Enhancing the online decision-making process by using augmented reality: a two country comparison of youth markets

Abstract. Although online stores extend the traditional offer of the brick and mortar ones, the limited possibilities to virtually try the product before the effective buying makes the online purchase decision a complex process for consumers. Therefore, online retailers face new challenges for supporting consumers consisting of the introduction of advanced technologies such as augmented reality systems. The present study investigates the effect of augmented reality technologies on consumer behaviour within the online retail environments, by comparing two different cultural settings. Drawing upon the technology acceptance model (TAM), new constructs related to the technology characteristics (e.g. quality of information, aesthetic quality, interactivity, and response time) developed a new conceptual model. This model has been tested for a new technology for virtual try-on (a smart mirror for virtual glasses). Focusing on young consumers, data collected in Italy and Germany yielding a total of 318 participants was used. Findings across these two markets reflect cross-market similarities, but also dissimilarities, related to consumers' motivation to employ augmented reality systems for supporting their online purchase decision. These insights should prove helpful to retailers in better manage the online channels, that could be easily extended to the mobile one.

Keywords. Augmented reality; aesthetic quality; interactivity; consumer behaviour; decision-making; e-tailing; technology acceptance model (TAM)

1. Introduction

Due to the rapid advancements in technology, also retailers are increasingly aware of the benefits of technological innovations providing a variety of systems, such as such as self-service technologies equipped with interactive touch screen displays, 3D virtual reality systems, mobile apps, etc. (Sha et al., 2013; Papagiannidis et al., 2014; Blázquez, 2014; Demirkan and Spohrer, 2014; Dennis et al., 2014; Rese et al., 2014; Pantano, 2016). Past literature in consumer behaviour largely investigated the role of these innovations in consumer decision-making, by considering the new technologies as decision support systems and drivers of positive evaluations of the shopping experience (including satisfaction, enhanced purchase decisions, and of loyalty to retailer) (Koufaris, 2002; Fiore et al., 2005a, b; Hernandez et al., 2009; Kim et al., 2011). Although these studies provide evidence of the extent to which consumers are influenced by the new technologies available in retail settings, this study emphasises the promising role of augmented reality. While it has been successfully introduced in other sectors like tourism to influence consumers buying decisions (in terms of the choice of the destination) (Chung et al., 2015), the benefits of augmented reality in retail settings is still under investigated.

When it comes to e-commerce adoption industries selling in particular high-involvement products such as clothes tend to lag behind (Blázquez, 2014). The lack of direct experience in touching, feeling, smelling and trying on an item makes the evaluation difficult and may negatively affect enjoyment and the purchase decision (Beck and Crié, 2016; Blázquez, 2014; Merle et al., 2012). Major concerns and problems are fit and size (Kim, 2016; Lin and Wang; 2016, Shin and Baytar, 2014), or matching with other items (Chen and Wang, 2010). Virtual try-on systems, as application of augmented reality for retailing, can overcome the main

limitation of online channels related to the possibility to try the products before the effective buying (Baum and Spann, 2014). Although their promising benefits for allowing consumers to save time and enjoy more the shopping experience, these systems are emerging as a promising line of inquiry for new researches in online retailing (e-tailing) and e-commerce (Dey and Sandor, 2014). In the meantime, technological progress that provides technologies with new capabilities (i.e. high realistic interfaces and interaction modalities) has increased (Sekhavat,2016) and retailers become aware of the importance of innovating within the process (Pantano, 2014). Consumer technology acceptance of virtual try-ons as non-personalized and personalized versions (Fiore et al., 2005a, b; Kim and Forsythe, 2008a, b; Merle et al., 2012; Yang and Wu, 2009), but also enriched with augmented reality (Rese et al., 2016) has been empirically investigated mostly in the context of online apparel retailing. However, technological characteristics were less in the focus, but utilitarian and hedonic value, risk or body esteem (e.g. Merle et al., 2012; Yang and Wu, 2009) (see Table 1).

In this paper, we attempt to fill this gap and examine the influence of technology characteristics on consumer behaviour, with emphasis on the effect of augmented reality systems on consumers' decision making to shop online. To achieve this goal, the present research starts from the exploitation of the traditional technology acceptance model (TAM), based on ease of use, usefulness and attitude (Davis, 1989) for including more specific dimensions related to interactive technologies such as quality of information, aesthetic quality, response time, and interactivity relying on the user experience concept (Olsson & Salo, 2011; Olsson et al., 2013). Since cultural settings might affect people usage and adoption of new technologies (Choi and Totten, 2012), the analysis focuses on a particular online technology (a system for virtual try-on glasses) involving a German and Italian sample. Due to the different fiscal policies, consumers' propensity to buy and different

investments in R&D (Fassio, 2015; Karagounis et al., 2015), consumers in these countries might show different behaviours towards the online technologies for e-tailing: Qualitative cross country research points to convergence, but also divergence phenomena with regard to augmented reality applications developed on a global scale (Gautier et al., 2016).

The contributions of this paper are manifold. First, the paper investigates the effects of augmented reality application on consumer online shopping behaviour, and sheds lights on the potential of augmented reality for the design of more effective online retail settings in a cross-country comparison (in European regions with a different economic context), which has not yet received significant attention in current research. Second, the paper opens up new lines of inquiry for future studies towards the increasing role of augmented reality for supporting e-tailing. To this end, the paper extends the traditional technology acceptance model (Davis, 1989; Baum and Spann, 2014) by including more constructs of other frameworks such as user experience that provide evidence on the role of specific technology characteristics, which can be used for developing new interactive systems and marketing management strategies. Therefore, the research contributes to the retail (with emphasis on e-tailing) literature by developing a conceptual framework that links the relationships between motivational factors with the consumers acceptance of augmented reality tools, online shopping, and cross-country youth marketing research.

The paper is organized as follows: the next section discusses the preliminary studies on the introduction of augmented reality, and the traditional technology acceptance models for investigating the effects of the technology on consumers' behaviour, with emphasis on retail settings. The subsequent section deeply investigates the Italian and German samples, by comparing the results from a cross-cultural perspective. The paper further ends with theoretical and managerial implications and proposals for future researches.

2. Theoretical Background

2.1 Augmented reality in retail settings

The recent progresses in information and communication technologies provide the opportunity to develop new environments enriched with digital technologies, in order to extend the possibilities offered by the *physical* word, where real and virtual objects are successfully integrated (or combined) (Pantano and Servidio, 2012; Lee and Park, 2014; Rese et al., 2014; Lin and Chen, 2015). Augmented reality is defined as a real-time view of the physical world enhanced (augmented) with virtual computer generated information, such as digital images or video stream, etc. (Azuma, 1997; Carmigniani et al., 2011). Within the 'reality-virtuality continuum' (Milgram et al, 1994) augmented reality is located towards the real-world environment side. Azuma (1997, p.356) refers to "the "middle ground" between VE (completely synthetic) and telepresence (completely real)". Virtual reality represents the opposite end and is defined as synthetic, but realistic looking three-dimensional environment generated by the computer (Burdea and Coiffet, 1999) "consisting solely of virtual objects" (Milgram et al, 1994, p. 283).

Prior studies showed the usefulness of these new worlds for enhancing the education process, by providing an entertaining context for learners able to maximize the knowledge transfer of complex concepts (Kaufmann and Schmalstieg, 2003; Pan et al., 2006). Similarly, it has been largely used for entertainment (game industry), training and military applications (simulations), manufacturing and tourism planning (Adhani and Rambli, 2012; Gervautz and Schmalstieg, 2012; Szczekala et al., 2014).

Recently, marketers started to be aware of the advantages of augmented reality also in retailing, as tool for improving consumers' perception of the shopping experience, extending the possibilities of buying in terms of moment of purchasing (which could be not

simultaneous to the moment of items pick up), products availability and customization (Pantano and Servidio, 2012; Cuomo et al., 2014; Rese et al., 2014). Furthermore, augmented reality provides more information able to influence and support consumer decision-making through visual information (digital and interactive images, videos, etc.), texts, audio, simulated experiences, etc. (Olsson et al., 2013; Papagiannidis et al., 2017). In fact, if compared to traditional e-commerce scenarios, augmented reality applications offer more dynamic 3D animation through high realistic interfaces (Li et al., 2013: Lee and Park, 2014). Moreover, applications such as the virtual try-on would be able to overcome a crucial limit of e-commerce, by enhancing interaction possibilities with the product through the possibility to *experience* or *try* the product in terms of scent, texture, appearance, fit, or sound (Lu and Smith, 2007).

Summarizing, augmented reality technology provides new systems giving consumers the possibility to virtually interact with the favoured items. In this direction, one the most promising area of research is the virtual garment try-on experience (or virtual fitting) (Chen et al., 2011; Pereira et al., 2011; Wang et al., 2012) (see Table 1). Its advantages rely on the possibility to virtually interact with the product in real time before the effective buying in the online context (or e-commerce).

[TABLE 1 ABOVE HERE]

Table 1: Studies on acceptance of image interactivity technology and virtual-try ons

2.2 Consumers technology acceptance models

Literature focusing on consumer acceptance of advanced technology largely employs the Technology Acceptance Model (TAM) and its key variables: ease of use, usefulness, attitude

and behavioural intention (Davis, 1989). This basic model posits that user perception of ease of use and usefulness determines his/her attitude towards a certain system; where perceived ease of use represents the degree to which a user believes that using the system requires no effort, and it could be based on the quality of interface, interaction modalities, no need of instruction for learning functionalities, etc.; whereas perceived usefulness represents the degree to which a user believes that using the system will improve his/her performance. Similarly, attitude represents user assessment of the system, and behavioural intention represents the degree to which a user will intend to use the system. In recent years TAM has been used for evaluating the online and mobile shopping engagement (Chong et al., 2012; Kim, 2012), new stores based on immersive technologies (Pantano and Servidio, 2012), and multimedia systems for enhancing the service delivered at the physical point of sale (Kim et al., 2011). In addition, the TAM relationships have been to the most part confirmed for virtual-try ons (Lee et al., 2006; Kim and Forsythe, 2007, 2008a, b, 2009) and augmented reality-based systems (Rese, et al., 2016).

Accordingly, we hypothesize:

H1: Perceived ease of use has a significant and positive relationship with consumers' attitude towards the adoption of the virtual try-on system for glasses.

H2: Perceived usefulness positively and significantly influences consumers' attitude towards the adoption of the virtual try-on system for glasses.

H3: Attitude towards the adoption of the virtual try-on system positively and significantly influences the subsequent behavioural intention to use this system.

TAM has been further extended including more constructs to propose a more comprehensive model. For instance, perceived enjoyment results being one of the most investigated constructs in extended TAM. This represents the degree to which using the system is perceived as pleasant apart from any expected performance, and it is able to influence consumer's usage of a certain system (Venkatesh, 2000; van der Heijden, 2004; Pantano and Servidio, 2012). Therefore, it is related to the fun deriving from the system usage (van der Heijden, 2004). In fact, consumers who exhibit pleasure while shopping are more willing to prefer that kind of retail environment for their purchases (Ha and Stoel, 2009). Much emphasis has been placed in previous research on the importance of entertainment technology for soliciting consumers to engage in more purchases (Soderlund and Julander, 2009), while stressing the higher degree to which consumers perceive the value of enjoyment in the virtual store than in the physical one due to the possibility to interact with the environment and products (Kim et al., 2007; Lee and Chung, 2008). The hedonic value of virtual try-ons has been confirmed for different levels of image interactivity technology (e.g. Merle et al., 2012) and augmented reality-based systems (Rese, et al., 2016).

