garments comparison procedure is based on the measurement of objects (virtusize.com, 2015).

Hirt (2012) highlights the difference between solutions like 3D scanners referring to them as virtual try-ons, since they reproduce online the actual fitting process basing on 3D systems, and solutions like garments comparison, which she calls “virtual advice” and which are based on a two-dimensional comparison of garments' measurements (Hirt, 2012).

In an interview to wired.co.uk (2013), the co-founder Peter Stubert declared that “The biggest misconception is about our industry rather than our business. Most retailers believe that virtual fitting solutions don't work because so many companies have tried and failed before. We believe this failure is because those companies used the wrong reference point. Previous companies painted an item of clothing to a customer's body to understand if it would fit. We believe the answer lies in comparing garment to garment” (wired.co.uk, 2013).

By possessing all the measurements of the clothes each brand sells in its e-commerce website, Virtusize permits a comparison between these garments and the reference garments of the consumers. Furthermore Virtusize's system does not have restriction in its use and it can be used for male and female measurements (Hirt, 2012). When shopping on websites that have implemented Virtusize, customers find a Virtusize button in the product page. Then the consumer that wants to buy a garment, like a t-shirt for example, has to take measurements of his/her own favorite t-shirt, a t-shirt with a similar style with respect to the one the e-tailer sells, under a clear guide provided by the platform, which explains how to take the measurements of the reference garment. Once all the measurements have been taken and entered in the platform, Virtusize lets the customer compare the two garments in all the details, like arms length, waistline, bust size, permitting him/her to choose the size and the fit that are more similar to the one of the t-shirt already in possess and that are more appropriate for the customer (Woollaston, 2014). In this way, since the reference garment is the one that fits the best the customer, the comparison of the two pieces will lead to the choice of the right size for the garment the customer wants to purchase (Woollaston, 2014). According to the firm, “it's vital that online shoppers having a way of being confident in clothing size as they do not have the luxury of using a fitting room” (Woollaston, 2014). For this purpose “Virtusize helps to solve the problem as it enables shoppers to visually compare the fit of clothing they already own and love with clothing they wish to buy” so that “[...] shoppers can be confident in how a new, untried garment will fit.” (Woollaston, 2014).

Figure 6: Garment Comparison through Virtusize



(Source: acnestudios.com, 2015)

Furthermore, after entering them, reference measurements of clothes are saved in the personal account of the consumer, and can be used for any other garments comparison among the e-tailers supported by the technology of Virtusize (Hirt, 2012).

By the point of view of e-tailers, implementation is rather quick, the complete integration takes three weeks, and the only issue e-tailers have to face is the provision of garments' measurements to Virtusize (Hirt, 2012). According to Virtusize co-founder Peter Stubert, e-tailers pay a small fee for each time a consumer uses Virtusize system on their websites (wired.co.uk, 2013).

According to Hirt (2012), the main advantages of Virtusize are its simplicity in the usage and the low time required to choose the right size (Hirt, 2012). Furthermore the possibility customers have to save the data of the garments they have already saved permits them to save even more time in their future purchases for the brands that have the Virtusize system integrated in their websites. The software is also available for international versions of websites and measurements can be switched between centimeters and inches (Woollaston, 2014).

A main disadvantage is that Virtusize's advice in garments fit and size becomes less reliable for garments that have difficult styles to measure. In this case the garment chosen for the comparison should be extremely similar to the one the customer wants to purchase, in particular in terms of fabric, fit and proportions (Hirt, 2012).

According to Tunhammar, the co-founder of the firm, Virtusize wants to become the global standard for size and fit (Hirt, 2012) and is now implemented on e-commerce websites like Asos, Acne Studios and Balenciaga and on other 24 minor apparel online stores (virtusize.com, 2015).

In the case of Asos, Virtusize reduced customer returns up to 50% (Singh, 2015).

5.5 Digital Tape Measurement

Another important technology developed for size optimization is the digital tape. This tool combines the common tape measurement with digital technology, and, behaving like a measuring tape, it is possible to take measurements of the body in specific landmarks (D'Apuzzo, 2007). The digital tape is a solution directed to customers, rather than to e-tailers and has several advantages:

1. *Efficient and fast measurement*: with respect to the classical tape this one permits a fast and precise measurement of the body, without any possibility of error (Apeagyei, 2010);
2. *Self-measurement*: while with the classic measuring tape the user may need the help of another individual, the digital tape is simpler to use and can be used efficiently by a single person (Hirt, 2012);
3. *Measurements record*: digital measuring tapes automatically record the measurements taken (xyze.it).

We will explore now the smart measuring tape developed by XYZE.

5.5.1 Case Study: XYZE

One of the main limits of taking measurements of a human body through a normal measuring tape is the difficulty in doing it alone. Taking measurements of the several parts of the body usually requires somebody that looks at the tape to define the measure of that part (Hirt, 2012). Furthermore, measurements can be wrong due to the margin of error in the procedure (e-pitti.com, 2015).

In order to find a solution to these problems and to the problems of choosing the right size and fit of garments bought online, the Italian startup Xyze has created and developed the smart measuring tape ON.

With the aim of reducing the errors in online purchase, Xyze has produced a package for users, rather than for e-tailers, which is made of three different components:

1. *ON*: on the hardware side there is ON, the smart measuring tape, which can take measurements for seven different parts of the body. Xyze has invented a “resize” technology that permits an autonomous, automatic and precise measurement, since the tape automatically adapts its shape on the user's body;

2. *Tutorial app and XYZE ID*: on the software side they have developed a tutorial application for smartphones, which helps users in taking measurements in the right way, and in which users can find all the data recorded by ON since they are immediately sent via bluetooth. After the data have been received, the application transform them into a "size ID card" which is called XYZE ID, and which contains all the measurements of the user;
3. *Mathematical algorithm*: the algorithm helps users in finding the right size according to the data taken by the smart measuring tape. In detail, the algorithm calculates the relationship between the codes of brands collections (XYCO) and the measurements of the individual. Furthermore a widget integrated in the e-commerce website gives the final advice to the customers proposing the size to choose (e-pitti.com, 2015).

Figure 7: The smart measuring tape developed by XYZE

(Source: xyze.it, 2015)

According to XYZE (xyze.it, 2015), this measuring tape allows to take body measurements as precisely as a trained tailor. As they state in their press kit (xyze.it, 2015), "You pull the tape out, put it around your head, neck, chest, waist and hips and the exact measurements are sent via Bluetooth to the On smartphone app". From this it can be derived that the measuring tape produced by XYZE cannot be used to measure all the parts of the body (arms, legs and feet are not included).

The intention of Xyze is to bring their system to a standard, in which e-tailers will sell in their apparel e-commerce websites the smart measuring tape, permitting them to reach also the measurement of shoes and accessories (Macciò, 2014).

The campaign they have launched on indiegogo.com has expired on March 27th, 2015, and the goal of 60.000 Euros, aimed at the production of ON, has not been reached (indiegogo.com, 2015).

5.6 3D Technology

5.6.1 Introduction

In apparel online shopping, the main difficulty of e-tailers is to provide the characteristics of garments, and in particular size and fit, in order to affect in a positive way the decision-making process of customers. The different sizing systems employed by e-tailers increase the risk perceived by customers and their purchase intentions, which is affected also by problems in body measurements that customers face (Kartsounis et al., 2003). One of the solutions the apparel industry is exploiting to face these problems is 3D technology.

In the last years the sector of 3D technology have seen tremendous development. 3D product development, animation and graphics, health and fitness management are just a few application field in which 3D technology had been employed (Apeagyei, 2010).

Beyond these functionalities in fact, there has been also an integration of 3D technology with the world of apparel e-commerce, through the provision of body measurements, the creation of avatar, virtual try-on and virtual mirrors based on Augmented Reality, which have led to developments not only in the ready-to-wear clothing market, but also in the one of made-to-measure garments and, as we will see, to mass customization (Ballester et al., 2014).

We present now this technology, based on 3D body scanners, we will see the ways in which this technology is exploited by the market of apparel e-commerce, and we will present the case studies of Styku, of My Virtual Model and of TryLive, which represent three firms which are providing different services based on three-dimensional technologies to e-tailers and customers. In the end we will see how 3D technology results as the basis for the creation of mass customization in the field of apparel.

5.6.2 3D Body Scanners

5.6.2.1 Introduction and History

According to Apeagyei (2010), a 3D body scanner can be defined as a tool that "scientifically extract anthropometric data in a valid and reliable manner" (Apeagyei, 2010).

3D body scanners capture the surface of the human body through optical techniques combined with light sensitive devices, and without physical contact with the body (Istook, Hwang, 2001). Over the years these systems have been employed in several application fields like statistical analysis, modeling, animation, medicine, anthropometry (Istook, Hwang, 2001), art, sculpture, ergonomics, cosmetics, biometry and fashion (D'Apuzzo, 2009).

According to Sohn (2012), the origin of the three-dimensional technology can be attributed to Douty. Douty (1968) was the first to conduct a research on the human body shape and on the fit of apparel on individuals, using the research technique called somatometry, through which the three-dimensional surface of the body could be captured by photography on the base of pattern alternations like curves and flat areas of the body. In his research, Douty (1968) also analyzed the posture, body mass, proportion and the contour of the body relating it with apparel, with the aim of improving the fit of basic garments. Through somatometry, Douty (1968) gave the birth to the study of 3D representation of the human body, and in particular in the field of the fit of apparel on individuals (Douty, 1968; Sohn, 2012).

After Douty, the use of digitalization was developed in the movie industry, in the eighties, with the creation of digital effects. With the first 3D body scanning system, the Loughborough anthropometric shadow scanner (LASS), developed by the University of

Loughborough in 1989, technology in the field of digitalization was applied for the first time in the fields of anthropometry and ergonomics (D'Apuzzo, 2009). In the nineties 3D body scanning technology was developed, achieving the first cases of application, also in the apparel industry (Sohn, 2012). In the military industry 3D technology was firstly used in the field of ergonomics and only in the middle of the nineties for the uniform fit, which represents one of the first episodes in which 3D body scanners have been used in the field of apparel. In 1998 [TC][2] launched in the market the first 3D body scanner developed specifically for the fashion industry (D'Apuzzo, 2009).

After the birth of 3D body scanners, three-dimensional technology have been continuously studied and developed, also with the creation of new methods to capture the human body figure. Its development led to the provision of a more efficient service to the users and to the realization of specific systems for specific application fields. At the same time also complementary new softwares for the collection of data resulted from scanning sessions were developed (D'Apuzzo, 2009).

5.6.2.2 3D body scanners technology

Three-dimensional body scanners are systems able to capture the external surface of the human body without physical contact with the body. The scanning session occurs through optical techniques combined with light sensitive devices, and the devices necessary for its performance are: one or more light sources, one or more capturing devices, a controller, a software, computer systems and a monitor screen to analyze the data collected (Istook, Hwang, 2001).

Through the scanning session, it is possible to collect three-dimensional clouds of points that constitute the surface of the human body; through points, lines, the surface, the shape and volume of the body, the body scanner provides a 3D digital human model (Sohn, 2012; Wang et al., 2007). As we will analyze later, a 3D body scanning session permits the extraction of anthropometric data, which represent the measurements of the human body (Wang et al., 2007); in particular it captures angles, shapes, linear measurements like length, width, and circumference (Sohn, 2012). Also the creation of a digital human avatar is possible (Wang et al., 2007) and the interaction with the avatar as well; the virtual model can be rotated, providing the possibility to observe the body shape at 360 degree (Sohn, 2012).

According to Istook and Hwang (2001), 3D body scanners may have a positive consequences in the field of apparel industry for the following reasons: in few seconds they permit the extraction of unlimited amount of linear and non-linear measurements of the human body; their flexibility permits to change location and description of the measurements can be easily changed. Furthermore this technology provides more precise and reproducible measurements with respect to tape measurements taken manually, which can easily lead to errors (Istook, Hwang, 2001). About this issue, according to Sohn (2012), 3D body scanners provide more accurate description of the body with respect standard linear methods, they are faster and less invasive. Moreover this technology can be the basis for a mass customization market since it can be automatically integrated with apparel CAD systems (Istook, Hwang, 2001).

In the field of 3D body scanning technologies, there are several systems that provide 3D scan through different ways. The following four are considered the typologies mostly used: laser scanning, white light scanning, passive methods, technologies based on other active sensors or touch sensors (D'Apuzzo, 2009).

According to our research, our interest is focused on their use in the sector of apparel e-commerce, in which they are exploited to address the problem of fitting and sizing since, as we have described before, it is one of the main concerns in shopping online both for e-tailers and customers (Pachoulakis, Kapetanakis, 2012). For this reason the research will go deeper on laser scanning and white-light scanning systems, since, according to D'Apuzzo (2009) and Istook and Hwang (2001) these two are the mostly used technologies in all the application fields, and also in the field of apparel:

- *Laser-based systems*: the laser technology implied in these systems is based on the projection of one or more thin and sharp stripes on the human body. During the projection the scene is acquired by light sensors and the external surface of the body is scanned through the application of simple geometrical rules. The stripes are generated by special optical systems and mirrors from a single laser light beam. The laser scanner unit, composed by the laser, the optical system and the light sensor, digitize the surface of the body by moving over it. The type of movement and the number of laser scanner units employed vary according to the part of the body that has to be measured (D'Apuzzo, 2009). During the scanning session the information is acquired by CCD (couple charged device) sensors, which records the surface and the displacements of the body, creating a digitized image of the body (Istook, Hwang, 2001). 3D body scanners based on this system are able to scan about 60,000 points per second (Apeagyei, 2010);

- *White Light scanning systems*: differently from laser scanners, which captures the surface of the body through the movement of one or more laser units across the body, these systems project white light stripes on the human body which are captured through cameras (D'Apuzzo, 2009). The resulting shape of the human body comes from triangulation, which means that measurements come from the curves generated by the stripes over the body (D'Apuzzo, 2009; Apeagyei, 2010). For these systems, the devices required are only a light projector and a camera (D'Apuzzo, 2009). The scanning session is faster for white light scanning systems with respect to laser-based systems. But, in order to extract measurements, white light scanning systems require more time and the area of measurements of these devices is limited; for the scanning of a wider area, like a full body scanning, more devices need to be employed (D'Apuzzo, 2009; Apeagyei, 2010; Istook, Hwang, 2001).

