

AUGMENTED REALITY IN FASHION E-COMMERCE

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ABSTRACT

As a result of digitalisation and the Covid-19 pandemic, the demand for online shopping is increasing. In the fashion sector, this implies changes in buying behaviour, especially due to different sizes, size systems and the ability to visualise clothes on one's own body. Customers' incorrect purchases result in a high number of returns, a big challenge for all fashion online retailers. Augmented reality (AR) is to be used to optimise the customer's shopping experience and to counteract the problem of returns. The aim of the research is to determine the drivers and barriers of AR in fashion e-commerce from the consumers' and fashion retailers' perspective. The aim is to analyse the influence of AR on the fashion shopping experience. The strongest drivers of the willingness to use AR from the customer's perspective are the right size selection, the reduction of incorrect purchases and the fit of the garments. The biggest barriers to AR are data security, technical challenges, and a lack of trust in AR. For fashion retailers, the main added value of AR is the reduction of returns. There is a significant, positive correlation between the convenience of customers and the usefulness of AR in fashion online shopping and the intention to use AR. In future, consumers will more likely shop for fashion online via a smartphone and AR glasses.

KEYWORDS

E-Commerce, Fashion, Online Shopping, Augmented Reality, 3D Body Scan, Virtual Try-On

1. INTRODUCTION

In times of digitalisation, the need for and supply of online retailers is constantly increasing. In particular, the ongoing Covid-19 pandemic is causing an *increase in the importance of online shops* for numerous consumers, for example in the fashion industry (Zumstein & Oswald, 2020). The buying behaviour of customers is changing and leading to an increased change in the distribution channels involved in fashion online shopping (Hohmann, 2020). Consumers face major challenges with the **size selection** of garments, different body shapes and inconsistent product specifications by retailers, as well as the resulting incorrect purchases. On the part of fashion online retailers, the problem is particularly reflected in the high number of returns (Henkel, 2020).

With augmented reality (AR), it is possible to counteract these problems and to achieve an optimised online shopping experience for consumers. AR is already being applied in different industries, such as games, cosmetics, medicine and fashion. The fashion online retailer Zalando has bought *Fision*, a software start-up from the ETH Zurich, to implement AR in its platform. With the help of three-dimensional (3D) body scans, customers will be recommended individual sizes and be able to try on clothes using 3D avatars (Henkel, 2020).

This research examines the *factors that influence the willingness to use AR in fashion e-commerce*. Both the drivers and the barriers of AR are examined. This contribution provides new insights into this young field of research regarding the combination of AR and fashion e-commerce to demonstrate the current research relevance (Tißler, 2018; Gilliland, 2019). Based on this work, the research outlook implies further possibilities for a deeper understanding of the drivers and barriers of AR.

2. AUGMENTED REALITY IN FASHION E-COMMERCE

2.1 Theoretical Foundations

The term **augmented reality** (AR) implies an *extension of the real world through additional, virtual elements* (Azuma, 1997). These include graphics, information, animations as well as a linking of these visualisations with acoustic components. AR is characterised by the following three core features: the combination of the real and virtual world, interaction in real time and representation in 3D (Seiler & Klaas, 2016).

Virtual reality (VR) is distinguished from AR by the *creation of an artificial world that is computer-generated*. In contrast to AR, VR completely hides the real world from the consumer (Nikic-Cemas, 2020, p. 72). The basis of this demarcation is the reality–virtuality continuum, which represents a completely real environment on the left and a completely virtual environment on the right (Milgram & Kishino, 1994, p. 3). In between lies mixed reality (MR) through the connection of both worlds by means of AR (Seiler & Klaas, 2016).

E-commerce (electronic commerce) is understood as the digital initiation, negotiation and/or settlement of transactions between economic entities (Clement et al., 2001, p. 56). According to Olbrich et al. (2019, p. 3f.), the focus of e-commerce is on *distribution policy*. All transactions within e-commerce are carried out as a result of an electronic network (Olbrich et al., 2019, p. 6). According to Holland (2014, p. 828), the customer makes contact with the company or product views or clicks of various touchpoints. In the age of digitalisation, customers interact with different digital channels and several touchpoints at the same time (Lemon & Verhoef, 2016, p. 69), making the process increasingly complex from a company's perspective (von Gizycki & Elias, 2018; Fachinger, 2019).