Therefore, we hypothesize:

H4: Perceived enjoyment has a significant and positive influence on consumers' attitude towards the usage of the virtual try-on system for glasses.

Perceived enjoyment has been related to perceived ease of use and perceived usefulness in numerous TAM studies (Pantano and Servidio, 2012; Padilla-Meléndez et al., 2013). With regard to hedonic systems in an Internet and marketing context, research has proposed and

empirically shown that perceived ease of use positively influences perceived enjoyment (van der Heijden, 2003; Novak et al., 2000; Chung and Tan, 2004). Balog and Pribeanu (2010) confirmed this relationship for an AR learning context (Balog and Pribeanu, 2010). Research has emphasized the mediating role of perceived ease of use between skill and the flow construct (Trevino and Webster, 1992). As an "optimal experience" (Csikszentmihalyi and LeFevre, 1989, p.816) flow can be described as "the complete engagement with and immersion in an activity" (Hoffman and Novak, 2009, p.24). One characteristic of experiencing flow in system usage is intrinsic enjoyment (Hoffman and Novak, 1996). Van der Heijden (2003, p. 544) argues that a system "that is easier to use provides better feedback to a visitor's stimuli, and consequently, leads to increased enjoyment and flow". In addition, beginning with Davis et al. (1992) literature has proposed a positive relationship between perceived usefulness and perceived enjoyment. Most often the causal direction between perceived enjoyment and perceived usefulness is investigated. However, relying on content analysis Chung and Tan (2004) identified perceived usefulness in terms of information obtained as an antecedent of perceived enjoyment searching the internet for general information. The informational aspect is also important for augmented reality.

Therefore, we propose:

H5: Perceived ease of use is positively and significantly associated with consumers' perceived enjoyment of the virtual try-on system for glasses.

H6: Perceived usefulness is positively and significantly associated with consumers' perceived enjoyment of the virtual try-on system for glasses.

2.2.1 Technology characteristics

Due to the nature of augmented reality-enriched retail environments, other variables might influence consumers' decision making process, in addition to the ones previously identified by TAM. For instance, Wixom and Todd (2005) defined the importance of system quality for influencing consumers' acceptance, including system capability to adapt according to consumers' requests, accessibility, and the response time to consumers' requests. In fact, they might involve the virtual interaction with products, through 3D animation, that provides *augmented* experiences able to compensate the lack of real product touch (Algharabat and Dennis, 2010; Pantano and Servidio, 2012; Papagiannidis et al., 2017). In the one hand, this implies the high realism of the graphical interface, whereas in the other, it enriches the quality of interaction modalities (Costantinides, 2004). Concerning the graphics, the vividness and realism of virtual images (or aesthetic quality) stimulate the user's sensory perceptions and the mental imagery formation (Cheng et al., 2014; Choi and Taylor, 2013), by positively influencing the confidence with the product derived from experiencing the augmented reality system (Lee, 2012). Overall with regard to a virtual reality context Steuer (1992, p. 76) argued that two technological dimensions are important for telepresence which "refers to the *mediated* perception of an environment", e.g. vividness (realness) and interactivity. These two dimensions are also considered as antecedents of the flow concept, therefore enhancing perceived enjoyment (Hoffman and Novak, 1996).

Following Churchill (1979) and Steuer (1992), we hypothesize the presence of a new construct based on aesthetic quality, which includes the graphical effects in terms of vividness, realism of 3D images, visual appealing of the graphical look, etc., developed from the website quality for e-commerce construct (Tsikriktsis, 2002; van der Hejiden, 2003; Cyr and Bonanni, 2005) for extending the TAM. Holbrook and Hirschman (1982) emphasize the

nonverbal, sensory experience that is related to many products and facilitates consumers' choice process, e.g. when using a virtual-try on (Huang and Liao, 2015). In addition, aesthetic quality is related to the hedonic dimension of a system creating pleasure and enjoyment of an electronic system (Norman, 2002; Zhang and Li, 2005). Therefore, we propose that aesthetic quality in turn impacts on the ease of use, but also the perceived enjoyment of the augmented reality system:

H7: The higher the aesthetic quality, the higher the perception of ease of use of the virtual try-on system for glasses will be.
H8: The higher the aesthetic quality, the higher the perception of enjoyment of the virtual try-on system for glasses will be.

The aesthetic quality enabled by the technical quality of the augmented reality technology in terms of software and hardware, enhances the feeling of realism of the experience. To achieve this goal, the system needs to improve the interactive tools, by simulating the real experience with the product, which allows also achieving enriched and detailed information on the potential product (Fiore et al., 2005a; Papagiannidis et al., 2017). In this way, consumers are able to explore the different features of the product and virtually manipulate it (i.e. visualizing from different perspectives, etc.) with benefits for the final positive product evaluation and choice (Jiang and Benbasat, 2004).

In fact, interactivity has been conceptualized as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (Steuer, 1992, p. 84). In interacting with the website (e-commerce platform) individuals are able to achieve customized information or services (Tsikriktsis, 2002). (Machine) interactivity has also been

related to the flow construct facilitating "a seamless sequence of responses" (Hoffman and Novak, 1996, p. 57) and enhancing enjoyment. Website and image interactivity have been proposed to offer not only utilitarian, but also hedonic aspects (Lee et al., 2006), such as "enjoyment with virtual product inspection" (Li et al., 2001, p. 22). Besides a "Wow" factor due to the innovative visualization and experience (Chandler, 2009), enjoyment is provided by the potential customization abilities (Li et al., 2001).

Therefore, we hypothesize that:

H9: Interactivity positively and significantly influences the ease of use a user perceives from experiencing the virtual try-on system for glasses.

H10: Interactivity positively and significantly influences the enjoyment a user perceives from experiencing the virtual try-on system for glasses.

As anticipated, previous studies focusing on the online shopping experience considered more key elements related to the functionality factors, such as the site speed and quality of information (Costantinides, 2004; Wixom and Todd, 2005). In fact, consumers expect to easily and fast find information (including selecting and filtering), which in turn should be useful for supporting the purchase decision. Hence, the system has to be able to rapidly reply to their request, in terms of acceptable response time (which may vary according to consumer's personal needs), as well as to provide high quality of information, in terms of availability, accessibility, completeness, accuracy and adequacy that might determine the overall usefulness of the system (Wixom and Todd, 2005; Fassnacht and Koese, 2006). Hence, an acceptable response time for consumers would help them to achieve the information requested rapidly, resulting the system to be more useful for their purposes.

Therefore, we hypothesize:

H11: Response time has a significant and positive influence on perceived usefulness of the virtual try-on system for glasses.

H12: Quality of information has a significant and positive relationship with the perceived usefulness of the virtual try-on system for glasses.

2.3 Two-country marketing research

The measure of the extent to which the above mentioned relationships (graphically summarized in Figure 1) differ in the two countries (Italian and German one) is investigated.

Although both Italy and Germany are well-established market economies, they show different economic and industrial context (especially with reference to the recent years) (Supino et al., 2010), thus the different propensity to buy (both online and offline) affecting consumers might change their adoption of augmented reality tools for supporting online shopping. Starting from Koopman et al.'s (1999) distinction of a North-Western and a South-Eastern European cluster with regard to cultural values, we build upon our research, by considering that Italian and German youth might show different approaches towards new technologies for supporting shopping, concerning their motivation, use of time, usefulness and ease of use of the new tools.

Moreover, we chose to compare two different cultural settings to also improve the generalizability of the results. In particular, due to the different economic situations and propensity to buy of Italy and Germany (higher in the latter), but a comparable diffusion of internet and mobile technologies among the youth, we considered these two European countries as meaningful example for our data settings. Although variations in structural

(industry, macro- and socioeconomic factors) and cultural characteristics exist, there are more similarities than dissimilarities. Germany is considered to be a mature online retail market with an online share (forecast) of 15.1%, in comparison to Italy with just 3.1% in 2016 (Centre for Retail Research, 2017). Around three quarters (74%) of the individuals aged 16 to 74 had purchased online in Germany in 2016, while the proportion is much lower for Italy with 29% (Eurostat 2016). However, the differences in online shopping are less obvious for younger consumers with a high formal education, e.g. individuals aged 16-24 (Germany: 96%, Italy: 60%), or individuals aged 25-54 (Germany: 93%, Italy: 58%).

With regard to differences across groups (multi-group analysis, e.g. gender, prior experience, type of application) research has shown that the instruments measuring ease of use and perceived usefulness provide to the most part an equivalent measurement (Doll et al., 1998; Deng et al., 2004). Comparing two samples of visitors using an AR application at a cultural heritage site in Europe and Asia Lee at al. (2015) found some differences in the path coefficients ranging from -0.296 to 0.112, but could not support all hypotheses proposed on the influence of cultural dimensions. In addition, a multi-group analysis was not used for establishing significant differences. Since there are only slight differences in the cultural dimensions of Hofstede between Italy and Germany (Leimeister et al., 2012), we expect invariance across the two groups:

H13: Technology characteristics and characteristics of the TAM model are invariant across the two countries.

3. Research Design

3.1 Research model

Starting from literature review, our research model is developed as shown in Figure 1, in order to highlight the factors (e.g. perceived ease of use, usefulness, and enjoyment, attitude, quality of information, aesthetic quality, interactivity, and response time) affecting the purchase decision in an online retail environment based the usage of augmented reality systems for supporting consumers online shopping experience and influencing the buying behaviour.

[Figure 1]

Figure 1: Research model

More in detail, our research refers to a particular virtual try-on system developed by Ray-Ban and available on the web site (http://www.ray-ban.com/usa/virtual-mirror) to allow consumers to virtually try sunglasses before the effective purchase through the e-commerce section.

3.2 Experimental setting: Ray-Ban virtual mirror

The Ray-Ban virtual mirror represents a meaningful example of augmented reality technology for supporting the online shopping experience. This system is accessible through the international website for virtual trying the favoured sunglasses among the available items (Figure 2). The virtual mirror accesses consumer's camera and takes a picture of his/her face (while providing some suggestions for the correct position to take the best picture for the system's right functioning). Using key points on the face pairs of augmented reality shadows

are mapped on the face. Afterwards, the consumer is able to choose the favourite items among the available glasses and virtually try them. The system further adds the glasses to the picture and simulates the final results. If a consumer likes the outcome, he/she can proceed with the effective purchase through the website.

[Figure 2]

Figure 2: Virtual mirror of Ray-Ban for virtual try the sunglasses through the website.

The virtual-try on offers several benefits to the customer (Yuang et al., 2011): clear view of the face when trying on dark sun glasses, easier comparison for users with weak eye-sight e.g. by making snapshots and comparison of a maximum of four glasses by using split screen. The system helps "to narrow down the selection to a few designs and sizes" (Yuang et al., 2011, p. 363).

The high potential of online sales of glasses (and contact lenses) highlights the US being still a leader with 16.7% of contact lenses and 6% of the sun glasses being sold online already in 2012 (http://www.statista.com/topics/1470/eyewear-in-the-us/). In Germany, the interest of consumers in virtual try-on systems varies considerably depending on the product category with eyeglasses (67.3%) on the first place followed by home furnishings (49.4%) and fashion/clothes (41.9%) (Fittkau and Maaß, 2013). However, the online share of total sales in the glasses and lenses sector (worth 5.831 billion euros) is still relatively low, with 3.86% (225 million euros) in 2015 (ZVA, 2016). 11.7 million glasses were bought in physical stores, but only 700.000 online. However, online activities are increasing with pure online market players (Brille 24 and Mister Spex), cooperation between these online market players and optical shops as well as optical shops implementing additional online shops. In Italy, the

market share of optical shops in the glasses and lenses sector is also high with 87 % in 2015. Similar to Germany, internet retailing of eyewear is increasing, e.g. with online shops specializing on sunglasses only (Tuttoocchiali.com and suneyez.com) (http://www.euromonitor.com/eyewear-in-italy/report).