For every system employed, it is necessary that during the scanning session the subject of the scan wear only form-fitting clothes, in order to have an efficient capture of the surface of the body and therefore accurate measurements (Istook, Hwang, 2001).

Table 5: Different types of scanning systems

Light-based systems Company	Product	Laser-based systems Company	Product	Other systems Company	Product
Hamamatsu	Body lines scanner	Cyberware	WBX, WB4	Immersion	Micro Scribe 3D Micro Scribe 3DX Micro Scribe 3DLX Micro Scribe 3DL
Loughborough University	LASS[a]	TecMath	Vitus Pro, Vitus Smart		
TC2	2T4, 3T6	Vitronic	Viro-3D (4L 8C ST), Viro-3D (4L 16C DT), Viro-3D (4L 16CDT colour), Viro-3D	Carl Zeiss	
Wicks and Wilson Limited	TriForm, TriForm BodyScan, TriForm3 (Torso Scan), TriForm2 (Headscan), TriForm1	Hamano	VOXELAN	Faro Technologies	
		Polhemus	FASTSCAN		
		3D scanners	REPLICA, Model Maker, REVERSA, Re Mesh, RI Software, PROFA		
Telmat	SYMCAD 3D Virtual model				
Turing	Turing C3D				
Puls Scanning System GmbH	Puls scanning system				
CogniTens	Optigo 100 system				

[a] = The Loughborough Anthropometric Shadow Scanner

(Source: Istook, Hwang, 2001)

5.6.2.3 Developments In 3d Body Scanning

In the last years, spread by the developments in the field, the apparel industry has demonstrated increasing interest in the 3D technology. At the same time new solutions and tools and the improvement of the existing ones have been developed exclusively for this sector, such that their implementation in the field has begun to become established (D'Apuzzo, 2009).

New developments are present in traditional scanning systems, through the development of autonomous body scanners (D'Apuzzo, 2009). For years this technology could not be easily employed from unexperienced people, since, in order to extract precise and reproducible measurement through 3D body scanners, skills and knowledge were necessary. This fact represented a limit, since it prevented the possibility to implement 3D body scanners in physical stores to let salespeople manage it in order to offer scanning session to customers (Istook, Hwang, 2001). The autonomy of 3D body scanners represents a turning point in the sector, since it is able to solve this limit. Now in fact also unexperienced people can manage a scanning session, since it is possible to perform a completely automatic and autonomous scan, without the need of expert personnel. The unexperienced operator just has to trig the process through a button placed in the scanning cabin. Furthermore a guiding voice and video tutorial inside the cabin provide instructions and guidelines to the person who wants to be scanned (D'Apuzzo, 2009).

There has been also a development in those softwares that provide the acquisition of 3D scan data: these new solutions extract automatically data on about 90 specific landmarks of the body and also about 120 specific body measurements. Furthermore they provide compatibility with anthropometric and ergonomic norms, which represent the worldwide standard measurements for the human body (D'Apuzzo, 2009).

Other two important constraints of 3D body scanning has been solved: the huge amount of data involved for the creation of the virtual model and the impossibility to change the model. These two issues affected the use of the model for online application and animation, limiting the flexibility in its use. The solution to these constraints is represented by parameterized 3D avatars. This type of avatars gives the possibility to modify the posture and to animate the virtual human model, through the use of a smaller amount of data. This means that the virtual model has a lower definition, but the accuracy is sufficient for the provision of the needed data in the field of fashion and for its representation online (D'Apuzzo, 2009).

In terms of the latest trends in the market, some new hardwares have permitted to bring 3D scanning to a great diffusion, providing an easy access to accurate full-body scans. Microsoft Kinect, ASUS Xtion are two hardwares developed for the gaming sector, but they are used also for 3D body scanning since they track the human body of users and also the motions in real-time of the users. These tools are not only exploited by users to scan bodies or objects, but they are used also for Augmented Reality, integrating digital information into video in real time, which is already used in physical apparel stores, so that customers have the possibility to virtually try garments just staying in front of a big TV screen that acts like a virtual mirror (Pachoulakis, Kapetanakis, 2012).

Microsoft Kinect, for example, is a compact depth camera able to capture depth and image data at video rate; it is available at a low price and is as easy to use that every individual can exploit it, and no experienced personnel is required for the procedure (Tong et al., 2012).

This new type of body scanners has lower costs and lower implementation and use efforts. According to Tong et al. (2012) in fact, 3D scanning technologies like laser and white light scanners are very expensive and often require experienced personnel for their use. As a limit, Kinect scanning session is performed at about 3 meters with respect to the user's body, and this leads to low resolution and so to low quality of the results with respect to laser and white-light scanners (Tong et al., 2012).

5.6.3 Measurement Provision

3D technology is used in the sector of apparel e-commerce to collect data of the human body as a tool that provides efficient and precise measurements to customers; this is done through a collection of a large set of points of the body surface through 3D scanners (Kartsounis et al., 2003).

The development in the field of 3D body scanning technology has led to quick and consistent extraction of measurements, which has consequences on the buying behavior of customers in online shopping, providing them with the right information to choose the right size and fit of garments. In fact measurements taken through this technology are more precise and reproducible than those obtained through traditional physical body measurement ways. In this way customers have the possibility to use their data repeatedly to shop online, without the need to repeat the measurement of their body for every purchase; in case their body has faced some changes over the time data can be renewed or revised (Apeagyei, 2010). Through this system it is possible to extract one-dimensional, two-dimensional and three-dimensional data, according to the needs in the application (Wang et al. 2007).

For an efficient data extraction, landmark identification is necessary. In fact, in order to extract data in an efficient way it is fundamental to define in advance the body landmarks. This activity should not be done manually due to the complexity of data in a three-dimensional model (Wang et al., 2007). According to Wang et al. (2007) the steps for an efficient landmark identification are: pre-marking, human body mapping, geometry analysis and approximate height location determination (Wang et al., 2007).

The previous definition of body landmark is fundamental, considering the huge amount of data acquired trough the scanning session (over 400.000 points) and the final need of data required for the collection of anthropometric dimensions. According to Simmons and Istook, (2003) the body landmarks are the following 21: mid-neck/neckbase, chest/bust, waist by natural indentation/waist by navel, hips/seat, sleeve length/arm length, inseam, outseam, shoulder length, across-back, across-chest, back of neck to waist, rise, crotch length, thigh circumference, biceps circumference, and wrist circumference (Simmons, Istook, 2003).

Furthermore, before and during the scanning session are also necessary some procedures like system calibration, lighting control, scanning posture standardization and the avoidance of body movement during the scanning session. These procedures safeguard the accuracy of measurements and the quality of the virtual body model (Wang et al., 2007; Daanen et al., 1997 ; Brunsman et al., 2000).

Through the provision of the right measurements, 3D technology affects the experience and the satisfaction perceived by customers in online shopping (Pantano, Naccarato, 2010).

The use of data generated by 3D body scanners is extensive. 3D scanners provide anthropometric dimensions and the morphology of the body, creating avatars and mannequins, giving the possibility to reproduce the human body in a 3D model in scale (Apeagyei, 2010).

According to Kartsounis et al. (2003), the automatic acquisition of data coming from the measurement of the human body through 3D body scanners can be distinguished by the amount of knowledge regarding the surface of the human body contained in software algorithms. The three approaches identified by Kartsounis et al. (2003) are the following:

1. *Directly implemented measurement algorithms*: independent measurement algorithms are implemented directly for each specific measurement. Since for this approach there is not a hierarchy among different measurements, algorithms are strongly dependent on the input characteristics of the scanning session

(posture of the body, scan properties, etc.). The advantage of this technique is low implementation effort for a specific type of scan and for a specific method of measurement, but they lack in flexibility and adaptation to other types of scans or other methods of measurement for which re-implementation efforts are required;

2. *Feature-Based Measurement*: this approach is base on a hierarchy of measurements and is made of two steps: at first body landmarks are detected on the scan. After this step, other measurements are taken by applying other important parameters of the body, like circumferences and lengths, and added to the previously taken features on the scan, through defined measurement rules;
3. *Man-model-based measurement*: this method is based on a man model used as a reference structure for the scan data. The model is constructed on the basis of a skeleton and on an external surface which represents the skin of the human body. The adaptation of the body dimensions, internal structure, posture and skin of the model happens according to the data acquired by the scanning session. After this step it is possible to extract body measurements. This technique permits flexibility in terms of adaptation to other scan systems types and methods of taking measurements, but requires a fully functional man model, which requires high implementation efforts and costs (Kartsounis et al., 2003).

Beyond the use of landmarks measurements which are specific for the single user, the measurements extracted after the body scanning session may also be useful for e-tailers in the development of size chart and fit testing (Apeagyei, 2010).

In apparel industry 3D technology is used for the provision of body measurements so that customers that have obtained these data about their body have the possibility to find the right size, without the possible errors in taking manual measurements.

Some firms have developed tools to integrate this technology to algorithms that automatically find the right size of garments to customers. Bodi.Me, one of the firms we have described as a case study for the use of algorithms, provides its service also through measurements obtained through 3D scanning sessions.

5.6.4 Virtual Try-On

Beyond the extraction of specific body measurements, 3D technology is considered the solution of fit problems in apparel e-commerce also because it is used for the creation of virtual model fit trials, also called "Virtual Try-On", that can have positive effects on the shopping experience of customers (Apeagyei, 2010).

Lim (2009) defines this technology as "[...] the computer simulation that enables customers to choose their 3D avatars that are adjusted to their body measurements, select their garments, and try them on 3D avatars". Virtual Try-On can be used as virtual stores for e-commerce websites and also for physical stores, to improve customers shopping experience (Divivier et al., 2008).

In fact Virtual Try-On technology provides the possibility to customers to see themselves in scale as a virtual model, through the result of a 3D body scanning session or by entering measurements on pre-built avatars; through the generation of an avatar they can virtually wear simulated garments, respecting their body measurements and shape (Apeagyei, 2010; Kartsounis et al. 2003). The virtual garments simulate the behavior of the fabric on the virtual body (D'Apuzzo, 2007).

Virtual try-on technology provides customers with optimal fit and affects in a positive way their online shopping experience since customers have the possibility to virtually try the clothes they would like to purchase, understanding the fit of garments before the conclusion of the transaction (Lim, 2009). In this virtual dressing room, through the generation of the personalized avatar, customers can understand whether the garment they would like to buy is the right one for them, in terms of size and fit but also in terms of mix-and-match with other garments (Apeagyei, 2010).

Through the virtual reproduction of in-store try-on, this technology has the potential to decrease the distance between online and offline shopping and reduce the risk perceived by customers in shopping online (Shin, Baytar, 2014), furthermore, as a ludic factor, they contribute to the online shopping experience (Pachoulakis, Kapetanakis, 2012)

In order to apply the Virtual Try-On technology, it is necessary not only the three-dimensional avatar created by the users, but also the production of three-dimensional virtual garments.

For this purpose, there is also the need of 3D cloth simulation engines so that the behavior of virtual garments is the same of real ones with respect to the virtual body (D'Apuzzo, 2007).

According to D'Apuzzo (2007), the procedure for 3D clothing simulation is made through clothing CAD systems and is made of the following steps: at first the garment is divided in different parts as 2D patterns and, for each piece, all the characteristics of the fabric, like thickness and elasticity, are defined; after this step the block of the garment of different sizes are placed on the digital body in the 3D environment and combined together; in the end the 3D cloth simulation engine will determine the behavior of the garment on the body (D'Apuzzo, 2007). In order to reproduce virtually the behavior of the garment it is fundamental to enter the fabric model: for this purpose fabric properties can be measured by testing systems, then texture mapping permits the creation of virtual fabrics (Lim, 2009). Once the virtual clothes have been created, they can be customized according to the size of the virtual body (Mok et al., 2011).

Beyond this type of usage, 3D cloth simulation engines can be used in the production phase of garments in order to create virtual clothes prototypes (D'Apuzzo, 2007).

Notwithstanding Virtual Try-On is available on some apparel e-commerce websites, the application of this technology is not yet widely available (Lim, 2009), in particular through the exploitation of 3D scans.

We will see now the case studies of Styku and My Virtual Model: the first one proposes a 3D body scanner system for measurement provision and Virtual Try-On for made-to-measure garments, the second one a Virtual Try-On system based on body measurements.