3.3 Questionnaire design establishing semantic equivalence

The questionnaire has been developed as an English version and translated into Italian and German. To ensure similar meaning back-translation of the two versions into English was used which has been indicated by literature to be an adequate process (Schaffer and Riordan, 2003).

Consistent with previous studies on technology acceptance and technology management in retail settings (i.e. Pantano, 2014; Papagiannidis et al., 2014; Rese et al., 2014), the variables have emerged from the extant literature. Five items were used to measure quality of information (adapted from Ahn et al., 2004, Hausman and Siepke, 2009), four items to perceived ease of use (adapted from Davis, 1989; Gefen et al., 2003), four to perceived enjoyment (adapted from Rese et al., 2014), four to perceived usefulness (adapted from Rese et al., 2014), five to attitude (adapted from Ahn et al., 2004; Porter and Donthu, 2006), five to behavioural intention (adapted from Ahn et al., 2004), four to response time (adapted from Loiacano et al., 2007; Yoo and Donthu, 2001), six to aesthetic quality (adapted from Tsikriktsis, 2002; van der Hejiden, 2003; Cyr and Bonanni, 2005), and four to interactivity (adapted from Tsikriktsis, 2002; van der Hejiden, 2003); whereas the questions on profile comprising age, ownership of glasses (including sunglasses, eyeglasses and sports glasses), online purchases of glasses (i.e. did you buy online glasses at least once?). Beside the

questions related to the demographics, all items have been based on a seven-points Likert scale (from 1= completely disagree to 7= totally agree).

3.4 Data collection procedure in a laboratory-controlled environment

The data to test the hypotheses was collected relying on university students in a controlled laboratory environment. The experimental choice task followed the same pattern in Italy and Germany between October and December 2014. Overall, two separated laboratory studies with the country of the respondents as the unique manipulated factor, were conducted.

In particular, students were approached randomly at university and invited to take part at the experiment. In a computer room they should connect to the smart mirror website through one of the available computers (which guaranteed a high resolution of graphics and a stable internet connection) and try the online system. The technical equipment at the same level in both countries should make the results comparable. Participants were asked to explore the international English e-commerce site of Ray-Ban virtual mirror and fill in a questionnaire on their experience. No manipulation of its functionalities took place. They were firstly introduced in the smart mirror section in order to familiarise themselves with the augmented reality environment, functions and interaction modality, under the guidance of an experienced researcher. Then, participants were asked to simulate the choice and purchase of two eyeglasses models (either glasses or sunglasses), and to virtually try them on. Afterwards, they have been asked to reply to the questionnaire on their recent experience. Overall, the participants had at least a time frame of thirty minutes at their disposition (see similar Merle et al., 2012). All of them were volunteers and did not get any award for their participation in the experiment. Since students samples are considered a consistent sample for testing new technologies in retail settings (Pavlou, 2003; Harris and Dennis, 2011), we chose this sample

as convenient one. In particular buying glasses online may mostly appeal young buyers being more comfortable with the internet and online shopping. The composition of the samples was not manipulated, e.g. with regard to gender, since Kim and Forsythe (2008b) found no significant gender differences in the adoption process of a virtual-try on.

Researchers collected 150 usable responses in Italy and 168 from the German experiment (none of questionnaires has been excluded). Table 2 shows the demographic profile for both samples.

[TABLE 2 ABOVE HERE]

Table 2: Sample demographics for Italian and German sample.

The gender distribution showed a higher percentage of females than males in both samples (p=0.737). The average age of the participants ranged between 24.8 years (Italy) and 24.0 years (Germany) (T=1.890, p=0.060). On average, the participants possessed more eyeglasses in the German sample (mean value: 2.89) than in the Italian sample (mean value 1.68) (T=-1.029, p=0.304). This is especially evident and statistically significant for sunglasses (German sample: 1.71, Italian sample: 0.91; T=-7.318, p=0.000) and sports glasses (German sample: 0.49, Italian sample: 0.24; T=-3.425, p=0.001), maybe reflecting the lower availability of purchase of Italian consumers, due to the actual not florid economic situation.

A noteworthy result concerns the online purchases of glasses. Only a very limited number of respondents in both data sets purchased at least one pair of glasses through the Internet (8.2% in the Italian sample, 11.4% in the German sample; p=0.449). A justification might lay in the

characteristics of glasses, which are permanently worn and able to totally modify the appearance of the face including a certain risk before the buying (i.e. consumers may be afraid that the glasses do not fit correctly or the frame colour is different from the colour shown on the screen, etc.). This implies the large importance of e-commerce also for glasses (including sports glasses and sunglasses), which may take advantages by the new technology of the virtual try-on.

3.4 Measure validation establishing scaling equivalence

For each of the two samples means, standard deviations, and correlations for each construct were calculated (see Table 3). In both samples all correlations were significantly positive, but below the suggested multicollinearity threshold of 0.9 (Hair et al., 2006). The pattern of correlations showed to the most part to be similar with regard to the Italian and the German sample, with differences ranging from -0.058 up to 0.296. Skewness and kurtosis of the constructs were for both samples well below the thresholds (skewness > $\left|2\right|$, kurtosis > $\left|7\right|$) (West et al., 1995). We have calculated the variance extracted and the composite reliability as well as testing for scale equivalence using the MICOM procedure and smart PLS 3.2.6 (Henseler et al., 2016).

[TABLE 3 ABOVE HERE]

Table 3: Correlation matrix and discriminant assessment (calculated with PLS), skewness and kurtosis (calculated with SPSS 23) of the explanatory constructs in the Italian and German sample.

3.4.1 Testing for construct quality

The quality of the constructs in both samples in terms of reliability, validity and uni-dimensionality was analyzed with the help of exploratory and confirmatory factor analysis (Gerbing and Hamilton, 1996). To improve construct quality some items had to be removed. The corresponding values for both data set, Italian and German, are summarized in Table 4. In all cases the threshold values indicating reliability of the constructs were exceeded (Cronbach's $\alpha \geq 0.7$, Nunnally, 1978 and composite reliability > 0.70). Average variance extracted (AVE) exceeded 0.50 showing some evidence for convergent validity (Hair et al., 2011). Discriminant validity was in addition confirmed due to square root of average variance extracted was greater than the correlations of the constructs (Fornell and Larcker, 1981) (see e.g. Table 4). Each measurement shows a good value for the two data sets, thus the proposed constructs satisfy the reliability and validity criteria.

[TABLE 4 ABOVE HERE]

Table 4: Reliability and validity measurement for the Italian and German sample.

3.4.2 Testing for scale equivalence

The measurement invariance of composite models (MICOM) procedure (Henseler et al., 2016) was used to test for measurement invariance, i.e. whether the scales measure the same constructs across the Italian and German sample, which legitimizes a cross-cultural comparison (Milfont and Fischer, 2015; Schaffer and Riordan, 2003; Vandenberg and Lance, 2000; Vandenberghe et al., 2001). The procedure consists of three steps assessing (1) configural invariance, (2) compositional invariance and (3) scalar invariance. Each of the first

two steps is a precondition of the following one. To compare the standardized path coefficients across groups (multigroup analysis) at least configural and compositional invariance have to be established. Henseler et al. (2016, p.413) refer to as "partial measurement invariance". With regard to configural invariance the models should include the same number of constructs and indicators relying on an identical coding. The MICOM procedure "usually automatically establishes configural invariance" (Garson, 2016, p.185) when applied. Compositional invariance is a test whether the indicator weights being used to calculate the composite's scores are equal. There is compositional invariance if the correlation between the calculated scores of two groups does not differ significantly, e.g. equals one. Interactivity has the lowest c value with 0.99694. Overall, compositional invariance is supported for all composites with the correlations lying within the 95% confidence interval of the distribution of the correlation testing 5,000 permutations (see Table 5). Finally, scalar invariance was assessed. However, scalar invariance could not be established. The mean values of behavioural intention, usefulness, response time and aesthetic quality showed significant differences across the two groups implying the need for "meaningful multigroup analyses by comparing the standardized coefficients in the structural model" (Henseler et al., 2016).

[TABLE 5 ABOVE HERE]

Table 5:MICOM results.

4. Hypotheses testing and multigroup analysis

The proposed relationships of the constructs (structural model) were further evaluated by measuring several goodness-of-fit indexes through smart PLS software. Table 6 summarizes the results for both Italian and German cases and also points to some significant differences.

[TABLE 6 ABOVE HERE]

Table 6: Hypotheses testing including multigroup analysis.

Results indicate that most of the estimated paths, representing the formulated hypotheses, are significant with $p < .05$. For both Italian and German experiments, most of the hypotheses are supported (see Table 6). Hypotheses 1, 2, 3. 4, 5 and 6 dealt with relationships of the TAM model and considered perceived enjoyment as additional antecedent of attitude to investigate the effect of augmented reality supporting an enjoyable shopping experience of trying-on glasses online. In both countries the relationships between usefulness and attitude (H2) as well as attitude and behavioural intention (H3) were significant each demonstrating a strong effect size (f^2) larger than 0.35 (Chin et al., 2003). The effect of enjoyment on attitude (H4) as well as usefulness on enjoyment (H5) were significant in both samples, with effect size displaying a strong effect in the Italian sample and a moderate one (large than 0.15) in the German sample. In contrast to our hypothesis (H1), the path between ease of use and attitude was only significant for the German sample (β=0.195, t=3.747, p=0.000), but significant in the negative direction for the Italian sample (β =-0.106, t=2.043, p=0.0041).

Overall, perceived usefulness and perceived enjoyment (and for the German Sample: perceived ease of use) have a direct effect on consumers' attitude towards the usage of an augmented reality system in e-commerce, as tool for supporting their purchase decision.

Despite these positive values, perceived usefulness has the greatest value when compared with the other causal relationships. Attitude has also a direct positive influence on the intention to use the system when purchasing glasses. This means that this kind of technology influences consumers' online buying decision.

Our results confirm a direct influence of technology characteristics on perceived ease of use, perceived enjoyment and perceived usefulness with similar values of the corresponding standardized coefficients and effective size, in terms of aesthetic quality on perceived ease of use (H7), and response time (H11) and quality of information (H12) on perceived usefulness. In both samples quality of information displays the strongest positive effect (on perceived usefulness). The effect of aesthetic quality was less strong in particular with regard to perceived enjoyment showing only moderate effect size for the German sample. Similar, the relationship between interactivity and dimensions of the TAM model was only moderately significant for perceived ease of use for the German sample (H9). In addition, the path between interactivity and perceived enjoyment was not significant at all (H10). This might imply that the role of technology impacts consumers' online shopping experience and purchase decision making process, in terms of collecting information and interaction with the accessible information. Having entertaining experiences is also important, but in particular for the Italian sample.

The predictive power of the proposed structural model can be described as moderate (Hair et al., 2011) since three out of five R^2 values of the endogenous constructs are 0.50 and higher (see Table 7). R^2 value of perceived ease of use is weak for both samples. The same holds for perceived usefulness. Being considerably above zero Q^2 values support the predictive relevance of the model. While the technical features have a rather good predicate relevance for perceived enjoyment, this effect is smaller for perceived usefulness and in particular for

perceived ease of use. Thus the effectiveness of technical features of the virtual try-on system influences at least to some extent consumers' perception of the technology. The R^2 values of behavioural intention to use and perceived enjoyment are significantly higher in the Italian sample. This result is reflected in the star rating of Ray-Ban virtual mirror asked for at the beginning of the questionnaire being significantly higher (t=2.916, p=0.004) in the Italian sample (mean value 3.83) compared to the German sample (3.55). Overall, even if technology characteristics and characteristics of the TAM model are to a large part invariant across the two countries, there are also some significant differences, not confirming H13.

TABLE 7 ABOVE HERE]

Table 7: R^2 (Q^2) for endogenous constructs

5. Discussion

In recent years, advances in virtual reality and 3D graphics have attracted a wide range of research interest due to the possible implications for (e)retail industry. However, the current studies did not focus on the effect of augmented reality for consumers performing on e-commerce scenarios. Prior studies concerning the usage of augmented reality in retailing have attempted to recognize specific factors influencing consumers' usage of the new tools for supporting the purchase decision (Pantano and Servidio, 2012; Cuomo et al. 2014; Papagiannidis et al., 2017). Although the literature emphasized the importance of these tools for enhancing consumers' shopping experience (Chen et al., 2011; Pereira et al., 2011; Wang et al., 2012; Lee and Park, 2014; Rese et al., 2014), empirical investigations of the effectiveness of augmented reality tools on consumer online buying decision remains scarce.

The present research seems to be the first to have incorporated also the constructs related to the technology characteristics into an acceptance model that examines the influence of augmented reality systems on consumer' intention to use the system to interact with the product in terms of fit and appearance which can help to make a buying decision online. In fact, our findings extend these studies by proposing, testing and comparing these elements in Italian and German data settings.

Both Italian and German settings highlighted the extent to which this system is able to support the buying decision within the enhanced e-commerce website, by providing information about the products and to simulate how they would look on oneself to be useful for making a better choice. This might seem a surprising result, since the most of the two samples seldomly bought glasses online (134 out of 150 of Italian and 147 out of 168 for German sample). Thus, this system provides an added service for improving the decision process that consumers may enjoy by influencing them to start buying this kind of products online, which most of respondents preferred buying in an offline context due to the possibility to try the product before testing the smart mirror. In fact, results suggest both utilitarian and hedonic value of an augmented reality system for both Italian and German consumers, who found the new available system for virtually trying the glasses enjoyable and useful (see Table 4). Although virtual try-on technology for trying glasses through the website is a relatively new technology, Italian and German consumers appreciated the new supporting tool, as they are quite strangers with online buying of glasses, which represent a particular kind of product requiring the try before the buying (as anticipated, around 90% of respondents never purchased glasses through internet). However, our analysis demonstrated their comfort in using the new technology, while the ease of use and usefulness will influence consumers' decision. In particular, this research found aesthetic quality and interactivity as

antecedents of perceived ease of use (.47 and .49 respectively for Italian sample, and .48 and .49 respectively for German sample), and response time and quality of information as antecedents of perceived usefulness (.31 and .70 respectively for Italian sample, and .38 and .76 for German sample), which in turn influence the attitude combined with the perceived enjoyment for both samples.

To date, only few eyewear retailers in Germany and Italy have already introduced augmented reality for supporting online and mobile shopping and influencing consumer buying decisions. In fact, the emphasis on these elements while developing and adopting a new technology would enhance the ability of retailers to positively influence consumers' purchase decision, this might have ripple effects on loyalty and word-of-mouth communication.

Our study pushes retailers to consider consumers' interaction with the technology as an enjoyable experience by focusing on aesthetic quality, interactivity, response time and quality of information as the most important elements of the technology able to solicit positive emotions and the online purchase of products that usually require to be tried before. Noteworthy results further emerge from the similarities in Italians and Germans, by suggesting that there are no significant cultural evidences for youth while interacting in online stores enriched with augmented reality technologies, in accordance with Hofstede's cultural score analysis for Italy and Germany (Hofestede, 1984; Leimeister et al., 2009).

Summarizing, our findings enhance understanding and managing augmented reality technology in an e-commerce scenario, by emphasizing the importance of technology characteristics through the virtual interactions, with some meaningful differences between Italian and Germans settings. The first difference emerges in the behavioural intention towards the usage of of the virtual try-on (see table 4 and 5). While Italian respondents are willing to give Ray-Ban shop and the virtual try-on priority over an optician's shop and to

use this system regularly in the future (mean 4.39 and 4.89 respectively), German respondents are more prudent towards these statements (mean 2.80 and 3.05 respectively). Similarly, concerning the response time of the system Italian respondents seemed very satisfied in terms of waiting time, loading and speed of the process (mean 4.15, 4.41 and 4.30 respectively), while Germans respondents showed a lower appreciation (mean 3.54, 3.43, and 3.57 respectively). A second noteworthy difference emerges on the overall hypotheses testing (see table 6), resulting in a different result for H1 (Perceived ease of use has a positive relationship with consumers' attitude towards the adoption of the virtual try-on system for their purchasing decision to buy glasses through this system) and H6 (Perceived usefulness has a positive effect on consumers' perceived enjoyment). In fact, H1 is not supported by Italian sample and fully supported by German sample, and H6 is fully supported by Italian sample and not supported by German one. While H9 (Interactivity will positively influence the ease of use a user perceives from experiencing the augmented reality-based system) shows a little difference between the two samples: it is fully supported by German sample and weakly supported by the Italian one. Although the model is valid, there are some differences among countries that should be taken into account while designing the introduction of this kind of system to support online retailing. In particular, the aspect of enjoyment is important for Italian users, while for German users perceived usefulness and in turn the quality of information and to a lesser extent ease of use are of relevance when forming an attitude towards usage intention. With regard to enjoyment additional technical characteristics should be considered since the explanatory power (R^2) is rather low with around 30%.

6. Conclusion

The purpose of this study was to investigate the influence of augmented reality technology on the usage decision within e-commerce among consumers in a controlled laboratory environment in Italy and Germany and compares and similarities (and differences) of their motives and adoption behaviour. In particular, the research focuses on consumer willingness to try on glasses (either sunglasses or eyeglasses) within the e-commerce environment enriched with augmented reality system such as the virtual try-on (smart mirror). The proposed conceptual model hypothesizes the presence of constructs related to the technology characteristics (aesthetic quality, interactivity, response time and quality of information) in addition to the traditional ones established in TAM (ease of use, usefulness, attitude and behavioural intention). Data collected in Italy and Germany supported all hypothesized relationships embedded in the conceptual model. In particular, we have investigated the effects of the introduction of augmented reality tools within e-commerce, with particular emphasis on the technology characteristics for the online consumer purchase decision two developed countries where the smart devices and infrastructures are quite advanced, but where consumers have different willing to expenditure. Hence, it provide evidence in a cross-country comparison, by extending the previous studies (Koopman et al., 1999) highlighting the possible differences of a North-Western and a South-Eastern European cluster, such as Italy and Germany (Fassio, 2015). At a country level, an interesting result was derived from the comparison of Italian and German consumers' motivation in adopting augmented reality systems for supporting e-shopping. Both consumers' cohorts considered the new system as powerful tool to be adopted for supporting the decision making process, able to change their consumer behaviour mainly thanks to the technology characteristics (aesthetic quality, interactivity, response time and quality of information). In fact, consumers showed a positive

attitude towards using virtual try-ons to test products such as sunglasses and eyeglasses that usually suggest physical trying before buying. The virtual try-on system would substitute the physical try by meeting their preferences. In both samples the mean value of the behavioural intention to use construct was at least by tendency higher for those (few) respondents who had already bought glasses online (mean value German sample: users: 4.12; non-users: 3.69; mean value Italian sample: users: 5.40; non-users: 4.74). Although extensive knowledge exists on consumers' acceptance of e-commerce and its influence on purchase decision (Baum and Spann, 2014), based upon the findings of our experimental study, online retailers should start the introduction of augmented reality systems, with emphasis on the try-on technology for supporting shopping experience, by focusing on the technology characteristics. In particular, they should pay attention to the realistic and interactive design, providing enriched information and with a limit response time for the both samples. When implementing this kind of systems, they should be aware of the recent progresses in technology, and try to have an active role in the innovation process, instead of being passive adopters as they actually behave (Pantano, 2014). Therefore, the paper opens up new lines of inquiry for future studies towards the increasing role of augmented reality for supporting e-tailing, by extending the traditional technology acceptance model (Davis, 1989; Chong et al., 2012; Kim, 2012; Pantano and Servidio, 2012; Baum and Spann, 2014; Pantano, 2014) with more constructs related to the specific technology characteristics. These elements can be used for developing new interactive systems and marketing management strategies. In addition, when developing augmented reality applications for European or global usage it has to be taken into account that the importance of technology characteristics might be divergent for different countries (Gautier et al., 2016).

Moreover, our study embraces the work of Bourlakis and colleagues (2009) by posit the basis of a new retail environment where virtual reality might be efficiently integrated in consumers' day life. Since only few retailers adopted this technology, which got the appreciations by consumers and pushed them to change their (online) purchase dynamics, retailers (especially in fashion and accessories industry) should be aware of the potential augmented reality offers within e-commerce scenario. In fact, this pioneer strategy might rewards e-retailers, especially while integrating with other offline retail practices.

Future studies could explore this topic, by understanding how the augmented reality tools can be extended to the mobile scenario and creating new integrated multichannel shopping environments. Additional technology characteristics should be investigated such as perceived control with regard to navigation or content (McMillan and Hwang, 2002; Song and Zinkhan, 2008; Wu, 2006).

Although the study makes a cross-country comparison, some limitations suggest that results should be generalized with caution. In fact, it investigated the two samples mainly focusing on a certain age range (between 20 and 30 years old). This range has been chosen due to the extensive use of technology youth do, but it might limit its success to a youth sample, thus evidences from older consumers would be welcome. Second, the present study relies on an experimental choice task in a laboratory-controlled environment with a convenient sample of students who simulated the purchase decision in the augmented reality environment. Although Pavlou (2003) tested and compared a student sample and a sample of online consumers by achieving similar results, further studies might extend our research to online consumers and compare the findings in order to collect more generable results. The laboratory setting with high-end technical equipment might not reflect the (quality of the) technical access to a personal computer of the consumers, in particular with regard to Italy

(71% vs. 91% in Germany) (Eurostat 2016). Third, the study considers a specific e-retailer (Ray-Ban) and a specific product category (glasses), while consumers' needs and requests may vary according to the different products they intend to buy. Thus, future research could compare the present findings in more sectors, such as fashion, etc. Fourth, despite the controlled laboratory setting, an experimental design with a control group, e.g. participants trying on and choosing glasses in an optician shop, was not used. The technology could have been further manipulated (e.g. Kim and Forsythe, 2007, 2008a, 2009; Merle et al., 2012) (see Table 1). Lastly, as augmented reality for e-commerce is relatively new in Europe, further studies can consider measuring the diffusion of these technologies across time and the impact on retailing in general. Similarly, it would be possible to compare the results with countries such as Korea and Singapore, where advanced technologies are more integrated in consumers' shopping experiences.

References

Adhani, N. I. & Awang, R. D. R. (2012). A Survey of Mobile Augmented Reality Applications. *In Proceedings of the 1st International Conference on Future Trends in Computing and Communication Technologies* (pp. 89-96).