5.6.5 Case Study: Styku

The core business of Styku, a Californian startup, is to provide the Smart Fitting Room, which is a virtual fitting room, to connect customers to the production system: through three-dimensional body scanning, customers have the possibility to collect all the data of their bodies and purchase a customized garment according to their necessities and tastes (Pachoulakis, Kapetanakis, 2012).

In fact, beyond the provision of body measurements, Styku proposes to use the scanner also for the creation of a 3D body scan model of the user with the aim of providing, in e-commerce websites, a virtual try-on technology in which customers can try on the clothing items in a virtual way, with the possibility to see how different sizes of garments fit the model (Garcia, Oroklu, 2012).

This solution, according to Pachoulakis and Kapetanakis (2012), represents a step further with respect to other 3D solutions.

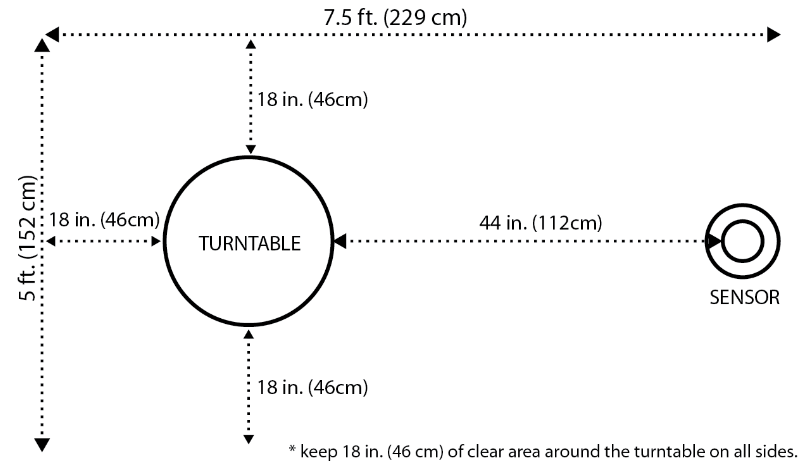
Styku business is developed through a partnership with Tukatech Apparel Technology, Critical Mass Manufacturing and AIMS apparel management system and is composed of five different stages:

1. *3D body scanning*: in the first phase of the process, customers' bodies are scanned by a 3D body scanner. Styku 3D technology is based on Microsoft Kinect, which permits the body scanning of customers and the creation of a virtual model of the body;
2. *Virtual try-on*: after the creation of the avatar, customers can try the clothes in a virtual way, such that they can examine the fit of the garment. This is made through Tukatech's TUKAcad and TUKA3D software;
3. *Online customization*: if customers need customization of a garment they would like to buy, they have the possibility to use a tool provided by Styku, that permits to design garments always checking the fit with their avatar.;
4. *Print and dye phase*: after the design of the new garment has been created, fabric printers like Critical Mass print and dye the garment through waterless and chemical-free technology;
5. *Sew phase*: in the last phase, fabrics are sewn and delivered to customers (Pachoulakis, Kapetanakis, 2012).

Beyond the possibility to create a garment customized directly by the customer, Styku developed this system to provide the right fit and size to customers, basing its business on 3D body scanning.

The 3D body scanner developed by Styku is made of two components: a Microsoft Kinect V2, which is a 3D Camera positioned on an aluminum support that has the power to collect data in 30 seconds, which, combined with depth sensors, is able to track body movement, and an automatic turntable that rotates by 360 degrees, which permits the 3D scanner to capture the full body of the user (styku.com, 2015). Their aim is to provide a solution without the use of traditional body scanners, which are too expensive per mass retail use, too slow to provide accurate measurements and bulky (microsoft.com, 2012).

Figure 8: Styku 3D body scanner



(Source: styku.com, 2015)

The measurements taken by the 3D body scanner are then transformed into data by the Styku App which gives the possibility to see the 3D model based on the scanning session, extract measurements and track changes in measurements taken by different body scan sessions. Furthermore the App permits to rotate, pan and zoom the 3D model. Since the amount of data generated is extremely high, Styku App automatically finds the landmarks of the body, selecting only the most important measurement of the body, which are those ones that can be used to find the right size of a garment (styku.com, 2015).

Styku is working with a uniform manufacturer and retailers, like Brooks Brothers and IM-Label, in the made-to-measure garments market, but still does not have implemented their service on apparel e-commerce websites (microsoft.com, 2012; styku.com, 2015).

5.6.6 Case Study: My Virtual Model

According to Lim (2009), My Virtual Model was a leader of the application of Virtual Try-On for apparel online shopping.

This Canadian company launched in 2001 "My Virtual Model Dressing Room" and "My Virtual Model Fit" which permitted customers to try different virtual 3D garments on a standard virtual model modified according to the body measurements of users. Furthermore users had the possibility to rotate the virtual model by 360 degree and see how the garment fits the body (Lim, 2009).

My Virtual Model closed in November 2009, with the aim of creating a new firm that would benefit from their technology development with a more current and open approach (Polvinen, 2010).

During their activity, the products evaluation through its technology has been applied by retailers like Adidas, Best Buy, Levi's, Sears, H&M, Land's End, Speedo and others (Salvador et al., 2009; Lim, 2009). In the period in which Land's End has implemented this system there has been an increase in the average order value of 15% and an increase in conversion rate of 45% (Salvador et al., 2009).

According to Lim (2009), My Virtual Model had limitations in body shapes, since the only three possible choices were "hourglass", "triangle" and "inverted triangles" shapes; another limitation was the choice of size, since, for the waist size, users could choose only between undefined and well-defined waist (Lim, 2009).

Now on their website (myvirtualmodel.com, 2015) is still possible to reproduce the process of the Virtual Try-On through a service called "My Virtual Size", available only for female users, which is made of the following steps: accessing their dressing room, the first step is to choose the shape of the upper part of the body among "hourglass", "triangle" and "inverted triangles" shapes. These shapes are determined mainly by hips and shoulders. Furthermore, in this step, it is possible to enter data like height and weight, bust information, frame size and waist definition and to choose among different body characteristics like hair, skin, lineaments of the face. After this step the virtual model is created and it is possible to proceed with the choice of the style (myvirtualmodel.com, 2015).

Beyond the limitations enlightened by Lim (2009) on the service provided before the closure of My Virtual Model in 2009, the system that can be tried on its website nowadays has still important limitations: first of all the Virtual Try-On is possible only for women, since the avatar is not provided for men, mix-and-match of clothes is not possible, the main part of clothes that can be tried on cannot be purchased and is not implemented in any apparel e-commerce website (myvirtualmodel.com, 2015).

5.6.7 The Virtual Mirror Through Augmented Reality

Augmented Reality, according to Nanda (2012) is "[...] a technology that helps display virtual elements in real situations". In other words, Augmented Reality (AR) permits to add virtual objects to a real-world environment through a camera, making possible the introduction of 3D objects into a video in real time. The interest towards Augmented Reality and its application are growing, being applied in fields like education, business, medicine, apparel industry and others (Parhizkar et al., 2011).

According to Nanda (2012), this technology works through the digital processing of the real-time video, which is therefore tuned and augmented with 3D elements, mixing real and virtual worlds together.

The application of Augmented Reality is becoming widely spread and it has been applied in several fields like Information Technology, economics, education, entertainment, communication and manufacturing (Lau et al. 2013)

Straka et al. (2011) define a Virtual Mirror as "an Augmented Reality (AR) system which renders an image of the user from a virtual viewpoint and creates the illusion of a mirror image". As an Augmented Reality system in fact, it permits to add virtual elements and to modify the image acting as a mirror, through the use of a camera and of a screen. In detail, the camera has a fixed position and the real-time video is streamed horizontally on the user monitor (Straka et al., 2011).

The main advantage of this technology is to provide to customers the illusion that the product is worn in the real world (Verhagen et al., 2013). The virtual mirror, in fact, try to simulate the properties of real mirrors, through the integration with virtual elements. Notwithstanding this, the mirror simulated is not the real reflection of the user from his/her point of view, but his/her image is the projection captured by the video source (Straka et al., 2011).

According to Nanda (2012), since these systems provide higher interactivity with respect to other product presentations typologies and a personalized shopping experience, they can be used also for marketing purposes. In fact they permit the access to huge amounts of data about preference of customers and other CRM insights, in particular because they could reach an extremely wide audience, since they have already been applied for PCs, smartphones and tablets (Nanda, 2012).

Virtual mirror technology is already used in physical stores (Nanda, 2012) and in some e-commerce websites specialized in the selling of accessories (like wristwatches) and eyewear.

In the sector of watches, Tissot gave the possibility for a limited period of time to try virtually the Tissot Touch collection on the wrist, through the use of a paper band to wear on the wrist, of a webcam, and of a specific software (Parhizkar et al., 2011).
In the sector of eyewear, websites propose to customers the use of real-time video or a view through a photo of the user on which 3D glasses can be added (Deniz et al., 2010).

We will see now the case study of TryLive, which technology has been implemented by Ray-Ban so that their customers are provided with an online shopping experience based on the virtual mirror.

5.6.8 Case Study: TryLive For Ray-Ban

Total Immersion, founded in 1999, has developed several solutions in the field of Augmented Reality. TryLive is one of Total Immersion solutions; it permits product visualization and virtual try-on for e-commerce websites through computer, tablets and smartphones. and it has been developed so far for three sectors: eyewear, home furniture and jewelry and watches (t-immersion.com, 2015).
Basing on their technology, in 2008 Ray-Ban launched the virtual mirror in its website so that customers are able to try virtual glasses and see how they fit on their face; this can be done in real time through the use of the webcam (Verhagen et al., 2013).

This solution can be easily adopted by the vast majority of people, since, in order to try this technology, are necessary only an internet connection, a computer and a webcam (Nanda, 2012).

This system is possible through face recognition and tracking, and is available for webcam, through a photo or a recorded video. On the side of implementation of the technology, according to trylive.com (2015), the application of this technology to a website is quite easy, since it requires only to enter lines of codes in the e-tailers website (trylive.com, 2015).

The program, developed by TryLive, a brand of Total Immersion, is based on Augmented Reality and it requires the following steps: at first the user has to match the face with an oval shape; in case the face is too close or too far from the webcam, the online application guides the customer so that the face fits the oval in the right manner. Once this step has been made, the application displays the virtual glasses on the face, with the possibility to rotate the head and see how the model of glasses fits the face. The users can switch the model of glasses according to their preferences, take screenshot of the try-on and buy the model of glasses. The user has also the possibility to use two other videos of a male and of a female models to see how glasses fit the face (ray-ban.com, 2015).

Figure 9: The Virtual Mirror on Ray-Ban's website

(Source: ray-ban.com, 2015)

With respect to physical try-on, the virtual mirror provides to customers several advantages (Yuan et al., 2011):

1. *Clear view of the face*: especially in the case of sunglasses try-on, in reality dark lenses impede a clear view of how the glasses fit the face; in the case of the virtual mirror, the view is not biased by the color of lenses, since the users are not actually wearing glasses;
2. *Easier wearing for weak eye-sight users*: trying new glasses is a problem for users with weak eye-sight, since new lenses are not graded and they have to remove the old glasses to try the new one, which is a limit of their view; with virtual mirrors users can keep their glasses on and see how the new ones look;
3. *Glasses comparison*: customers can't compare different models physically at the same time, but with virtual mirrors they can compare them through the photos of their trial or applying a maximum of 4 different models in the real-time video by splitting the screen (Yuan et al., 2011).

5.6.9 Mass Customization

3D technology, in particular through the provision of exact measurements and of Virtual Try-On systems does not have consequences only on the ready-to-wear garments market, but also, on the made-to-measure garments market (Apeagyei, 2010). As we will see, this possibility given by 3D technology results as the basis for the creation of mass customization in the field of apparel (Istook, Hwang, 2001).

Mass customization is defined by Lim (2009) as “the integration of standardized processes of mass production with information technology that allows efficient production of individually tailored products and services on a comprehensive scale” (Anderson-Connell et al., 2002; Lim, 2009; Zipkin, 2001).

Through mass customization, consumers have the possibility to change the characteristics of the ready-to-wear garments of a brand in order to meet their personal requirements in terms of style, fabric, color, size etc. Once the choice of the specifics has been made and the transaction has been concluded by the customer, the manufacturer creates the customized garment according to the specifications required in a few days (Lim, 2009).

Through 3D technology, customers can have the scan of their body and submit their measurements and specifications to apparel brands in order to buy a garment produced according to their requirements (Rzepka, 2011).

According to Anderson-Connell et al. (2002), 3D body scanning technology will permit to apparel brands the supply of mass customized clothes to their customers. Customers will have the possibility to try-on virtually the products and see how they fit on their body, increasing their satisfaction and customer loyalty due to the possibility of personalization of clothes (Anderson-Connell et al., 2002).

In order to develop mass customization, information technology and automation are fundamental to apply in the process, so that the requirements of customers and the ability of the manufacturer will be connected for the realization of the customized product (Apeagyei, Otieno, 2007).

Beyond 3D technology, mass production will be spread also through made-to-measure pattern development, web-enabled data transport, single ply cutting, computerized routing (Anderson-Connell et al., 2002) and CAD systems; in particular CAD systems, according to Apeagyei and Otieno (2007), are increasingly being adopted and becoming a basic tool of the industry.

Due to the specificity of the information required in terms of size and fit, Virtual Try-On and measurements captured using 3D technology become of utmost utility. According to Lim (2009), Virtual Try-On technology, by allowing customers to try garments on the avatar and by the full provision of their body measurements, permits the creation of a unique design through the choice of specifications like silhouette, fabric, color, and further decorating details (Lim, 2009).