Ahn, T., Seewon, R., & Han, I., (2004). The impact of the online and offline features on the user acceptance of Internet shopping malls. *Electronic Commerce Research and Applications, 3* (4), 405-420.

Algharabat, R. & Dennis, C. (2010). Using authentic 3D product visualisation for an electrical online retailer. *Journal of Customer Behaviour, 9* (2), 97-115.

Azuma, R.T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments, 6* (4), 355-385.

Balog, A., & Pribeanu, C. (2010). The role of perceived enjoyment in the students' acceptance of an augmented reality teaching platform: A structural equation modelling approach. *Studies in Informatics and Control*, *19* (3), 319-330.

Baum, D. & Spann, M. (2014). The Interplay Between Online Consumer Reviews and Recommender Systems: An Experimental Analysis. *International Journal of Electronic Commerce*, *19* (1), 129-162.

Baytar, F., Chung, T. L. D., & Shin, E. (2016). Can Augmented Reality Help E-shoppers Make Informed Purchases on Apparel Fit, Size, and Product Performance?. International Textile and Apparel Association (ITAA) Annual Conference Proceedings. 95. http://lib.dr.iastate.edu/itaa_proceedings/2016/presentations/95

Beck, M., & Crié, D. (2016). I virtually try it… I want it! Virtual Fitting Room: A tool to increase on-line and off-line exploratory behavior, patronage and purchase intentions. *Journal of Retailing and Consumer Services*. http://doi.org/10.1016/j.jretconser.2016.08.006

Blázquez, M. (2014). Fashion shopping in multichannel retail: the role of technology in enhancing customer experience. *International Journal of Electronic Commerce*, *18* (4), 97-116.

Bourlakis, M., Papagiannidis, S. & Li, F. (2009). Retail spatial evolution: Paving the way from traditional to metaverse retailing. *Electronic Commerce Research*, *9* (1-2), 135-148.

Burdea, G., & P. Coiffet (1994). *Virtual Reality Technology*. New York: John Wiley.

Byrne, B. M. (2004). Testing for multigroup invariance using AMOS graphics: A road less traveled. *Structural Equation Modeling*, *11* (2), 272-300.

Carmigiani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. (2011). Augmented reality technologies, systems and applications. *Multimedia Tools and Applications*, *51* (1), 341-377.

Centre for Retail Research (2017). Online Retailing: Britain, Europe, US and Canada 2017. http://www.retailresearch.org/onlineretailing.php (accessed April 19th, 2017).

Chandler, P. (2009). Dynamic visualisations and hypermedia: Beyond the "Wow" factor. *Computers in Human Behavior*, *25* (2), 389-392.

Chen, A., Kao, C.-Y., Chen, Y.-H., & Wang, W.-C. (2011). Applying augmented reality to consumer garment try-on experience. *Lecture Notes in Computer Science*, *6750*, 169-190.

Chen, Y. H. & Wang, W. C. (2010). An interactive virtual fitting room for improved service in Taiwan. *Asian Journal of Distance Education*, *8* (1), 63-80.

Cheng, L.-K., Chieng, M.-H. & Chieng, W.-H. (2014). Measuring virtual experience in a three-dimensional virtual reality interactive simulator environment: a structural equation modelling approach. *Virtual Reality*, *18* (3), 173-188.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, *14* (2), 189-217.

Choi, Y.K., & Taylor, C.R. (2014). How do 3-dimensional images promote products on the Internet?. *Journal of Business Research*, 67 (10), 2164-2170.

Choi, Y. K., & Totten, J. W. (2012). Self-construal's role in mobile TV acceptance: Extension of TAM across cultures. *Journal of Business Research*, *65* (11), 1525-1533.

Chung, N., Han, H., & Joun, Y. (2015). Tourist' intention to visit a destination: the role of augmented reality (AR) application for a heritage site. *Computers in Human Behaviour*, *50* (31), 588-599.

Chung, J., & Tan, F. B. (2004). Antecedents of perceived playfulness: an exploratory study on user acceptance of general information-searching websites. *Information & Management*, *41* (7), 869-881.

Churchill, G.A. Jr. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, *16* (1), 64-73.

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology*, *56* (5), 815-822.

Cuomo, M.T., Tortora, D., & Metallo, G. (2014). In store augmented reality: retailing strategies for smart communities. *Mondo Digitale*, *13*, 49.

Cyr, D., & Bonanni, C. (2005). Gender and website design in e-business, *International Journal of Electronic Business*, *3* (6), 565-582.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13* (3), 319-340.

Davis, F., Bagozzi, R., & Warshaw, P. (1992). Extrinsic and intrinsic motivation to use computers in the workplace, *Journal of Applied Social Psychology*, *22* (14), 1992, 1111-1132.

Demirkan, H. & Spohrer, J. (2014). Developing a framework to improve virtual shopping in digital malls with intelligent self-service systems. *Journal of Retailing and Consumer Services*, *21* (5), 860-868.

Deng, X., Doll, W. J., Hendrickson, A. R., & Scazzero, J. A. (2005). A multi-group analysis of structural invariance: an illustration using the technology acceptance model. *Information & Management*, *42* (5), 745-759.

Dennis, C., Brakus, J., Gupta, S. & Alamanos, E. (2014). The effect of digital signage on shoppers' behavior: the role of evoked experience. *Journal of Business Research*, 67 (11), 2250-2257.

Dey, A & Sandor, C. (2014). Lessons Learned: Evaluating Visualizations for Occluded Objects in Handheld Augmented Reality. *International Journal of Human-Computer Studies, 72* (10-11), 704-716.

Doll, W. J., Hendrickson, A., & Deng, X. (1998). Using Davis's perceived usefulness and ease-of-use instruments for decision making: a confirmatory and multigroup invariance analysis. *Decision Sciences*, *29* (4), 839-869.

Eurostat (2016). *Eurostat Yearbook. The Statistical Guide to Europe* (10.4 Digital economy and society - households and individuals). Luxembourg: OOPEC.

Fassio, C. (2015). How similar is innovation in German, Italian and Spanish medium-technology sectors? Implications for the sectoral systems of innovation and distance-to-the-frontier perspectives. *Industry and Innovation, 22* (2), 102-125.

Fassnacht, M., & Koese, I. (2006). Quality of electronic services conceptualizing and testing a hierarchical model. *Journal of Service Research, 9* (1), 19-37.

Fiore, A.M., Kim, J. & Lee, H.H. (2005a). Effect of image interactivity technology on consumer responses toward the online retailer. *Journal of Interactive Marketing, 19* (3), 38-53.

Fiore, A. M., Jin, H. J., & Kim, J. (2005b). For fun and profit: Hedonic value from image interactivity and responses toward an online store. *Psychology & Marketing*, *22* (8), 669-694.

Fittkau & Maaß (2013). Augmented Reality im E-Commerce. http://www.fittkaumaass.de/news/augmented-reality-im-e-commerce (accessed June 1st, 2016).

Garson, G.D. (2016). Partial Least Squares: Regression and Structural Equation Models. Asheboro, NC: Statistical Associates Publishers.

Gautier, S., Gauzente, C., & Aikala, M. (2016). Are AR shopping services valued the same way throughout Europe? A four-country Q-investigation. *Systèmes d'information & management, 21* (1), 69-102.

Gefen, D., Karahanna, E., & Straub, D.W. (2003). Trust and TAM in online shopping: an integrated model. *MIS Quarterly, 27* (1), 51-90.

Gervautz, M. & Schmalstieg, D. (2012). Anywhere Interfaces Using Handheld Augmented Reality. *IEEE Computer*, *45* (7), 26-31.

Ha, S. & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research, 62* (5), 565-571.

Hair, Jr., J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006) *Multivariate Data Analysis* (6th ed.). Upper Saddle River, N.J.: Pearson Prentice Hall.

Hair, J.F., Ringle, C.M. & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19* (2), 139-152.

Harris L., & Dennis, C. (2011). Engaging customers on Facebook: Challenges for e-retailers. *Journal of Consumer Behaviour. 10* (6), 338-346.

Hausman, A.V., & Siepke, J.S. (2009). The effect of web interface features on consumer online purchase intentions. *Journal of Business Venturing*, *62* (1), 5-13.

Hernandez, B. Jimenez, J. & Martin, M.J. (2009). The impact of self-efficacy, ease of use and usefulness on e-purchasing: An analysis of experienced e-shoppers. *Interacting with Computers*, *21* (1-2), 146-156.

Hoffman, D. L., & Novak, T. P. (2009). Flow online: lessons learned and future prospects. *Journal of Interactive Marketing*, *23* (1), 23-34.

Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *The Journal of Marketing*, *60* (3), 50-68.

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values*. Beverley-Hills: Sage.

Holbrook, M. B., & Hirschman, E. C. (1982). The experiential aspects of consumption: Consumer fantasies, feelings, and fun. *Journal of Consumer Research*, *9* (2), 132-140.

Huang, T. L., & Liao, S. (2015). A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness. *Electronic Commerce Research*, *15* (2), 269-295.

Jiang, Z. & Benbasat, I. (2004). Virtual product experience: effects of visual and functional control of products on perceived diagnosticity and flow in electronic shopping. *Journal of Management Information Systems*, *21* (3), 111-147.

Kaufmann, H. & Schmalstieg, D. (2003). Mathematics and geometry education with collaborative augmented reality. *Computers and Graphics*, *27* (3), 339-345.

Karagounis, K., Syrrakos, D., & Simister, J. (2015). The stability and growth pact, and balanced fiscal stimulus: evidence from Germany and Italy. *Intereconomics*, *50* (1), 32-39.

Kim, D.E. (2016). Psychophysical testing of garment size variation using three-dimensional virtual try-on technology. *Textile Research Journal*, *86* (4), 365-379.

Kim, J.B. (2012). An empirical study on consumer first purchase intention in online shopping: integrating initial trust and TAM. *Electronic Commerce Research*, *12* (2), 125-150.

Kim, J., Fiore, A.M. & Lee, H.H. (2007). Influences of online store perception, shopping enjoyment, and shopping involvement on consumer patronage behavior towards an online retailer. *Journal of Retailing and Consumer Services*, 14 (2), 95-107.

Kim, J., & Forsythe, S. (2007). Hedonic usage of product virtualization technologies in online apparel shopping. *International Journal of Retail & Distribution Management. 35* (6), 502–514.

Kim, J., & Forsythe, S. (2008a). Sensory enabling technology acceptance model (SE-TAM): A multiple-group structural model comparison. *Psychology & Marketing, 25* (9), 901-922.

Kim J., & Forsythe, S. (2008b). Adoption of virtual try-on technology for online apparel shopping, *Journal of Interactive Marketing, 22* (2), 45-59.

Kim, J., & Forsythe, S. (2009). Adoption of sensory enabling technology for online apparel shopping. *European Journal of Marketing, 43* (9–10), 1101–1120.

Kim, K.K., Shin, H.K. & Kim, B. (2011). The role of pshychologycal traits and social factors in using new mobile communication services. *Electronic Commerce Research and Applications, 10* (4), 408-417.

Koopman, P. L., Den Hartog, D. N., Konrad, E., & Al, E. (1999). National culture and leadership profiles in Europe: Some results from the GLOBE study. *European Journal of Work and Organizational Psychology, 8* (4), 503-520.

Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behaviour. *Information Systems Research, 13* (2), 205-223.