In terms of fit and size, 3D body technology in this field would therefore replace the use of size charts, by providing the exact measurements of the body and by the creation of garments according to the precise body shape (Apeagyei, Otieno, 2007).

On the side of e-tailers, mass customization strongly depends on the degree through which they are able to provide specific characteristics to their products, with low delivery times and appropriate costs (Rzepka, 2011).

Brands like Levi's and Brooks Brothers have been able to implement mass customization for specific garments of their collections. Brooks Brothers offers 3D scanning sessions in its New York flagship store. Through the scan, which acts as a “digital tailor”, customers can buy customized garments (Rzepka, 2011). Levi Strauss & Co., for a period, launched the program “Levi's Original Spin” through which it gave the opportunity to customers to have a 3D body scan in its San Francisco flagship for the creation of a pair of jeans customized by each customer (Lim, 2009).

Chapter 6: Findings and Discussions

6.1 Introduction

In this chapter we will analyze the solutions developed through technological innovation that we discussed in Chapter 5, through a review of their main advantages and disadvantages. Where possible, a further analysis will be done through the use of a extended TAM model, in order to predict the acceptance of the solutions by users. About this issue, we will exploit the survey of other scholars where possible, for the other solutions we will analyze the benefits and constraints found. Then we will understand how these solutions may affect each actor of the market, which solution may become a dominant design for the apparel industry and how 3D technology in particular has the potential to change the market.

6.2 Analysis Of Solutions With Technological Innovation

6.2.1 Robot Mannequins and Fits.Me

Robot mannequins have the power to show to customers a personalized view of the product, since it is possible to model the mannequin according to customers' measurements and see how a product fits the body according to different shapes (Abels, Kruusmaa, 2013).

According to Abels and Kruusmaa (2013), with respect to Virtual Try-On systems, the robot mannequin provides more realistic and trustworthy try-on experience to customers, mainly in terms of images.

According to the survey made by Hirt (2012), the fitting process through the robot mannequin of Fits.Me is easy to use and indications provided are clear. On the constraints, customers need to measure themselves which is perceived as a difficult procedure and it is often necessary the help of a third person for taking measurements with the tape. Furthermore the choice provided in terms of size is restricted to five different sizes, limiting the choice to the most central part of the spectrum of the sizing systems and therefore limiting the choice of customers (Hirt, 2012).

There are limits also in the use of the mannequin on the side of e-tailers: since the mannequin can assume a huge amount of different shapes and proportions, it is difficult for e-tailers to manage this range of different possibilities for the different fits of garments (Hirt, 2012).

According to the survey of Hirt (2012), still the system is not precise in providing an instrument to choose the right size of a garment.

Furthermore Lara Mazzoni, CEO of Bodi.Me, stated in our interview (Appendix A) that "Technologies like Fits.me are difficult to start to use. They are expensive for SMEs and are not profitable with small inventory and little online sales"

Fits.Me over the time has solved the limit of sex of their mannequin: at first only the male version of the robot mannequin was developed, because it was simpler to design and control. Only later Fits.Me developed the female version, which was difficult to complete because of the necessary development of the breast region (Abels, Kruusmaa, 2013).

Since the system has been developed only for the upper part of the body, still is not possible to apply it for the other parts of the body, like legs, feet, etc. (hugoboss.com, 2015; thomaspink.com, 2015; prettygreen.com, 2015; hawesandcurtis.co.uk, 2015).

6.2.2 Systems based on algorithms, Fashion Metric and Bodi.Me

Firms like Fashion Metric and Bodi.Me have developed algorithms that provide size advice through a platform integrated in apparel e-commerce websites. Customers need to enter their body measurements and the size advice is provided according to the brand's e-commerce website in which they want to buy a garment. Through few clicks and the possibility to record body measurements on a personal account, these systems result to be time saving.

Fashion Metric provides an integration to apparel e-commerce website, so that customers, by entering body measurements can find out the right size of the apparel of that brand. This system can provide a decrease in the return rate and in the risk perceived by customers; furthermore brands have available data about customers that can provide knowledge about their target and can help in the production phase and marketing campaigns (Piras, 2015).

Like Fashion Metric, Bodi.me has developed an integration for e-commerce websites based on an algorithm that predicts the size on the base of customers' body measurements. This can be done manually, i.e. with a measuring tape, through the webcam and through 3D body scanners. Their main target within the market, according to our interview with Lara Mazzoni (Appendix A), the CEO of Bodi.Me, are Uniform brands, tailors online and SMEs.

For customers, their service is free, their revenues come from the service implemented by apparel e-tailers on their websites (Ingham, 2014).

As Lara Mazzoni, CEO of Bodi.Me stated in our interview (Appendix A), in order to establish their system as a dominant design in the market, they need for opportunities in the start-up international community for both growing the business and investments, to have the right business investor for a 3-4 years growth plan.

In the interview she also declares that one of the main limit for which their technology has not become established yet is that customers still do not trust size advice solutions.

6.2.3 Garment Comparison and Virtusize

Garment comparison solutions have the advantage of not implying the measurement of the human body, for which accuracy is difficult to reach due to human error and to interpreting in a subjective way the body landmarks to be measured (Apeagyei, 2010). Through this system the garments already owned by customers become the reference for the determination of the size of clothes to buy online.

According to Hirt (2012), Virtusize is perceived as a simple tool to find the right size of garments. The system in fact is not based on the measurements of the human body, which is considered time-consuming and tedious, with results that can be affected by human errors (Wang et al., 2007), but on a garment which the customer evaluates to be a reference due its fit on him/her body. For this reason the process of measurement and the procedure to find the right size are easy and fast, also because reference garments can be saved in the personal account of the customer and used for other purchases, decreasing even more the time necessary for future online shopping. As a constraint, in order to purchase garments with a particular fit it is necessary to find a reference garment with a very similar style (Hirt, 2012).

According to the co-founder of Virtusize Gustaf Tunhammar, interviewed by Hirt (2012), the brand Nelly, which has implemented Virtusize's technology on its e-commerce, has seen a decrease of 50% on return rate and an increase of conversion rate of 20%. Virtusize had a positive impact also on Asos, with reduced customer returns up to 50% (Singh, 2015).

According to the survey of Hirt (2012), in which the TAM model has been used, the solution proposed by Virtusize is easy to use, perceived as useful and efficient in finding the right size: these are the main characteristics that this firm wants to exploit in order to become the global standard for size and fit (Hirt, 2012)

For e-tailers, this solution requires only a quick implementation: Virtusize requires only the measurements of the garments belonging to their collection (Hirt, 2012) and a small fee for each time a consumer uses Virtusize system on their website (wired.co.uk, 2013).

Virtusize is available for female and male garments. It can be used for clothes worn on the upper part of the body and on the downer part. Shoes and accessories are not included in the system (acnestudios.com, 2015).

At the moment Virtusize has been implemented on 27 apparel e-commerce websites (virtusize.com, 2015), which represents the highest number of implementations among the systems analyzed in this research.

6.2.4 Digital Tape Measurement and XYZE

The digital measuring tape is a tool that provides body measurements in a more precise, easier and faster way to users, with respect to traditional tapes.
According to Apeagyei (2010) in fact, the smart measuring tape, with respect to the traditional measuring tape, provides a more accurate measurement, since human error is deleted by technology; measurements do not have to be tracked by individuals, the

smart tape provides them automatically (Apeagyei, 2010). Furthermore it prevents the need for a third person to help in the measurement procedure and the procedure is faster (Hirt, 2012).
Notwithstanding the advantages, this tool does not solve the problem of finding the exact location of body landmarks, so that determination of landmarks remains a subjective issue (Apeagyei, 2010).

Furthermore, according to Sohn (2012), linear measurements of the body, like length and circumference, are not an efficient input for size optimization, since, while the human body is three-dimensional, they provide only two-dimensional measurements, not reflecting the body shape. In fact even though for different bodies the measurement of a specific part of the body can be the same, the shape of that part may be different (Sohn, 2012).

XYZE has developed a smart measuring tape called ON, with the intention to bring their system to a standard, having the goal of selling it also in e-tailers' apparel e-commerce websites (Macciò, 2014). At the moment this scenario has not being reached, and the measuring tape is available only through the pre-order on indiegogo.com, (indiegogo.com, 2015).
About the cost for using ON, on the customers side, this smart measuring tape can be purchased at the price of 63.37 dollars (59 euros). On the side of e-tailers, they need to integrate the system in their e-commerce websites, so that measurements are recognized by the platform and customers can easily choose the size of the garments. For e-tailers the cost of the implementation of XYZE system is 1377,79 dollars (credit2b.com, 2015).
A constraint of this system is that it does not provide advice on size for shoes and accessories (Macciò, 2014), in fact the smart measuring tape cannot provide measurements for all the parts of the body; arms, legs and feet are not included so far (xyze.it, 2015).

6.2.5 3D body scanners

6.2.5.1 Advantages and Constraints of 3D body scanners

As we have seen in the previous chapter, 3D technology in the form of body scanners enabled the possibility to easily provide body measurements, the creation of Virtual Try-On and of Virtual Mirrors, which have made possible not only the creation of systems that aim at helping customers to find the right size and fit of clothes they want to buy online, but also studies on body measurements, sizing systems, body shapes and the categorization and classification of human bodies. Furthermore this technology has also permitted several other important initiatives in the apparel market, like the creation of tests of garments on body shapes, according to different target markets and the validation and revision of sizing systems (Apeagyei, 2010).

Notwithstanding the several advantages that 3D body scanners brought, this technology has several limitations in its functionalities, like in the extraction of data of some parts of the body, like hair and armpits. Moreover, since they scan the human body in a horizontal way, the horizontal areas of the body, like under the chin and on the shoulders, are poorly sampled (Kartsounis et al., 2003). There are also problems in some areas in which data are not recorded, which are translated into gaps on the resulting 3D surface. Other limitations are in details like body hairs, skin tone and the clothes worn during the scanning session affect the quality of the scan (Apeagyei, 2010).

In terms of the quality of the scan, the body natural movements during the session affects the results. This is due to the difficulty for individuals to remain still for the whole time of the scanning session for common actions like breathing, which implies expansion and contraction of the body, which translates into natural movements. Due to natural movements of the body, its surface constantly changes and also worn garments may be distorted by the movements, affecting the quality and the results of the scanning session (Sohn, 2012). However about this issue, D'Apuzzo (2007) states that the uncontrolled movements of the body are a problem only with laser scanners, since, with respect to white-light scanners, they require more time for the acquisition of data.

Furthermore laser and white-light scanners, are an expensive instrument and tools that

can be managed only by experienced personnel (Tong et al., 2012). According to D'Apuzzo (2007), the price of a full body scanning system goes from 20.000 euros up to 400.000 euros. Moreover the choice of a specific type of body scanner affects significantly the results that can be obtained, since each system provides different types of results, like point clouds, surface models, textured models, unprocessed data, etc. (D'Apuzzo, 2007). For this reason the choice of a specific scanner must be evaluated in advance according to the desired measurement part, the expected quality and type of results desired, the limitations regarding processing and of physical location, and the field of application for which the system is going to be exploited (D'Apuzzo, 2007).
Ultimately, another important constraint of this technology is the size of the scanner booths, since the space they require affects the space available in physical stores, which translates into a cost (Istook, Hwang, 2001).

All these limitations, and in particular the costs and the knowledge required for their use, prevent this technology to become a dominant design in the field of apparel for size optimization purposes, since this tool could not be easily bought and managed by the general public (Peng et al., 2012). A wide diffusion of this technology is not possible also for e-tailers, due to their costs in terms of buying the machine and of experience personnel required to make it work.
Notwithstanding the limitations of laser and white-light body scanners, in the last years there has been a large cost reduction in the necessary equipment, making this technology a candidate for the resolution of the problem of size and fit of the apparel market (D'Apuzzo, 2009). In fact the market has seen the introduction of Microsoft Kinect and of ASUS Xtion, two hardwares that had their birth in the gaming sector but that are exploited also for 3D body scanning and Augmented Reality. These two hardwares are easier to use and their prices are extremely lower with respect to laser and white-light scanners, permitting the access to this technology potentially to everybody (Pachoulakis, Kapetanakis, 2012). In this way the appearance of low cost scanning technologies in the market is facilitating the use of scanners both by individuals and by e-tailers (Ballester et al., 2014). However, with respect to laser and white-light scanners, hardwares like Microsoft Kinect provide lower quality results and lower resolution (Tong et al., 2012). Other important developments in this field are in the functionality of

laser and white-light scanners, since now the systems permits automation in the scanning process and an easier acquisition of data from the body scan (D'Apuzzo, 2009).

6.2.5.2 Measurements Provision

Obtaining body measurements through 3D body scanners has several advantages, since, with respect to measuring tape, scanners are faster, more accurate and more consistent; manual measurement is time-consuming and tedious and the results obtained through this method can be affected by human errors and subject variations (Wang et al., 2007). But even if this technology permits a more accurate definition of body measurements, the problem of determining body landmarks remains (Simmons, Istook, 2003).

Also according to Apeagyei (2010), manual measurement procedures can provide invalid, unreliable and subjective results, furthermore 3D body scanners provide measurements without physical contact (Apeagyei, 2010). Beyond the speed and the accuracy, 3D body scanning provide reproducible measurement data, since they can be recorded and used several times, and revised in case of body changes (Istook, Hwang, 2001).