Lee, K.C. & Chung, N. (2008). Empirical analysis of consumer reaction to the virtual reality shopping mall. *Computers in Human Behavior, 24* (1), 88–104.

Lee, K.-Y. (2012). Consumer processing of virtual experience in e-commerce: A test of an integrated framework. *Computers in Human Behavior, 28* (6), 2134-2142.

Lee, E.-J. & Park, J. (2014). Enhancing virtual presence in e-tail: dynamics of cue multiplicity. *International Journal of Electronic Commerce,* 18 (4), 117-146.

Lee, H., Chung, N., & Jung, T. (2015). Examining the cultural differences in acceptance of mobile augmented reality: Comparison of South Korea and Ireland. In *Information and communication technologies in tourism 2015* (pp. 477-491). Springer International Publishing.

Lee, H. H., Fiore, A. M., & Kim, J. (2006). The role of the technology acceptance model in explaining effects of image interactivity technology on consumer responses. *International Journal of Retail & Distribution Management*, *34* (8), 621-644.

Legris, P., Ingham, J. & Collerette, P. (2003). Why Do People Use Information Technology? A Critical Review of the Technology Acceptance Model. *Information and Management*, *40* (3), 191-204.

Leimeister, S., Leimeister, J. M., Knebel, U. & Krcmar, H. (2009). A cross-national comparison of perceived strategic importance of RFID for CIOs in Germany and Italy. *International Journal of Information Management*, *29* (1), 37-47.

Li, H., Daugherty, T. and Biocca, F. (2001). Characteristics of virtual experience in electronic commerce: a protocol analysis. *Journal of Interactive Marketing*, *15* (3), 13-30.

Li, H., Daugherty, T., & Biocca, F. (2002). Impact of 3-D advertising on product knowledge, brand attitude, and purchase intention: The mediating role of presence. *Journal of Advertising*, *31* (3), 43-57.

Li, X.-J., Xie, B. & Ye, F. (2013). Research and application of online product display technology based on augmented reality. *Information Technology Journal*, *12* (6), 1134-1142.

Lin, H.-F. & Chen, C.-H. (2015). Design and application of augmented reality query-answering system in mobile phone information navigation. *Expert Systems with Applications*, *42* (2), 810-820.

Lin, Y. L. & Wang, M. J. J. (2016). The development of a clothing fit evaluation system under virtual environment. *Multimedia Tools and Applications*, *75* (13), 7575-7587.

Loiacono, E. T., Watson, R. T., & Goodhue, D. L. (2007). WebQual: An instrument for consumer evaluation of web sites. *International Journal of Electronic Commerce*, *11* (3), 51-87.

Lu, Y. & Smith, S. (2007). Augmented reality e-commerce assistant system: trying while shopping. *Lecture Notes in Computer Science*, *4551*, 643-652.

McMillan, S. J., & Hwang, J. S. (2002). Measures of perceived interactivity: An exploration of the role of direction of communication, user control, and time in shaping perceptions of interactivity. *Journal of Advertising*, *31* (3), 29-42.

Merle, A., Senecal, S., & St-Onge, A. (2012). Whether and how virtual try-on influences consumer responses to an apparel web site. *International Journal of Electronic Commerce*, *16* (3), 41-64.

Milfont, T. L., & Fischer, R. (2015). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research*, *3* (1), 111-130.

Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: A class of displays on the reality-virtuality continuum. *Proc. SPIE Conf. Telemanipulator and Telepresence Technologies, 282-292*.

Norman, D. (2002). Emotion & design: attractive things work better. I*nteractions*, *9* (4), 36-42.

Novak, T. P. Hoffman, D. L., & Yung, Y.-F. (2000). Measuring the customer experience in on-line environments: a structural modelling approach, *Marketing Science, 19* (1), 22-42.

Nunnally, J.C. (1978). *Psychometric Theory.* 2nd ed., New York, NY: McGraw Hill.

Olsson, T., Lagerstam, E., Kärkkäinen, T. & Väänänen-Vainio-Mattila, K. (2013). Expected user experience of mobile augmented reality services: a user study in the context of shopping centres. *Personal and Ubiquitous Computing*, *17* (2), 287-304.

Olsson, T., & Salo, M. (2011). Online user survey on current mobile augmented reality applications. *10th IEEE International Symposium on Mixed and Augmented Reality (ISMAR)* 75-84.

Padilla-Meléndez, A., Del Aguila-Obra, A. R., & Garrido-Moreno, A. (2013). Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario. *Computers & Education*, *63*, 306-317.

Pan, Z., Cheok, A.D., Yang, H., Zhu, J. & Shi J. (2006). Virtual reality and mixed reality for virtual learning environments. *Computers and Graphics*, *30* (1), 20-28.

Pantano, E. (2014). Innovation drivers in retail industry. *International Journal of Information Management*, *34* (3), 344-350.

Pantano, E. (2016). Benefits and risks associated with time choice of innovating in retail settings. *International Journal of Retail & Distribution Management, 44* (1), 58-70.

Pantano, E. & Servidio, R. (2012). Modeling innovative points of sales through virtual and immersive technologies. *Journal of Retailing and Consumer Services*, *19* (3), 279-286.

Papagiannidis, S., See-to, E. & Bourlakis, M. (2014). Virtual test-driving: the impact of simulated products on purchase intention. *Journal of Retailing and Consumer Services*, *21* (5), 877-887.

Papagiannidis S., Pantano E., See-To E., Dennis C., Bourlakis M. (2017). To immerse or not? Experimenting with two virtual retail environments. *Information Technology & People*, *34* (1).

Pavlou, P.A. (2003). Consumer Acceptance of Electronic Commerce: Integrating Trust and

Risk With the Technology Acceptance Model. *International Journal of Electronic Commerce, 7* (3), 101-134.

Pereira, F., Silva, C. & Alves M. (2011). Virtual fitting room augmented reality techniques for e-commerce. *Communications in Computer and Information Science, 220,* 62-71.

Poncin, I., & Mimoun, M.S.B. (2014). The impact of e-atmospherics on physical stores. *Journal of Retailing and Consumer Services, 21* (5), 851-859.

Porter, C. E., & Donthu, N. (2006). Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics. *Journal of Business Research, 59* (9), 999-1007.

Rese, A., Baier, D., Geyer-Schulz, A., & Schreiber, S. (2016). How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions. *Technological Forecasting and Social Change*. http://doi.org/10.1016/j.techfore.2016.10.010

Rese, A., Schreiber, S. & Baier, D. (2014). Technology acceptance modelling of augmented reality at the point of sale: can surveys be replaced by an analysis of online reviews?. *Journal of Retailing and Consumer Services, 21* (5), 869-876.

Schaffer, B.S. & Riordan, C. (2003). A Review of Cross-Cultural Methodologies for Organizational Research: A Best-Practice Approach. Organizational Research Methods, 6 (2), 169-215.

Sekhavat, Y. A. (2016). Privacy preserving cloth try-on using mobile augmented reality. *IEEE Transactions on Multimedia*.

Sha, D.Y., Perng, D.B. & Lai, G.L. (2013). Study of using smart digital content technology in retail store. *Applied Mechanics and Materials, 411-414,* 2161-2166.

Shin, E. & Baytar, F. (2014). Apparel fit and size concerns and intentions to use virtual try-on: impacts of body satisfaction and images of model's bodies. Clothing *and Textiles Research Journal*, *32* (1), 20-33.

Soderlund, M. & Julander, C. (2009). Physical attractiveness of the service worker in the moment of truth and its effects on customer satisfaction. *Journal of Retailing and Consumer Services*, *16* (3), 216-226.

Song, J. H., & Zinkhan, G. M. (2008). Determinants of perceived web site interactivity. *Journal of Marketing, 72* (2), 99-113.

Steenkamp, J.-B.E.M., & van Trijp, H.C.M. (1991). The use of LISREL in validating marketing constructs. *International Journal of Research in Marketing*, *8*, 283–299.

Steuer, J. (1992). Defining virtual reality: dimensions determining telepresence. *Journal of Communication, 42* (4), 73-93.

Supino S., Malandrino O., Testa M., & Sica D. (2016). Sustainability in the EU cement industry: the Italian and German experiences. *Journal of Cleaner Production*, *112* (1), 430-442.

Szczekala, M., Karczamrz, D., Madrzycki, P. & Perz-Osowska, M. (2014). Usage of augmented reality technology in the training given to military technical personnel. *Frontiers in Artificial Intelligence and Applications*, *262*, 602-610.

Trevino, L. K., & Webster, J. (1992). Flow in computer-mediated communication: Electronic mail and voice mail evaluation and impacts. *Communication Research, 19* (5), 539-573.

Tsikriktsis, N. (2002). Does culture influence website quality expectations? An empirical study. *Journal of Service Research, 5* (2), 101-112.

Vandenberg, R. J., & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods*, *3* (1), 4-70.

Vandenberghe, C., Stinglhamber, F., Bentein, K., & Delhaise, T. (2001). An examination of the cross-cultural validity of a multidimensional model of commitment in Europe. *Journal of Cross-Cultural Psychology*, *32* (3), 322-347.

Van der Heijden, H. (2003). Factors influencing usage of websites: the case of a generic portal in The Netherlands. *Information and Management*, *40* (6), 541-549.

Van der Heijden, H. (2004). User Acceptance of Hedonic Information Systems. *MIS Quarterly*, 28 (4), 695-704.

Venkatesh, V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. *Information Systems Research*, *11* (4), 342-365.

Wang, W.-C., Chen, Y.-H. & Kao, C.-Y. (2012). The digital design applied to consumer garment try-on experience integrated with augmented reality. *Lecture Notes in Electrical Engineering*, *124* (1), 115-122.

West, S. G., Finch, J. F., & Curran, P. J. (1995). Structural equation models with nonnormal variables: problems and remedies. In: Hoyle, R.H. (ed.). *Structural equation modeling: Concepts, issues, and applications*, Newbury Park, CA: Sage, 56-75.

Wixom, B.H. & Todd, P.A. (2005). A Theoretical Integration of User Satisfaction and Technology Acceptance. *Information Systems Research*, 16 (1), 85-102.

Wu, G. (2006). Conceptualizing and measuring the perceived interactivity of websites. *Journal of Current Issues & Research in Advertising*, *28* (1), 87-104.

Yang, H. E., & Wu, C. C. (2009). Effects of image interactivity technology adoption on e-shoppers' behavioural intentions with risk as moderator. *Production Planning and Control*, *20* (4), 370-382.

Yoo, B., & Donthu, N. (2001). Developing a scale to measure the perceived quality of an Internet shopping site (SITEQUAL). *Quarterly Journal of Electronic Commerce*, *2* (1), 31-47.

Yuan, M., Khan, I. R., Farbiz, F., Niswar, A., & Huang, Z. (2011). A mixed reality system for virtual glasses try-on. *Proceedings of the 10th International Conference on Virtual Reality Continuum and Its Applications in Industry* (pp. 363-366). ACM.

Zhang, P., & Li, N. (2005). The importance of affective quality. *Communications of the ACM, 48* (9), 105-108.