According to Pantano and Naccarato (2010) the use of this technology for this purpose has positive consequences on customers' online shopping experience and on their satisfaction derived from it (Pantano, Naccarato, 2010).

Beyond the positive effects that the provision of measurement by 3D body scanners have on customers side, this solution provides several advantages also to apparel brands. First of all because anthropometric data are the basis for the validity and the reliability of sizing systems created in the garments production phase, in particular when the production must address the needs and requirements of different markets and targets, which may have different body characteristics. About this issue, apparel retailers and manufacturers are continuously trying to create niches and to target customers, and this exploitation of 3D body scanners, which enables a deeper knowledge of sizing systems, provides advantages for standardization, labelling, stock management and to the production of size charts. Furthermore data resulted from body scanning may respond to several needs of the apparel industry like made-to-measure production, customization, fit trials, the production of standardized sizing systems for specific targets, creating niches and efficient and rapid prototyping (Apeagyei, 2010).

On the side of constraints, in order to be efficiently used, data obtained from scanning sessions need to be processed, compressed and eventually edited through a software; first of all because the amount of data produced with the scan is huge and the main part of the data are not useful for finding body measurements in the field of apparel (D'Apuzzo, 2007), and moreover because the direct result of the scan contains “surface gaps”, which are areas of the body in which information is not provided due to occlusion effects (Kartsounis et al., 2003).

Furthermore, the actual limit of body scanners, for which is not possible to exchange scanned data of a specific body scanner with other systems, makes impossible to use scan data for stores that exploit other systems (Apeagyei, 2010).

6.2.5.3 Virtual Try-On

The main advantage of Virtual Try-On is that, through the virtual simulation, customers are provided with more accurate information about products with respect to static photos and descriptions. Furthermore also the interactivity of the shopping experience is positively affected by Virtual Try-On, and for this reason the intentions of customers may be positively influenced (Kim, 2012). An important advantage of Virtual Try-On, that affects the production side of the apparel industry, comes from the 3D simulation of garments, which has positive effects on the production phase, since it reduces the length of the development process and the costs in the creation of product prototypes (Mok et al., 2011).

Beyond the limitations that we observed for 3D body scanners, like the problems in scanning certain parts of the body, there are also important constraints in the creation of 3D apparel.

First of all, as the survey of Mok et al. (2011) reveals, for some specific types of fabrics the simulation does not perform efficiently and virtual fabrics look significantly different with respect to real ones (Mok et al., 2011).

According to Abels and Kruusmaa (2013), one of the main disadvantages of Virtual Try-On is the difficulty of e-tailers in obtaining data related on clothing properties and cutout disadvantages, necessary to make an accurate model of the garments.

Problems in the creation of 3D garments also arise in terms of costs and knowledge required: according to Cheng et al. (2009), the cost for the creation of 3D garment models through CAD/CAM technology, which starts with the creation of 2D CAD clothing patterns of real apparel, leads to costs both in terms of the price to buy and maintain a virtual fitting room and in terms of experienced personnel. The cost is such high that e-tailers of the ready-to-wear market cannot bear them and implement this system (Cheng et al., 2009).

Also the images provided of the Try-On simulation are not realistic or trustworthy for customers (Abels, Kruusmaa, 2013).

6.2.5.4 Styku

Now we analyze the technology and the implementation level which have been developed by Styku through its system based on 3D body scanners which aims at the provision body measurements and Virtual Try-On.

Its service aims at providing customers with a better online experience through the visualization of products on the body before the purchase. On the e-tailers side, Styku declares to increase conversions in 3 months by 126%, to decrease the losses generated by returns, providing customers with the right size of the garments. Furthermore through the spread of Styku system, e-tailers can take advantage of aggregate measurement data of customers for production, design and marketing purposes (microsoft.com, 2012).

About this solution, the main limitation of Styku is that it does not provide a complementary service needed for Virtual Try-On, which is the creation of 3D garments and garment simulation, forcing e-tailers to solve this issue with other suppliers of the

service. Furthermore other two constraints are that, for the implementation of this solution, e-tailers need special hardwares and that the cost of Styku's service is high for e-tailers. About these issues in fact, Lara Mazzoni, the CEO of Bodi.Me, stated in our interview (Appendix A): “We can say Styku builds scanners. But it does not fit exactly the needs of brands because it does not scan clothes. It is not usable by clients because requires special hardwares and is too expensive.”
According to fibre2fashion.com (2012), the prices for the online implementation are 29 dollars per size of each garment, 10 dollars for each customer that exploits their technology, plus a 2% fee on transactions for size and fit recommendation, and a 3% fee on transactions for Virtual Try-On. However the body scanner is available only for physical stores at a price of 10.000 dollars, with a yearly fee of 1.000 dollars for the license of the software (fibre2fashion.com, 2012).

The service that Styku provides is still very limited: according to styku.com (2015), their online service has been completed in the development only for fitness and health purpose, while online solutions for the apparel industry are still not ready. For this reason their technology has not been implemented by any apparel e-commerce website yet (styku.com, 2015).

6.2.5.5 My Virtual Model

My Virtual Model provided until 2009 a service that enabled customers to change a virtual avatar according to their physical characteristics, and most of all, the measurements of the body in order to choose a garment and try it on online, according to the preferred choice of fit (like, loose, comfort, tight, etc.). This service was provided in its website and on the websites of some famous e-tailers, like H&M, Adidas, Levi's, etc. During its activity, My Virtual Model has led its clients to an increase in conversion rate from 15% to 45% and to an increase in the average order value up to 165% (Piller, 2008).

As we have discussed in the relative case study in the previous chapter, My Virtual Model had several constraints: there were limitations in building the avatar according to the body of the users, since the possible choices of the shape of the body did not cover a large spectrum of different possibilities (Lim, 2009). On the service provided nowadays on myvirtualmodel.com, (2015), the limitations are the following: the service is provided only for female users; mix-and-match of clothes is not possible; garments have a low definition, not permitting the customer to understand the fit and the fabric of clothes; the main part of clothes cannot be purchased on any website and it is not implemented in any apparel e-commerce website (myvirtualmodel.com, 2015).

The survey made by St-Onge et al. (2008) revealed several important results about how users perceived My Virtual Model: the use of the avatar had impacts on the perceived quality, attitude and stickiness of a website, that customers perceived more in-depth information about products but that the system did not influence customer's attitude toward an e-commerce website (St-Onge et al., 2008).

Furthermore, as proven by the survey of Lim (2009), Virtual Try-On avatars like My Virtual Model may be perceived by customers as not similar to their bodies.

6.2.5.6 The Virtual Mirror through Augmented Reality (TryLive for Ray-Ban)

The Virtual Mirror permits customers to try on a product in real-time through the use of Augmented Reality. In this way customers are provided with the illusion that they are wearing a product in the real world (Verhagen et al., 2013).

According the survey made by Verhagen et al. (2013), virtual mirror systems are perceived by customers as a more interactive and vivid product presentation with respect to the photos of the product or the 360 degree rotation presentation. Furthermore they found that virtual mirrors contribute to product tangibility and likability which are variables that strongly affect the online shopping experience of customers and their purchase intentions (Verhagen et al., 2013).

Moreover the interactivity provided by Virtual Mirrors can be exploited not only for improving the shopping experience of customers, but also to exploit data on preferences of customers and other insights for marketing purposes (Nanda, 2012).

An important constraint of the Virtual Mirror is in its application, since so far it has been applied only for the try-on of accessories, like eyewear, wristwatches, and not for clothing.

According to the survey made by Parhizkar et al. (2011), the Virtual Mirror implemented on the website of Ray-Ban respects the following criteria: quality of the application design, simplicity in the use of the Virtual Mirror, usability, in terms of the use of the interface, efficiency, in terms of time and effort to use it, and availability, in terms of necessary time to use the application (Parhizkar et al., 2011).

As enlightened in the previous chapter, the Virtual Mirror implemented by Ray-Ban let customers evaluate the try-on without being biased by the lenses, since the user is not wearing real glasses, it permits weak eye-sight users to keep their real glasses and evaluate the virtual ones (which is not possible in reality), and to easily compare different models of glasses by splitting the screen (Yuan et al., 2011). On the constraints side, the Virtual Mirror has only a limited selection of models (ray-ban.com, 2015).

6.2.6 The evolution of the apparel industry through 3D technology: Mass Customization

As we have seen, the implementation of these technologies in the market of apparel is still quite slow and the main part of the solutions which imply technological innovation has been implemented just by few apparel brands, which means that a dominant design is not present in this market yet and that the industry is still in the “era of ferment” theorized by Anderson and Tushman (1990). One of the causes of this fact may be that, notwithstanding these technologies bring many advantages, they all have many constraints on the side of e-tailers and of customers.

Notwithstanding this, the problem of fit and size still remains of utmost importance and apparel brands are continuously trying to solve it in order to meet customers requirements and satisfy customers' demand. According to Apeagyei (2010), conventional competitive advantages in this market are not sustainable anymore, and a new business paradigm has emerged which seems to be the solutions to the problems of customers in finding the right size and fit of clothes online: mass customization (Apeagyei, 2010).

As we have seen in the previous chapter, mass customization permits the customers to change the characteristics of ready-to-wear garments according to their personal requirements, with the possibility to choose different styles, fabrics, colors, sizes, fits, etc. (Lim, 2009). Apparel mass customization is made possible in particular by 3D technology, which permits the precise extraction of those body measurements needed for the modifications on garments that customers require (Rzepka, 2011). Through this business paradigm, once the specifics of garments have been chosen and the customer has concluded the transaction, the manufacturer realizes the customized garment in a few days, according to the specifications of the customers (Lim, 2009).

Today consumers are looking for a more personalized experience in terms of products, which translates into an increasing demand of a wider choice of unique products, passing from the ready-to-wear garments era, in which standardized products are offered to customers, to the era of made-to-measure clothes, for which the mass customization based on 3D technology is the key for its implementation. In fact, through the exploitation of rapid collection of data provided by 3D body scanners, the focus of apparel industry is shifting from mass production to mass customization, which enables customers to require customized features for the production of made-to-measure garments at competitive prices and fast turnaround times (Apeagyei, 2010).

The 3D technology not only has the advantage of providing precise body measurements, but it gives also the possibility to keep them permanently for future purchase. This advantage increases also the possibility to shop from several apparel brands: customers will buy garments that are cut according to their body specifications which will results in garments with a better fit with respect to ready-to-wear clothing (Rzepka, 2011)

According to Peng et al. (2012), the benefits that apparel mass customization will bring through 3D technology are several: on the customers' side, the fit of garments will be better since the body shape of customers will be respected due to the precise measurements provided by 3D body scanners; since the fit of garments will be right for customers, returns will be reduced and so will be for the costs for managing returns, of the products returned which remain unsold and of customer service (Peng et al., 2012).

In order to provide apparel mass customization, manufacturers and retailers need to make capital investments in the necessary technology, and also in flexible production and distribution systems. It will be necessary also to invest in time to learn, and this is valid both for companies, which have to learn the new processes, and consumers. Furthermore they will have to engineer products and develop consumer services to support customization (Anderson-Connell et al., 2002).

According to Senanayake and Little (2010), the success of mass customization will depend on how efficiently companies will handle the extent of customization in apparel design, development, production, and delivery (Senanayake, Little, 2010).

On the customers side, Berman (2002) states that mass customization will provide customers with a more reliable fit of clothes, with respect to mass production. This improvement in the provision of the products to customers and by letting customers to choose according to their needs and preferences can be seen as a competitive advantage (Peng et al., 2012).

According to the study conducted by Fiore et al. (2004), apparel mass customization not only increases value perceived by customers through the development of differentiated and unique products but it also provides experiences that affect customers' purchase intentions (Fiore et al., 2004).

The survey made by Anderson-Connell et al. (2002) revealed that there is an interest of customers in customizing apparel. Also the expansion of individual research and selection capability were seen by customers as positive points of mass customization. However the survey revealed also that customers may feel unconfident with the freedom they have in the personalization of garments; in particular they may feel anxious in the creation of the design of garments, uncertain in their creativity and unable in technical skills, like in the use of CAD technology (Anderson-Connell et al., 2002).

Chapter 7: Conclusions

With this research we have examined in depth some of the most important solutions developed through technological innovation aimed at solving the issue that both customers and apparel e-tailers face in the field of apparel e-commerce: the problem of size and fit in purchasing clothing online.

The research started with a study on apparel e-commerce, focusing on its characteristics, on its components and, in particular, on the theoretical elements that compose the issue of finding the right size and fit in online shopping. The problem of size and fit has been studied by the point of view of customers mainly, but also by the point of view of e-tailers, which are continuously trying to solve it, through different systems which involve or not technological innovation.

At first we have analyzed some solutions which can be developed without the use of technological innovation: these solutions may solve the problem of this industry through the provision of more information to customers in the product page, through an online shopping experience enhanced by usability, through the Home Try On or through the return to the unique sizing system, which would solve the problem through the removal of the differences in sizing among countries or among apparel brands. These solutions may solve only partially the problem due to their limitations in realization or in the low impact they may have on customers' decisions.

We have further analyzed some solutions which face the problem of size and fit through technological innovation. We have studied the characteristics of each solution and we examined the products and the services developed by firms and startups through several case studies.