ZVA (Zentralverband der Augenoptiker und Optometristen - Association of Optometrists) (2016). Augenoptik in Zahlen Branchenbericht 2015/16. ZVA gefoerdert durch Bundesministerium fuer Wirtschaft und Energie, retrieved September 25, 2016, http://www.zva.de/branchenberichte

FIGURES

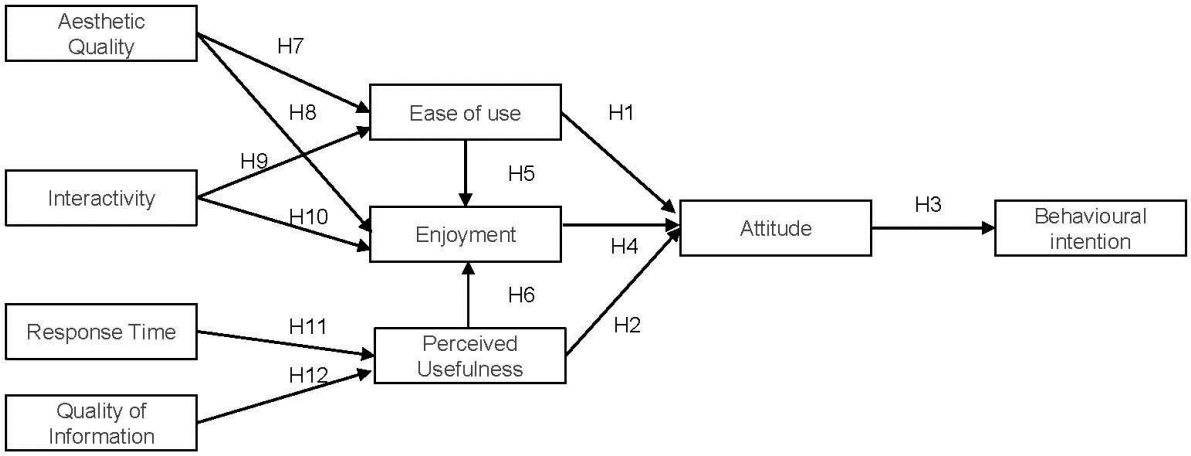

Figure 1: Research model

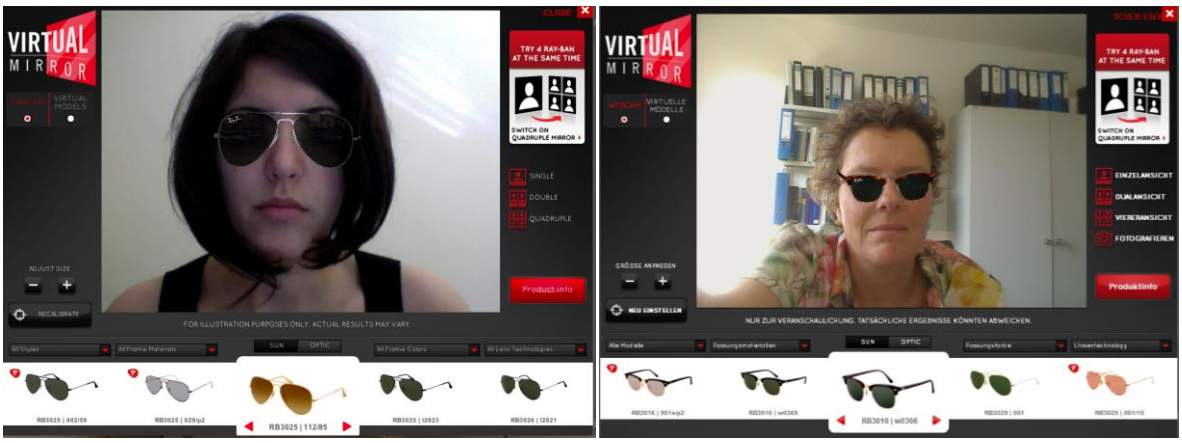

Figure 2: Virtual mirror of Ray-Ban for virtual try the sunglasses through the website

Reference	Application	Object of research	Investigated research dimensions	Data collection	Control group	Sample size	Participants
Li et al. (2001)	3-D visualizations	Bedding material, laptop computer, ring, and watch	Formation of product knowledge, perception of presence, treatment of affordances	Concurrent verbalization, laboratory controlled environment, survey	None	30	US university students
Li et al. (2002)	Product website	Video camera (Experiment 1) Watch and jacket (Experiment 2)	Presence, product knowledge, brand attitude, and purchase intention	Experimental task in a university laboratory, survey	Ex 1: 3-D vs. 2-D Ex 2: 3-D vs. 2-D and product type (geometric vs. material)	60 (Ex 1)	US university students
Fiore and Jin (2003), Fiore et al. (2005b)	Guess.com	Apparel	Global attitude toward on-line store, willingness to purchase, willingness to return to the online store, willingness to patronize (Fiore et al. ,2005b: optimum stimulation level, arousal, pleasure)	Experimental task in a university laboratory, survey	None (mix-and match condition)	103	US university students
Fiore et al. (2005a)	www.imaginariX.com	Apparel	Telepresence, experiential value, instrumental value, attitude towards the online retailer, willingness to purchase from the online retailer, willingness to patronize the online retailer	Experimental task in a university laboratory, survey	High level of IIT (models, back views, interactive product / product and product try-on features) Low level of IIT	206	US university students
Lee et al. (2006)	www.imaginariX.com	Apparel	Utilitarian shopping orientation, hedonic shopping orientation, perceived usefulness, perceived ease of use, perceived enjoyment, attitude towards the online retailer, behavioral intention	Experimental task in a university laboratory, survey	Level of IIT	206	US university students
Kim and Forsythe (2007)	Apparel shopping simulation	Apparel	Perceived usefulness, perceived ease of use, attitude towards using, intention to purchase, reuse, and revisit	Online survey after completing a shopping simulation	3D rotation views Virtual Try-on	978	US national sample of online shopper, 19 and older (3,000)
Kim and Forsythe (2008a, 2009)	My Virtual Model™, Viewpoint™	Apparel	Perceived usefulness, perceived ease of use, perceived entertainment, attitude towards using, actual use, post-use evaluation, technological anxiety, innovativeness	Online survey after completing a shopping simulation	2D/alternate views, 3D rotation views, virtual try-on	354	US university students (3,000)
Kim and Forsythe (2008b)	Virtual Try-on (High level of IIT: models, zoom in on product features, rotate and view the product from different angles, view the product in a variety of colors)	Apparel	Perceived usefulness, perceived ease of use, perceived entertainment, attitude towards using, actual use, post-use evaluation, technological anxiety, innovativeness	Online survey after completing a shopping simulation (try on a top, an outerwear item, and a pair of pants)	Male / female	491	US national sample of online shopper (2,000)

Yang and Wu (2009)	My Virtual model™	Apparel	Vivideness, interactivity, telepresence, utilitarian value, hedonic value, risk, satisfaction, purchase, rebrowse	Online survey after completing a shopping simulation	None	302	Taiwanese respondents from a survey portal
Merle et al. (2012)	Modified version of My Virtual model™	Apparel	Virtual-try on self-congruity, body esteem, confidence in apparel fit, hedonic value, utilitarian value, purchase intentions	Experimental task in a university laboratory, survey	Mix-and match condition, non-personalized condition, personalized condition highly personalized condition	152	Female students from a European Business School
Shin and Baytar (2014)	Mock website	Apparel	Models' bodies (actual vs. ideal), body satisfaction (low vs. high), concerns about garment fit and size, intention to use virtual try-on technology	Online survey after completing a shopping simulation	2 x 2 between-subject factorial design	249	Female US university students
Huang & Liao (2015)	Augmented reality interactive technology (ARIT)	Apparel	Perceived usefulness, perceived ease of use, perceived aesthetics, service excellence, perceived playfulness, consumers cognitive innovativeness, sustainable relationship behaviour, presence	Online survey after completing a shopping simulation	None	220	Taiwanese university students
Beck and Crié (2016)	Website	Apparel (experiment 1) Glasses (experiment 2)	Perceptual specific curiosity, online (Ex 1) / online (Ex 2) patronage intention, offline (Ex 1) / offline (Ex 2) patronage intention, diversive curiosity, involvement, expertise	Experimental task in a university laboratory, survey (Ex 1), online survey after completing a shopping simulation (Ex 2)	Experiment 1, 2: e-catalogue, magic mirror based on augmented reality	228 (Ex 1) 241 (Ex 2)	European university students (Ex 1), consumers (Ex 2)
Rese et al. (2016)	Ray-Ban virtual-try on Mister spex virtual-try on	Glasses	Perceived usefulness, perceived ease of use, perceived enjoyment, perceived informativeness, attitude towards using, behavioral intention	Experimental task in a university laboratory, survey	None	284 Ray-Ban, 213 Mister Spex	European university students
Baytar et al. (2017)	Virtual dress implemented in augmented reality	Apparel	Fit and size perceptions of the dress, product performance risk perceptions, attitudes towards the dress, purchase intentions	Experimental task in a university laboratory, survey	None	87	Female US university students

Table 1: Studies on acceptance of image interactivity technology and virtual-try ons

		Italian Sample	German Sample
Age			
	18-23	89 (50.7 %)	69 (41.3 %)
	24-29	38 (25.5 %)	94 (56.3 %)
	30-35	15 (10.1 %)	4 (2.4 %)
	Over 35	7 (4.7 %)	0 (0.0 %)
	Missing	1	1
	Mean value	24.8	24.0
Gender			
	F	80 (53.7 %)	87 (51.8 %)
	M	69 (46.3 %)	81 (48.2 %)
	Missing	1	0
Ownership of glasses (including sunglasses, eyeglasses, sports glasses)			
	0-1	61 (45.9 %)	25 (14.9 %)
	2-3	68 (51.1 %)	98 (58.3 %)
	4 or more	4 (3.0 %)	45 (26.8 %)
	Missing	17	0
	Mean value	1.68	2.89
Online purchases of glasses (including sunglasses, eyeglasses, sports glasses)			
	No	134 (91.8 %)	147 (88.6 %)
	Yes	12 (8.2 %)	19 (11.4 %)
	Missing	4	2

Table 2: Sample demographics for Italian and German sample.