What has emerged from this research is that these solutions, notwithstanding the potential impact they have or may have on the market and on the industry, are still limited due to their several disadvantages, which can be seen as the causes for such a slow implementation by the side of e-tailers and for which a dominant design has not emerged yet.

The most interesting aspect that has emerged is how the 3D technology not only has the potential to solve the issue of size and fit, but is also creating the possibility for the development of a new paradigm in the apparel industry: mass customization. 3D technology, by allowing customers to try garments virtually and by the provision of body measurements, permits the creation of customized garments in which customers will have the possibility to choose fit, fabric, color, and other details. In this way the apparel market, which is now based on the mass production of ready-to-wear garments, could change in favor of mass customization, for which ready-to-wear garments will be easily customized according to the preferences and the requirements of customers, solving the issue of size and fit and providing them with a more satisfying shopping experience.

Appendices

Appendix A

Interview with Lara Mazzoni, CEO of Bodi.Me

How was the starting point of Bodi.Me?

The birth of Bodi.Me was in 2010, trying to solve a real problem that customers face when they shop clothes: to find the right size online and offline. At first we analyzed this problem, and then we realized which kind of solutions we could provide. The fashion online sales are recently experiencing considerable growth. Bodi.Me provides a platform with ready-to-implement tools to address the very low conversion rate of 0.5% in transactions that the apparel industry faces, as well as returns due to wrong size. Our system allows operating at many different levels of the fashion industry, from a High Street fashion, through Uniform industry up to Bespoke Tailoring.

What has Bodi.Me developed and which is your goal?

We have developed an algorithm that predicts accurate size through the body measurements of users which they can obtain in different ways: manually, through webcam and through 3D body scanners. Our main goal was to develop a system which was extremely simple for the user, and it is never simple enough! By 2017 fashion E-commerce is expected to be 27 billion dollars and E-Tailors are expected to reach 340 billion dollars. Among our goals are building brand awareness, converting online requests into sales, market launch of depth sensor camera on mobile and tablet devices for the end of 2015, increase online marketing and upgrade platform.

Why do you think your service could be successful?

Beacuse it is a platform which is easy to set-up. It is able to provide accurate size advise from a simple T-shirt to sophisticated tailor suit. It is also able to measure customers with different technologies, from tape-measure to sophisticated scanner, and it is all integrated in one platform.

Which is the target of Bodi.Me?

Our ideal customers in phase 1 are fashion e-commerce brands and retailers, Uniform Manufacturers, E-tailors in the fashion industry. No other size advisor provider is focusing on Uniform, eTailors and eFashion SMEs. Other competitors are focusing on large brands.

Which profiles, in terms of human resources, did you use to develop your service?

We have developed the Bodi.Me project through internal R&D and external partners: in particular we have built it through fashion experts, programmers, UX experts and online marketing specialist.

What do you need to make your service a dominant design?

In order to establish our service as a dominant design in the market, we look for opportunities to contact the right people in the start-up international community for both growing the business and investments. We are looking for the right business investor for its 3 to 4 year growth plan. Furthermore at the moment customers still do not have enough trust in size advice solutions, which is one of the main limits for our service to become established.

What do you think about the services provided by your competitors?

We can say Styku builds scanners. But it does not fit exactly the needs of brands because it does not scan clothes. It is not usable by clients because requires special hardwares and is too expensive. Technologies like Fits.me are difficult to start to use. They are expensive for SMEs and are not profitable with small inventory and little online sales.

References

Abels, A., Kruusmaa, M., (2013), “Construction of a Female Shape-Changing Robotic Mannequin”, *Journal of Automation and Control Engineering*, Vol. 1, No. 2.

acnestudios.com, (2015), ACNE Studios, http://www.acnestudios.com/ (August 1st – December 31st, 2015).

Agnelli-Fernandes, A.L., (2015), “eCommerce: To compare how online business-to-consumer retailers build their e- brands to become competitive players in their respective markets”, Unpublished doctoral dissertation, The IIE, Vega School of Brand Leadership, Johannesburg, South Africa.

Anderson, R.E., Swaminathan, S., (2011), “Customer Satisfaction and Loyalty in E-Markets: A PLS Path Modeling Approach”, *Journal of Marketing Theory and Practice*, Vol. 19, No. 2, pp. 221-234.

Anderson-Connell, L.J., Ulrich Evelyn, P.V., Brannon, L., (2002), "A consumer-driven model for mass customization in the apparel market", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 6, No. 3, pp. 240-258.

Anderson, P., Tushman, M.L., (1990), “Technological discontinuities and dominant designs”, *Administrative Science Quarterly*, Vol. 35, pp. 604-633.

Apeagyei, P.R., (2010), “Application of 3D body scanning technology to human measurement for clothing Fit”, *International Journal of Digital Content Technology and its Applications*, Vol. 4, No. 7, pp. 58-68.

Apeagyei, P.R., Otieno, R., (2007), "Usability of pattern customising technology in the achievement and testing of fit for mass customisation", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 11, No. 3, pp. 349-365.

Ashdown, S., (1998), “An investigation of the structure of sizing systems: A comparison of three multidimensional optimized sizing systems generated from anthropometric data with the ASTM standard D5585-94”, *International Journal of Clothing Science and Technology*, pp. 324-341.

Ashdown, S.P., Loker, S., Schoenfelder, K., Lyman-Clarke, L., (2004), “Using 3D Scans for Fit Analysis”, *Journal of Textile and Apparel - Technology and Management*, Vol. 4, No. 1.

ayr.com, (2015), AYR Home Try-On, https://ayr.com/hometryon (retrieved online on December 8th, 2015).

Bae, S., Lee, T., (2011), “Gender differences in consumers’ perception of online consumer reviews”, Electronic Commerce Research, Vol. 11, pp. 201–214.

Baeva, A.Y., (2011), “Online Consumer Behavior Web Experience Elements In Online Clothing Market”, Unpublished doctoral dissertation, Coimbra University, Coimbra, Portugal.

Ballester, A., Parrilla, E., Uriel, J., Pierola, A., Alemany, A.,Nacher, B., Gonzalez, J., Gonzalez, J.C., (2014), “3D-based resources fostering the analysis, use, and exploitation of available body anthropometric data”, *Proceedings of the 5th International Conference and Exhibition on 3D Body Scanning Technologies*, Lugano, Switzerland

Beazley, A., (1998), “Size and Fit: Formulation of Body Measurements Tables and Sizing Systems”, *Journal of Fashion Marketing and Management*, Vol. 2, No. 3, pp. 260-284.

Beazley, A., Bond, T., (2003), “Computer-aided pattern design and product development”, Blackwell Science Publishing, Oxford, United Kingdom.

Beck, B., (2000), “Key strategic issues in online apparel retailing - the need for an online fitting solution”, *www.techexchange.com*, http://www.techexchange.com/library/Key%20Strategic%20Issues%20in%20Online%20Apparel%20Retailing.pdf (retrieved online, September 20th, 2015).

belstaff.eu, (2015), Belstaff Online Store, http://www.belstaff.eu/ (August 1st – December 31st, 2015).

Berman, B., (2002), “Should your firm adopt a mass customization strategy”, *Business Horizons*, Vol. 45, No. 4, pp. 51-60.

Berry, T.H., (1963), “Cases of mobile fitting of patterns for clothing construction”, Unpublished doctoral dissertation, Columbia University, New York, United States of America.

Bhatnagar, A., Ghosh, S., (2004), “A latent class segmentation analysis of E-Shoppers”, *Journal of Business Research*, Vol. 57, No. 7, pp. 758-767.

Bhatnagar, A., Misra, S., Rao, H.R., (2000), “On risk, convenience and Internet shopping Behavior”, *Commun ACM*, Vol. 43, No. 11, pp. 98-106.

bodi.me, (2015), Bodi.Me, http://fashion.bodi.me (August 1st – December 31st, 2015).

Bohdanowicz, J., Clamp, L., (1994), “Fashion Marketing”, Routledge, New York.

Boyer, K.K., Laseter, T.M., Mollenkopf, D.A., Rabinovich, E., (2007), “Managing Internet Product Returns: A Focus on Effective Service Operations”, *Journal compilation*, Vol. 38, No. 2

Brooke, E., (2015), “Can $1 home try-ons help an online denim brand win new customers?”, fashionista.com, http://fashionista.com/2015/03/ayr-home-try-on (retrieved online on August 31st, 2015).

Brunsman, M.A., Daanen, H.M., Robinette, K.M., (2000), “Optimal postures and positioning for human body scanning”, *Proceedings of International Conference on 3-D Digital Imaging and Modeling*, Ottawa, Canada, pp. 226–273.

Burrows, V., (2014), “5 brands that won’t have to deal with returns any longer”, fashion.bodi.me, http://fashion.bodi.me/5-brands-wont-deal-returns-any-longer/ (retrieved online on December 8th, 2015).

Byers, R., (2015), “The Ayr Home Try On Program Will Ship You a Pair of Jeans to Test Out”, trendhunter.com, http://www.trendhunter.com/trends/ayr-home-try-on (retrieved online on August 31st, 2015).

Cai, Y., Cude, B.J., (2008), “Online Shopping”, *Handbook of Consumer Finance Research*, Chapter 9, pp. 137-139.

Casaleggio e associati, (2015), “E-commerce in Italia 2015”, casaleggio.it https://www.casaleggio.it/focus/rapporto-e-commerce-in-italia-2015/ (retrieved online on September 12th, 2015).

Çelik, H., Yilmaz, V., (2011), “Extending the Technology Acceptance Model for Adoption of E-Shopping”, *Journal of Electronic Commerce Research*, Vol. 12, No. 2, pp. 152-164.

Chaffey, D., (2009), “E-business and E-commerce Management”, 4th Edition, Marketing Insights Limited, Financial Times – Prentice Hall.

Cheng, C.I., Liu, D.S.M., Tsai, C.H., Chen, L.T., (2009), “A 3D Virtual Show Room for Online Apparel Retail Shop”, *Proceedings of Asia-Pacific Signal and Information Processing Association*, pp. 193-199.

Cheong, H.J., Morrison, M.A, (2008), “Consumers’ reliance on product information and recommendations found in UGC”, *Journal of Interactive Advertising*, Vol. 8, No. 2, pp. 38-49.

Cheruiyot, M., (2013), “Assessment Of Size And Fit Of Ready-Made Formal Clothing Among Male Consumers: A Case Of Kenyatta University”, Unpublished doctoral dissertation, Kenyatta University, Nairobi, Kenya.

Childers, T.L., Carr, C.L., Peck, J., Carson, S., (2001), “Hedonic and utilitarian motivations for online retail shopping behavior,” *Journal of Retailing*, Vol. 77, No. 4, pp. 511-535.

Christ, P., (2009), “KnowThis: Marketing Basics”, 1st edition, KnowThis Media.

Chun-Yoon, J., (1996), “Key dimensions of women's read-to-wear apparel: Developing a consumer size-labeling system”, *Clothing and Textiles Research Journal*, pp. 89-95.

Constantinides E., (2004), “Influencing the online consumer’s behavior: the Web experience”, *Internet Research,* Vol.14, No.2, pp. 111-126.

Cordier, F., Seo, H., Magnenat-Thalmann, N., (2003), “Made-to-Measure Technologies for an Online Clothing Store”, *IEEE Computer Society*, pp. 38- 48.

Cox, D.F., (1967), “Risk taking and information handling in consumer behavior”, Graduate School of Business, Harvard University, Boston, United States of America.

Cox, D.F., Rich, S.U. (1964), “Perceived risk and consumer decision making – the case of telephone shopping”, *Journal of Marketing Research*, Vol. 1, No. 4, pp. 32-39.

credit2b.com, (2015), “Retail Performance Monitor”, Vol. 24, No. 3, http://www.credit2b.com/UploadedDocuments/RPM-03-2015.pdf (retrieved online on December 15th, 2015).

D'Apuzzo, N., (2007), “3D body scanning technology for fashion and apparel industry”, in: Beraldin, J., Remondino, F., Shortis, M.R., (2007), “Videometrics IX”, *Proceedings of SPIE-IS&T Electronic Imaging*, Vol. 6491, San Jose, United States of America.

D'Apuzzo, N., (2009), “Recent Advances In 3d Full Body Scanning With Applications To Fashion And Apparel”, in: Gruen, A., Kahmen, H., (2009), “Optical 3-D Measurement Techniques IX”, Vienna, Austria.

Daanen, H.A.M., Brunsman, M.A., Robinette, K.M., (1997), “Reducing movement artifacts in whole body scanning”, *Proceedings of International Conference on Recent Advances in 3-D Digital Imaging and Modeling*, IEEE Computer Society Press, Los Alamitos, CA, pp. 262–265.

Dai, B., Forsythe, S., Kwon, W., (2014), “The impact of online shopping experience on risk perceptions and online purchase intentions: does product category matter?”, *Journal of Electronic Commerce Research*, Vol. 15, No. 1, pp. 13-24.

Damanpour, F., (1996), “Organizational complexity and innovation: developing and testing multiple contingency models”, *Management Science*, Vol. 42, No. 5, pp. 693-716.

Davis, S.M., (1987), “Future Perfect”, Addison-Wesley, Reding, New York.

Davis, F., (1989), “Perceived usefulness, perceived ease of use, and user acceptance of information technology”, *MIS Quarterly- ABI/INFORM Global*, Vol. 13, No. 3, pp. 320-340.

Davis, F.D., Bagozzi, R.P., Warshaw, P.R., (1989), “User Acceptance of Computer Technology: a Comparison of two Theoretical Models”, *Management Science*, Vol. 35, No. 8, pp. 982-1003.

Deniz, O., Castrillòn, M., Lorenzo, J., Antòn, L., Hendandez, M., Bueno, G., (2010), “Computer vision based eyewear selector”, *Journal of Zhejiang University-SCIENCE C (Computers & Electronics)*, Vol. 11, No. 2, pp. 79-91.

Dewey, J., (1910), “How we think”, Heath, Boston.

Divivier, A., Trieb, R., Ebert, A., Hagen, H., Gross, C., Fuhrmann, A., Luckas, V., Encarnação, J.L., Kirchdörfer, E., Kimmerle, S., Keckeisen, M., Wacker, M., Strasser, W., Sarlette, R., Klein, R., (2008), “Virtual Try-On Topics in Realistic, Individualized Dressing in Virtual Reality”, Proceedings of the Virtual and Augmented Reality Status Conference, 2004.

Dong, B., Jia, H., Li, Z., Dong, K., (2012), “Implementing Mass Customization in Garment Industry”, *Systems Engineering Procedia*, Vol. 3, pp. 372 – 380.

Douty, H.I., (1968), “Visual somatometry in health related research”, *Journal of Alabama Academy of Science*, Vol. 39, pp. 21-24.

Eckman, M., Damhorst, M.L., Kadolph, S.J., (1990), “Toward a model of the in-store purchase decision process: consumer use of criteria for evaluating women's apparel”, *Clothing and Textiles Research Journal*, Vol.8, No. 2, pp. 13-22.

Ecommerce Fundation, (2015), “Global B2C E-commerce Report 2014 Light”, *ecommerce-europe.eu*, https://www.ecommerce-europe.eu/facts-figures/free-light-reports (retrieved online, September 12th, 2015).

emarketer.com, (2012), “Apparel drives US retail ecommerce sales growth”, *emarketer.com*, http://www.emarketer.com/newsroom/index.php/apparel-drives-retail-ecommerce-sales-growth/ .

emarketer.com, (2015), “Apparel Retailers and Ecommerce: Direct Marketers Dominate”, *emarketer.com*, http://www.emarketer.com/Article/Apparel-Retailers-Ecommerce-Direct-Marketers-Dominate/1012671 .

Ennis, H., (2006), “Vanity sizing: The Manufacturing of Self Esteem”, *Journal of Undergraduate Research*, Vol. 5, pp. 26-37.

e-pitti.com, (2015), “XYZE”, http://www.e-pitti.com/it/fieradigitale/our-brands/UI14/XYZE (retrieved online on August 31st, 2015).

Erwin, M., Kinchen, L., Peters, K., (1979), “Clothing for moderns (6th ed.)”, Englewood Cliffs, NJ: Prentice Hall.

Evans, M., (2014), “12 E-Commerce Strategies To Grow Your Business This Year”, forbes.com http://www.forbes.com/sites/allbusiness/2014/01/16/12-e-commerce-strategies-to-grow-your-business-this-year/#2715e4857a0b78fc41846ec9 (retrieved online on December 13th; 2015).

fibre2fashion.com, (2012), “Styku, the smart fitting room”, http://www.fibre2fashion.com/softtex2012/exhibitors/tukatech/downloads/pro4.pdf (retrieved online on December 12th; 2015).

Fiore, A.M., Lee, S.E., Kunz, G., (2004), "Individual differences, motivations, and willingness to use a mass customization option for fashion products", *European Journal of Marketing*, Vol. 38, No. 7, pp. 835-849.

Fishbein, M., Ajzen, I., (1975), “Beliefs, attitude, intention, and behavior: An introduction to theory and research”, Reading, MA: Addison-Wesley.

fits.me, (2015), Fits.me, http://fits.me (August 1st – December 31st, 2015).

Flanagan, J., (2014), “Virtual Reality and Retail: Fashion's Ecommerce Trends”, *huffingtonpost.com*, http://www.huffingtonpost.com/fueled/virtual-reality-and-retai_b_5594653.html (retrieved online on August 31st, 2015).

Forsythe, S., Liu, C.L., Shannon, D., Gardner, L.C., (2006), “Development of a scale to measure the perceived benefits and risks of online shopping”, *Journal of Interactive Marketing*, Vol. 20, No. 2, pp. 55-75.

Gaal, B., (1997), “Apparel Descriptions in Catalogs and Perceived Risk Associated with Catalog Purchases”, Unpublished doctoral dissertation, Oregon State University, Corvallis, United States of America

Garcia, C., Oroklu, E., (2012), “Human Friendly Interface Design for Virtual Fitting Room Applications on Android Based Mobile Devices”, *Journal of Signal and Information Processing*, Vol. 3, pp. 481-490.

Golletz, M., Ogheden, P., (2010), “Customer Returns in E-Commerce & Consumer Interaction via Social Media”, Unpublished doctoral dissertation, University of Borås, Borås, Sweden.

Guerrero, M.M., Egea, J.M.O., González, M.V.R., (2007), “Characterization of online shoppers with navigation problems”, *Direct Marketing: an international journal*, Vol. 1, No. 2, pp.102-113.

Hammond, J., Kohler, K., (2002), “In the Virtual Dressing Room Returns Are A Real Problem”, *hbswk.hbs.edu*, http://hbswk.hbs.edu/item/2883.html (retrieved online, September 20th, 2015).

hawesandcurtis.co.uk, (2015), Hawes & Curtis, http://www.hawesandcurtis.co.uk (August 1st – December 31st, 2015).

Hines, T., Bruce, M., (2007), “Fashion Marketing”, Contemporary Issues, 2nd Edition, *Elsevier.*

Hirst, A., Omar, O., (2007), “Assessing woman apparel shopping behavior on the internet”, *Journal of retail marketing research*, Vol. 1, No. 1, pp. 32-40.

Hirt, K., (2012) “Apparel E-Commerce & Enabling Technologies”, Unpublished doctoral dissertation, Swedish School of Textiles, University of Borås, Borås, Sweden

Horrigan, J. B., (2008) “Online Shopping: Convenient But Risky”, *pewresearch.org*, http://pewresearch.org/pubs/733/online-shopping (retrieved on October 20th, 2015).

hugoboss.com, (2015), Hugo Boss, http://hugoboss.com/ (August 1st – December 31st, 2015).

indiegogo.com, (2015), “On. Smart measuring tape to shop fashion online” https://www.indiegogo.com/projects/on-smart-measuring-tape-to-shop-fashion-online#/ (August 1st – December 31st, 2015).

Ingham, L., (2014), “3d Body Scanning: Bringing Perfect Sizing To Online Clothes Shopping”, *factor-tech.com*, http://factor-tech.com/3d-modelling/871-3d-body-scanning-bringing-perfect-sizing-to-online-clothes-shopping/ (retrieved online on December 15th, 2015).

Istook, C.L., Hwang S.J., (2001),"3D body scanning systems with application to the apparel industry", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 5 No. 2, pp. 120-132.

Jacoby, J., Kaplan, L.B., (1972), “The Components of Perceived Risk”, *Paper presented at the Third Annual Convention of the Association for Consumer Research*, pp. 382-393.

Jarvenpaa, S. L., Tractinsky, N., Saarinen, L., (1999), "Consumer Trust in an Internet Store: A Cross‐Cultural Validation", *Journal of Computer‐Mediated Communication*, Vol. 5, No. 2.

Kanttila, N., (2005), “Time, attention, authenticity and consumer benefits of the Web”, *Business Horizons*, Vol. 48, pp. 63- 70.

Kartsounis, G.A., Megnenat-Thalmann, N., Rodrian, H.C., (2003), “E-TAILOR: Integration of 3D Scanners, CAD and Virtual-Try- on Technologies for Online Retailing of Made-to-Measure Garments”, Unpublished doctoral dissertation, University of Athens, Athens, Greece.

Khakimdjanova, L., Park, J., (2005), “Online visual merchandising practice of apparel e-merchants”, *Journal of Retailing and Consumer Services*, Vol. 12, No. 5, pp. 307-318.

Kim, H., Lennon, S.J., (2010), “E-atmosphere, Emotional, Cognitive, and Behavioral Responses,” *Journal of Fashion Marketing and Management,* Vol. 14, No. 3, pp. 412-428.

Kim, H.W., Gupta, S., (2009), “A comparison of purchase decision calculus between potential and repeat customers of an online store”, *Decision Support Systems*, Vol. 47, No. 4, pp. 477-487.

Kim, J., (2012), “Gender difference in usage of IPS”, *Innovative Marketing*, Vol. 8, No. 1, pp. 81-91.

Kinley, T.R., (2003), “Size Variation in Women's Pants”, *Clothing and TextilesResearch Journal*, Vol. 21, No. 1, pp. 19-31.

Klein, L.R. (1998), “Evaluating the potential of interactive media through a new lens: Search versus experience goods”, *Journal of Business Research*, Vol. 41, No. 3, pp. 195-203.

Koufaris, M., (2002), “Applying the technology acceptance model and flow theory to online consumer behavior”, *Information Systems Research*, Vol. 13, No. 2, pp. 205-223.

Kwan, C.Y., Yeung, K.W., Au, K.F., (2004), “Decision-Making Behavior Towards Casual Wear Buying: A Study of Young Consumers in Mainland China”, *Journal of Management and World Business Research*, Vol. 1, No. 1, pp. 1-10.

Kwon, Y. H., Paek, S. L., Arzeni, M., (1991), “Catalog vs. non-catalog shoppers of apparel: Perceived risks, shopping orientations, demographics, and motivations”, *Clothing and Textiles Research Journal*, Vol. 10, No. 1, pp. 13-19.

Lau, H.F., Lau, K.W., Kan, C.W., (2013), “The Future of Virtual Environments: The Development of Virtual Technology”, *Computer Science and Information Technology*, Vol. 1, No. 1, pp. 41-50.

Lee, Y., (2014), “Older women's experiences with online apparel shopping”, Unpublished doctoral dissertation, Iowa State University, Ames, United States of America.

Lee, H., Kim, J., Fiore, A. M., (2010), “Affective and cognitive online shopping experience: Effects of image interactivity technology and experimenting with appearance”, *Clothing and Textiles Research Journal*, Vol. 28, No. 2, pp. 140-154.

Liang, T. P., Huang, J. S., (1998), “An empirical study on consumer acceptance of products in electronic markets: A transaction cost model”, *Decision Support Systems*, Vol. 24, pp. 29-43.

Lim, H.S., (2009), "Three Dimensional Virtual Try-on Technologies in the Achievement and Testing of Fit for Mass Customization", *A dissertation submitted to the Graduate Faculty of North Carolina State University.*

Lorenzo, C., Constantinides, E., Gómez-Borja, M.A., (2009), "Effects of Web Experience factors on virtual retail purchase preferences", *International Retail and Marketing Review.*

Macciò, A., (2014), "Un metro digitale per gli acquisti online", corriereinnovazione.corriere.it, http://corriereinnovazione.corriere.it/coverstory/2014/12-marzo-2014/metro-digitale-gli-acquisti-online-2224203366724.shtml?refresh_ce-cp (retrieved online on August 31st, 2015).

Madu, C.N., Madu, A. (2002), "Dimensions of e-quality", *International Journal of Quality & Reliability Management*, Vol. 19, No. 3, pp. 246-58.

Majava, J., Nuottila, J., Haapasalo, H., Law, K.M.Y., (2013), "Customer Definition And Representation In Market-Driven Product Development", *Proceedings of 2013 International Conference on Technology Innovation and Industrial Management*, Phuket, Thailand.

Maria, C., (2014), "The Technology of Shopping", thehippocollective.com, http://www.thehippocollective.com/2014/11/11/technology-shopping/ (retrieved online on August 31st, 2015).

Martinez, R., (2010), "Best practices in returns management", *multichannelmerchant.com*, http://multichannelmerchant.com/opsandfulfillment/best-practices-in-returns-management-01122009/ (retrieved online on October 20th, 2015).

Masoud, E.Y., (2013), "The Effect of Perceived Risk on Online Shopping in Jordan", *European Journal of Business and Management,* Vol. 5, No. 6, pp. 76-87.

Mathieson, K., (1991), "Predicting user intentions:comparing the technology acceptance model with theory of planned behavior", *Information Systems Research*, Vol. 2, No. 3, pp. 173-191.

Matic, M., Vojvodic, K., (2014), “Customer-Perceived Insecurity of Online Shopping Environment”, *International Review of Management and Marketing*, Vol. 4, No. 1, pp. 59-65.

McNulty, E., (2015), “The data-driven future of fashion”, *dataconomy.com*, http://dataconomy.com/the-data-driven-future-of-fashion/ (retrieved online on September 12th, 2015).

Mehrabian, A., Russell, J. A., (1974), “An approach to environmental psychology”, MA: MIT Press, Cambridge, United Kingdom.

Merrilees, B., Fry, M.L., (2002), “Corporate Branding: A framework for E- retailers”, *Corporate Reputation Review*, Vol. 5, No. 2-3, pp. 213-255.

microsoft.com, (2012), “Startup Revolutionizes Apparel Shopping, Reduces Returns with Virtual Fitting Room”, *Microsoft Case Study* (retrieved online on December 12th, 2015).