	Italian sample German sample	M	SD	Square root AVE	1	2	3	4	5	6	7	8	skewness	kurtosis
1	Attitude	5.20	1.25	**0.886**									-.740	.642
		5.19	1.16	**0.861**									-1.066	1.377
2	Behavioural intention	4.82	1.43	0.825	**0.871**								-.719	.159
		3.76	1.38	0.713	**0.784**								-.124	-.678
3	Ease of use	5.93	1.13	0.440	0.432	**0.934**							-1.328	2.042
		5.87	0.98	0.462	0.323	**0.896**							-.906	.180
4	Interactivity	5.13	0.99	0.569	0.578	0.474	**0.861**						-.730	1.018
		5.10	1.05	0.615	0.500	0.485	**0.819**						-.965	1.368
5	Usefulness	4.85	1.47	0.784	0.765	0.471	0.523	**0.904**					-.507	-.505
		5.09	1.14	0.774	0.699	0.337	0.571	**0.838**					-.750	.326
6	Enjoyment	5.82	1.05	0.728	0.729	0.675	0.577	0.681	**0.884**				-1.117	1.484
		5.65	0.94	0.607	0.433	0.382	0.521	0.605	**0.798**				-.691	.286
7	Quality of information	5.07	1.12	0.629	0.571	0.447	0.609	0.630	0.532	**0.877**			-.630	.226
		5.19	0.95	0.617	0.495	0.420	0.667	0.600	0.498	**0.744**			.-.743	.745
8	Response time	4.29	1.41	0.321	0.411	0.282	0.299	0.346	0.377	0.287	**0.952**		-.778	-.116
		3.51	1.47	0.369	0.293	0.281	0.352	0.337	0.385	0.266	**0.915**		.224	.-.739
9	Aesthetic quality	5.49	0.99	0.711	0.674	0.515	0.756	0.608	0.647	0.621	0.299	**0.887**	-.477	-.091
		5.12	0.99	0.617	0.445	0.510	0.557	0.610	0.617	0.640	0.313	**0.870**	-.985	1.282

In bold in the diagonal. square root of AVE

Table 3. Correlation Matrix and discriminant assessment (calculated with PLS), skewness and kurtosis (calculated with SPSS 23) of the explanatory constructs

	Italian sample					German sample				
Construct	Mean[a] (Std.)	Cronbach's Alpha	Variance explained	CR	AVE	Mean[a] (Std.)	Cronbach's Alpha	Variance explained	CR	AVE
Ease of use		0.951	87.90	0.965	0.872		0.918	80.29	0.942	0.803
I found the virtual try-on to be very easy to use.	5.87 (1.28)					5.71 (1.19)				
The virtual try-on was intuitive to use.	5.89 (1.21)					5.57 (1.30)				
It was easy to learn how to use the virtual try-on.	5.95 (1.16)					6.18 (0.91)				
Handling the virtual try-on was easy.	5.97 (1.19)					6.02 (0.99)				
Usefulness		0.925	81.76	0.947	0.817		0.858	70.31	0.903	0.701
For me the virtual try-on has great value.	4.81 (1.72)					4.54 (1.52)				
The virtual try-on provides beautiful ideas for eyeglasses.	5.05 (1.41)					5.64 (1.15)				
The virtual try-on is very inspiring in terms of eyeglasses.	4.61 (1.79)					5.30 (1.24)				
The virtual try-on is a perfect aid to come to a decision in the selection of eyewear.	4.93 (1.57)					4.89 (1.55)				
Attitude		0.931	78.65	0.948	0.785		0.912	74.25	0.935	0.742
I am positive about the virtual try-on.	5.24 (1.37)					5.56 (1.21)				
The virtual try-on is so interesting that you just want to learn more about it.	4.65 (1.54)					4.46 (1.48)				
It just makes sense to use the virtual try-on.	5.23 (1.40)					4.96 (1.46)				
The virtual try-on is a good idea.	5.47 (1.30)					5.67 (1.26)				

Other people should also use the virtual try-on.	5.41 (1.44)					5.28 (1.34)				
Behavioural intention		0.921	76.22	0.940	0.759		0.842	61.64	0.888	0.615
If I were to buy glasses in the future, I would…										
...use Ray-ban shop and the virtual try-on immediately.	4.96 (1.57)					4.31 (1.80)				
...give Ray-ban shop and the virtual try-on priority over an optician's shop.	4.39 (1.70)					2.80 (1.73)				
...give Ray-Ban shop and the virtual try-on priority over other online shops.	4.82 (1.50)					4.43 (1.85)				
I will recommend using Ray-Ban shop and the virtual try-on to my friends.	5.05 (1.61)					4.20 (1.78)				
I will use Ray-Ban shop and the virtual try-on regularly in the future.	4.89 (1.78)					3.05 (1.65)				
Enjoyment		0.905	78.24	0.934	0.782		0.806	63.74	0.874	0.637
Using the virtual try-on is really funny.	5.92 (1.16)					5.46 (1.34)				
The virtual try-on is a nice gimmick.	5.89 (1.20)					6.10 (0.90)				
It is fun to discover the virtual try-on.	5.88 (1.19)					5.68 (1.09)				
The virtual try-on invites you to discover Ray-Ban online shop.	5.60 (1.18)					5.35 (1.42)				
Aesthetic quality		0.946	79.09	0.957	0.788		0.936	75.80	0.949	0.758
The virtual try-on is visually pleasing.	5.62 (1.03)					5.13 (1.10)				
The virtual try-on displays a visually pleasant design.	5.52 (0.98)					5.08 (1.13)				
The virtual try-on is visually appealing.	5.43 (1.25)					5.01 (1.17)				
Overall, I find that the virtual try-on looks attractive.	5.41 (1.15)					5.14 (1.22)				
The virtual try-on looks professionally designed.	5.56 (1.06)					5.33 (1.11)				
The virtual try-on design (i.e. colors, layout, etc.) is attractive.	5.45 (1.15)					5.05 (1.13)				

Quality of information		0.921	76.98	0.943	0.769		0.802	55.90	0.861	0.554
The virtual try-on showed me the information I expected.	4.97 (1.23)					5.14 (1.21)				
The virtual try-on provides detailed information about eyeglasses.	4.91 (1.25)					5.04 (1.25)				
The virtual glasses try-on provides the complete information about eyeglasses.	4.89 (1.31)					4.27 (1.50)				
The virtual try-on provides information that helps me in my decision.	4.89 (1.41)					5.54 (1.34)				
The virtual try-on provides information to compare eyeglasses.	5.71 (1.20)					5.98 (1.07)				
Response time		0.949	90.86	0.967	0.907		0.904	83.85	0.939	0.837
When I use the virtual try-on, there is very little waiting time between my actions and the virtual try-on response.	4.15 (1.50)					3.54 (1.67)				
The virtual try-on loads quickly.	4.41 (1.42)					3.43 (1.63)				
The virtual try-on has a quick process.	4.30 (1.50)					3.57 (1.51)				
Interactivity		0.883	74.18	0.919	0.741		0.837	67.23	0.891	0.671
The virtual try-on allows me to interact with it to receive tailored information about glasses.	5.17 (0.94)					5.06 (1.18)				
The virtual try-on has interaction features, which help me to come to a decision in the selection of eyewear.	5.05 (1.23)					5.32 (1.31)				
I am able to interact with the virtual try-on in order to get information tailored to my specific needs.	5.11 (1.30)					4.94 (1.31)				
The degree of interaction with the virtual try-on is sufficient.	5.20 (1.14)					5.08 (1.32)				

[a]: Scale: 1 = strongly disagree, 7 = strongly agree
Cronbach's Alpha, CR= Composite Reliability, AVE= Average Variance Extracted were calculated with Smart PLS; Variance explained was calculated with SPSS

Table 4: Reliability and validity measurement for Italian and German sample.

Composite	*C value (= 1)*	*95% confidence interval*	*Compositional invariance?*
Attitude	0.99995	0.99963	Yes
Behavioural intention	0.99934	0.99830	Yes
Ease of use	0.99952	0.99926	Yes
Interactivity	0.99694	0.99629	Yes
Usefulness	0.99927	0.99924	Yes
Perc. Enjoyment	0.99886	0.99849	Yes
Quality of information	0.99715	0.99614	Yes
Response time	0.99729	0.99696	Yes
Aesthetic quality	0.99930	0.99832	Yes
Composite	*Difference of the composite's mean value (Italy-Germany) (= 0)*	*95% confidence interval*	*Equal mean values?*
Attitude	0.00349	-0.22276; 0.21631	Yes
Behavioural intention	0.67096	-0.21921; 0.22292	No
Ease of use	0.03426	-0.22660; 0.21366	Yes
Interactivity	0.04338	-0.22288; 0.22589	Yes
Usefulness	-0.18256	-0.22181; 0.21973	No
Perc. Enjoyment	0.15223	-0.22246; 0.21580	Yes
Quality of information	-0.16865	-0.22529; 0.22055	Yes
Response time	0.51981	-0.21783; 0.22941	No
Aesthetic quality	0.37027	-0.22131; 0.21838	No
Composite	*Difference of the composite's variances (Italy-Germany)* (= 0)	*95% confidence interval*	*Equal variances?*
Attitude	0.15116	-0.39172; 0.38958	Yes
Behavioural intention	0.02747	-0.27937; 0.26849	Yes
Ease of use	0.29145	-0.41618; 0.40104	Yes

Interactivity	-0.11492	-0.40267; 0.39651	Yes
Usefulness	0.48179	-0.31787; 0.31419	No
Perc. Enjoyment	0.25996	-0.39600; 0.38283	Yes
Quality of information	0.33269	-0.36472; 0.34994	Yes
Response time	-0.09513	-0.24235; 0.23197	Yes
Aesthetic quality	-0.03691	-0.36392; 0.37606	Yes

Table 5. MICOM results

					Path coefficients (Effect size - f^2)		T statistics (p-value)			
Hypotheses					Italian sample	German sample	Italian sample	German sample	Path coefficient differences	T statistics (p-value)
H1	Ease of use	→	Attitude	I. Not Supported G. Supported	-0.106 (0.029)	0.195 (0.093)	2.043 (0.041)	3.747 (0.000)	0.301	4.093 (0.000)
H2	Usefulness	→	Attitude	Supported	0.539 (0.505)	0.609 (0.678)	9.054 (0.000)	10.637 (0.000)	0.069	0.841 (0.401)
H3	Attitude	→	Behavioural intention	Supported	0.825 (2.125)	0.713 (1.036)	25.450 (0.000)	21.057 (0.000)	0.111	2.369 (0.018)
H4	Enjoyment	→	Attitude	Supported	0.432 (0.227)	0.165 (0.048)	6.284 (0.000)	2.518 (0.012)	0.268	2.830 (0.005)
H5	Usefulness	→	Enjoyment	Supported	0.353 (0.215)	0.312 (0.102)	5.256 (0.000)	3.664 (0.000)	0.042	0.378 (0.705)
H6	Ease of use	→	Enjoyment	I. Supported G. Not supported	0.380 (0.288)	0.043 (0.002)	5.844 (0.000)	0.547 (0.584)	0.337	3.288 (0.001)
H7	Aesthetic quality	→	Ease of use	Supported	0.366 (0.080)	0.347 (0.122)	3.538 (0.000)	4.642 (0.000)	0.019	0.149 (0.882)
H8	Aesthetic quality	→	Enjoyment	Supported	0.177 (0.032)	0.327 (0.103)	2.335 (0.020)	3.679 (0.000)	0.149	1.267 (0.206)
H9	Interactivity	→	Ease of use	I. Weakly supported G. Supported	0.197 (0.023)	0.292 (0.086)	1.871 (0.061)	3.629 (0.000)	0.094	0.722 (0.471)
H10	Interactivity	→	Enjoyment	Not supported	0.078 (0.007)	0.140 (0.021)	0.880 (0.379)	1.561 (0.119)	0.062	0.490 (0.624)
H11	Response time	→	Usefulness	Supported	0.180 (0.052)	0.192 (0.056)	2.883 (0.004)	3.614 (0.000)	0.011	0.141 (0.888)
H12	Quality of information	→	Usefulness	Supported	0.578 (0.535)	0.549 (0.462)	12.867 (0.000)	10.700 (0.000)	0.029	0.428 (0.669)

Table 6. Hypotheses testing including multigroup analysis

R^2 (Q^2)	Overall model	Italian sample	German sample	$\lvert R^2$ diff.$\rvert$	t-value (p-value)
Attitude	0.654 (0.470)	0.691 (0.509)	0.661 (0.465)	0.030	0.418 (0.676)
Behavioural intention	0.529 (0.341)	0.680 (0.491)	0.509 (0.295)	0.171	2.399 (0.017)
Ease of use	0.294 (0.231)	0.282 (0.222)	0.318 (0.244)	0.037	0.369 (0.712)
Usefulness	0.406 (0.291)	0.427 (0.332)	0.394 (0.260)	0.033	0.375 (0.708)
Enjoyment	0.552 (0.364)	0.657 (0.487)	0.480 (0.286)	0.177	2.154 (0.032)

Table 7. R^2 (Q^2) for endogenous constructs