Mitchell, V.W., (1999), "Consumer perceived risk: conceptualisations and models", *European Journal of Marketing*, Vol. 33, No. 1-2, pp. 163-195.

Mok P.Y., Wu, Y.Y., Kwok Y.L., Fan J.T., Xin J. H., (2011), “An investigation on the validity of 3D clothing simulation for garment fit evaluation”, *Proceedings of the IMProVe 2011 International conference on Innovative Methods in Product Design*, pp. 463-468.

Møller-Hansen, T.R., (2013), “Online consumer behavior among Norwegian business students”, Unpublished doctoral dissertation, University of Agder. Kristiansand, Norway

Moreno, K., McCormack, S., (1998), “E-shopping”, *forbes.com*, http://www.forbes.com/forbes/1998/0209/6103040a.html (retrieved online on November 21st 2015).

Morris, M.G., Dillon, A., (1997), “The influence of user perceptions on software utilization: application and evaluation of a theoretical model of technology acceptance”, *IEEE Software*, Vol. 14, No. 4, pp. 56-75.

myvirtualmodel.com, (2015), My Virtual Model, http://www.myvirtualmodel.com (August 1st – December 31st, 2015).

Nanda, S., (2012), "Augmented Reality: The Future of Marketing", *International Journal Of Innovative Research & Development*, Vol. 1, No., 4, pp. 187-195.

Niiler, E., (2014), "Robo-Mannequin Solves Online Shopping's Thorniest Problem", *wired.com*, http://www.wired.com/2014/01/qq_robofitroom/ (retrieved online on December 15th, 2015).

Ola-Afolayan, O., Mastamet-Mason, A., (2013), "A customised size chart for the African pear-shaped plus-size South African women", *DEFSA Conference Proceedings.*

Pachoulakis, I., Kapetanakis, K., (2012), "Augmented Reality Platforms For Virtual Fitting Rooms", *The International Journal of Multimedia & Its Applications (IJMA)*, Vol.4, No. 4, pp. 35-46.

pacificissue.com, (2015), Pacific Issue, https://www.pacificissue.com (August 1st – December 31st, 2015).

Pantano, E., Naccarato, G., (2010) "Entertainment in Retailing: the Influences of Advanced Technologies", *Journal of Retailing and Consumer Services*, Vol. 17, No. 3, pp. 200-204.

Parhizkar, B., Al-Modwahi, A.A.M., Lashkari, A.H., Bartaripou, M.M., Babae, H.R., (2011), "A Survey on Web-based AR Applications", *IJCSI International Journal of Computer Science Issues*, Vol. 8, No. 4.

Park, J.H., (2002), "The Effect Of Product Presentation On Mood, Perceived Risk, And Apparel Purchase Intention In Internet Apparel Shopping", Unpublished doctoral dissertation, Ohio State University, Columbus, United States of America.

Pastore, M., (2000), "Online apparel shopping gaining in popularity", *clickz.com*, http://www.clickz.com/clickz/news/1713759/online-apparel-shopping-gaining-popularity (retrieved online on November 15th, 2015).

Peng, F., Sweeney, D., Delamore, P., (2012), "Digital Innovation in Fashion - How to 'Capture' the User Experience in 3D Body Scanning", *International Journal of Industrial Engineering and Management (IJIEM)*, Vol. 3 No. 4, pp. 233-240.

Peter, J.P., Olson, J.C., (1994), “Understanding consumer Behavior”, Burr Ridge: Irwin.

Piller, F.T., (2008), “Observations on the present and future of mass customization”, *International Journal of Flexible Manufacturing Systems.*

Pine, B.J., (1993), “Mass customization: The new frontier in business competition”, Harvard Business School Press, Boston, United States of America.

Piras, L., (2015), “Fashion Metric brings tailoring into modern times using data to offer one of the quickest, most accurate services on the market”, *psfk.com*, http://www.psfk.com/2015/01/algorithmic-tailor-fashion-metric-online-shopping.html (retrieved online on August 31st, 2015).

Polvinen, E., (2010), “Gregory Saumier-Finch, General Manager, My Virtual Model”, *fashiontech.wordpress.com*, https://fashiontech.wordpress.com/2010/02/20/gregory-saumier-finch-general-manager-my-virtual-model/ (retrieved online on September 15th, 2015).

Porat, T., Tractinsky N., (2012), “It's a Pleasure Buying Here: The Effects of Web-Store Design on Consumers' Emotions and Attitudes, Human–Computer Interaction”, Vol. 27, No. 3, pp. 235-276.

prettygreen.com, (2015), Pretty Green, http://www.prettygreen.com (August 1st – December 31st, 2015).

Radu, L.D., (2015), “Investments In Technological Innovations: A Literature Review Of Organization Determinants”, *European Scientific Journal February*, pp. 52-59.

ray-ban.com, (2015), Ray-Ban Virtual Mirror, http://www.ray-ban.com/usa/virtual-mirror (August 1st – December 31st, 2015).

Reichheld, F., (1995), “Loyalty and the Renaissance of Marketing”, Marketing Management, Vol. 2, No. 4, pp. 10-21.

Rzepka, A.M., (2011), “Fashion: Hedonic vs. Utilitarian A Study of Fit Issues of Women’s Ready to Wear and an Examination of the Technology Acceptance Model for Consumer Adoption of 3D Body Scanning for Improved Fit of Denim Pants”, Unpublished doctoral dissertation, School of Technology Studies, Eastern Michigan University, Ypsilanti, United States of America.

Salo, J., Karjaluoto, H., (2007), “A conceptual model of trust in the online environment”, *Online Information Review*, Vol. 31, No. 5, pp. 604-21.

Salvador, F., de Holan, P.M., Piller, F., (2009), “Cracking the Code of Mass Customization”, *MIT Sloan Management Review*, Vol. 50, No. 3, pp. 71-78.

Samadi, M., Yaghoob-Nejadi, A., (2009), “A Survey of the Effect of Consumers’ Perceived Risk on Purchase Intention in E-Shopping”, *Business Intelligence Journal,* pp. 262-275.

Sarkar, A., (2011), “Impact of Utilitarian and Hedonic Shopping Values on Individual’s Perceived Benefits and Risks in Online Shopping”, *International Management Review*, Vol.7, No. 1, pp. 58-65.

Schiffman, L.G. Kanuk, L.L., (2009) “Consumer behaviour”, 10th edition, Prentice-Hall. New York.

Schilling, M., (2010), “Strategic Management of Technological Innovation”, McGraw-Hill, ISBN: 9780071289573.

secondbutton.com, (2015), Second Button, http://secondbutton.com (August 1st – December 31st, 2015).

Seitz, V., (1988), “Information needs of catalog consumers”, *Journal of Home Economics*, pp. 39-42.

Senanayake, M.M., Little, T.J., (2010), "Mass customization: points and extent of apparel customization", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 14, No. 2, pp. 282-299.

Sheth, J. N., Parvatiyar, A., (1995), "Relationship marketing in consumer markets: antecedents and consequences", *Journal of the Academy of marketing Science*, Vol. 23, No. 4, pp. 255-271.

Sheth, J. N., Venkatesan, M., (1968), "Risk-reduction process in repetitive consumer behavior", *Journal of Marketing Research*, Vol. 5, No 3, pp. 307-310.

Shin, E., Baytar, F., (2014), "Apparel Fit and Size Concerns and Intentions to Use Virtual Try-On: Impacts of Body Satisfaction and Images of Models' Bodies", *Clothing and Textiles Research Journal*, Vol. 32, No. 1, pp. 20-33.

Simmons, K.P., Istook, C.L., (2003),"Body measurement techniques", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 7, No. 3, pp. 306-332.

Simpson, L., Lakner, H. B., (1993), "Perceived risk and mail order shopping for apparel", *Journal of Consumer Studies and Home Economics*, Vol 17, pp. 377-389.

Singh, K., (2015), "Reducing Customer Returns In An Online Marketplace", Unpublished doctoral dissertation, National Institute Of Fashion Technology, Mumbai, India.

Sohn, M., (2012), "Analysis of Upper Body Measurement Change Using Motion Capture", Unpublished doctoral dissertation, University of Minnesota, Minneapolis, United States of America.

Song, S.S., Kim, M., (2012), "Does More Mean Better? An Examination Of Visual Product Presentation In E-Retailing", *Journal of Electronic Commerce Research*, Vol. 13, No. 4, pp. 345-355.

St-Onge, A., Crete, D., Merle, A., Arsenault, N., Nantel J., (2008), "Personalized Avatar, A New Way to Improve Communication and E-Service", EMAC, Brighton, England.

startupbeat.com, (2015), "Techstars grad Fashion Metric wants to ensure that consumers buy better-fitting clothes, whether online or in-person", http://startupbeat.com/2015/03/04/fashion-metric-qa-id5035/.

Straka, M., Hauswiesner, S., Rüther, M., Bischof., H., (2011), “A Free-Viewpoint Virtual Mirror with Marker-Less User Interaction”, *Springer-Verlag Berlin Heidelberg*, pp. 635–645.

styku.com, (2015), http://www.styku.com/bodyscanner (August 1st – December 31st, 2015).

Szajna, B., (1996), “Empirical evaluation of the revised technology acceptance model”, *Management Science*, Vol. 42, No. 1, pp. 85-92.

Szymanski, D. M., Hise, R. T., (2000), “E-satisfaction: An initial examination”, *Journal of Retailing*, Vol. 76, No. 3, pp. 309-322.

t-immersion.com, (2015), Total Immersion, http://t-immersion.com (August 1st – December 31st, 2015).

Ternent, S., (2015), “Sasha Ternent examines innovation in e-commerce for 2015”, *hudsonwalker.com*, http://www.hudsonwalker.com/2015/01/19/sasha-ternent-examine-ecommerce-innovations-and-development-for-2015/ (retrieved online on August 31st, 2015).

Then, N.K., DeLong, M.R., (1999), “Apparel shopping on the web”, *Journal of Family and Consumer Sciences*, Vol. 91, No. 3, pp. 65-68.

thomaspink.com, (2015), Thomas Pink, http://www.thomaspink.com (August 1st – December 31st, 2015).

Tong, J., Zhou, J., Ligang, L., Zhigeng, P., Yan, H., (2012), “Scanning 3D Full Human Bodies using Kinects”, *IEEE Transactions visualization and computer graphics*, Vol. 18 , pp. 643-650.

trylive.com, (2015), TryLive by Total Immersion, http://www.trylive.com (August 1st – December 31st, 2015).

Ulrich, P.V., Anderson-Connell, L.J., Wu, W., (2003),"Consumer co-design of apparel for mass customization", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 7, No. 4, pp. 398-412.

Uzan, M., (2014), “Consumers´ Online And Offline Shopping Behavior”, Unpublished doctoral dissertation, University of Borås, Borås, Sweden.

Verhagen, T., Vonkeman, C., Feldberg, F., Verhagen, P., (2013), “Making online products more tangible and likeable: The role of local presence as product presentation mechanism”, Unpublished doctoral dissertation, Vrije Universiteit, Amsterdam, Netherlands.

virtusize.com, (2015), Virtusize, https://www.virtusize.com/ (retrieved online on December 20th, 2015).

Wang, M.J.J, Wu, W.Y., Lin, K.C. Yang, S.N., Lu, J.M., (2007), “Automated anthropometric data collection from three-dimensional digital human models”, *International Journal of Advanced Manufacturing Technology,* Vol. 32, pp. 109-115.

warbyparker.com, (2015), https://www.warbyparker.com/home-try-on (retrieved online on December 8th, 2015).

Weitz, B. A., (2010), “ Electronic Retailing”, in: Krafft, M., Mantrala, M.K., (2010), “Retailing in the 21st Century: Current and Future Trends”, *Springer-Verlag Berlin Heidelberg*, pp. 357-371.

wired.co.uk, (2013), “Startup of the Week: Virtusize”, *wired.co.uk*, http://www.wired.co.uk/news/archive/2013-12/06/startup-of-the-week-virtusize (retrieved online on August 31st, 2015).

Wolfinbarger, M., Gilly, M., (2001), “Shopping online for freedom, control and fun”, *California Management Review*, Vol. 43, No. 2, pp. 34-55.

Woollaston, V., (2014), “The end of online returns? App lets you see how clothes will fit based on items you already own”, *dailymail.co.uk*, http://www.dailymail.co.uk/sciencetech/article-2582685/The-end-online-returns-Shopping-app-lets-clothes-fit-based-items-own.html?ITO=1490&ns_mchannel=rss&ns_campaign=1490, (retrieved online on August 31st, 2015).

xyze.it, (2015), XYZE, http://www.xyze.it (August 1st – December 31st, 2015).

Yoon, S.Y., (2002), “The antecedents and consequences of trust in online-purchase decisions”, *Journal of Interactive Marketing*, Vol. 16, No. 2, pp. 47-63.

Yuan, M., Khan, I.R., Farbiz, F., Niswar, A., Huang, Z., (2011), “A Mixed Reality System For Virtual Glasses Try-On”, *Institute for Infocomm Research*, pp. 363-366.

Zhou, M., Dresner, M., Windle, R.J., (2008), “Online reputation systems: design and strategic practices”, *Decision Support Systems*, Vol. 44, No. 4, pp. 785-97.

Zipkin, P. H., (2001), “The limits of mass customization”, *MIT Sloan Management Review*, Vol. 42, No. 3, pp. 81-87.