2.2 Practical Fields of Application in AR

AR offers an attractive global **growth market**, forecast to be worth around \$97 billion by 2028 (Deloitte, 2020; Gilliland, 2019). Worldwide sales of over 50 million VR and AR glasses are expected by 2026 (IDC, 2022). As a result of the gaming industry, especially through the apps *Pokémon Go* and *Snapchat*, AR technology has experienced a significant upswing in recent years and now has great potential in various fields of application. So far, AR has found practical application in the automotive, logistics, interior design, marketing, beauty and fashion sectors (Orsolits & Lackner, 2020).

In **fashion online shopping**, the potential of using AR lies in *individualised product presentations* and informed product decisions for consumers (Tißler, 2018; Gilliland, 2019). The e-commerce company Mister Spex is considered as one of the pioneers, offering a glasses online shop and a virtual fitting in two or three dimensions (2D/3D; Malev, 2020). In the luxury brand sector, the implementation of future-proof technologies, such as AR, is of increasing importance, especially for the pre-purchase phase of the customer. Gucci is the first brand to implement a *virtual sneaker fitting* in its app through an embedded AR technology. A digital overlay shows 19 different sneakers that customers can virtually try on their own foot by swiping (House of Eden, 2020; Gilliland, 2019). Burberry uses AR technology to display products in Google Search. Customers can view the products, for instance the Arthur Check sneaker and bag, in their individual environment instead of on their own body. Thus, they experience a *simulated in-store experience*.

AR technology is used in physical fashion stores with the help of so-called **magic mirrors**. This mirror allows customers to try on different products virtually in the shop. Magic mirrors offer fashion shoppers the advantage of not having to change clothes or find the garments in the fashion store. In addition, products that are not physically available in the shop can be tried on virtually. The magic mirror takes on the function of a personal shopping assistant and recommends products to customers individually.

The following chapter explains how AR is used specifically by the leading fashion online retailer Zalando.

2.3 AR Shopping Service of Zalando

Zalando currently owns the digital shopping service **Zalon**, which is integrated into the online platform and offers customers *personal advice with the help of stylists*. This takes place in the following three steps: (1) customer input on needs, budget and size, (2) stylists put together the outfit and (3) free delivery of the styling box to customers (Zalando, 2020a). In addition, Zalando offers *individualised size recommendations*

based on general customer feedback, personal purchase and return history, as well as retailers' information on product dimensions (Henkel, 2020). Currently, this service is available for about half of Zalando's products.

The technology start-up **Fision** was acquired by Zalando in October 2020. Fision acts as a *3D body scan specialist* via the innovative *AR app meepl* (Zalando, 2020b). Using the smartphone, the customer takes two pictures from the front and the side of their body via the meepl app (see Figure 1, picture left and centre). The body shape is analysed and measured to a **3D body scan**. Based on the 3D body scan, a personal **3D avatar** of the customer is created (see Figure 1 on the right) and more than *50 body masses* are derived.



Figure 1. 3D body scan of the author using the meepl app (Source of images: meepl app, own realisation)

3D body scans and 3D avatars enable both *customised garments and a virtual changing room* for the customer. Moreover, the use of meepl offers consumers an *individual size recommendation* for all products, a pictorial representation of the clothes on their own body and an interactive online shopping experience (Fision, 2020).

The individual body scan and avatar can be stored in the user's own profile for size recommendations, independent of size systems and brands. Consequently, the user *saves time when choosing sizes and reduces the number of incorrect purchases*. This goes hand in hand with Zalando's strategic ecological goal of reducing returns (Fision, 2020; Zalando, 2020b).

3. RESEARCH METHOD AND SAMPLE

For this research contribution, a mixed research approach was chosen to guarantee well-founded findings from different perspectives. To gain insights about the potential of AR in fashion e-commerce, in a preliminary study two **qualitative expert interviews** with AR specialists were conducted. Expert 1 is a professor of business administration with a focus on international management and expert 2 is a research assistant and PhD student in digital marketing and consumer behaviour.

Secondly, a **quantitative user survey** was used to analyse the willingness to use, benefits and challenges of AR in fashion e-commerce. Based on these results, a **hypothesis model** on the willingness to use AR in fashion e-commerce was derived. Finally, the hypotheses were tested for statistical significance using a multivariate regression analysis using SPSS.

The quantitative survey was designed for users of AR in fashion e-commerce. This includes those users who have previously shopped online for fashion using AR or can imagine doing so in the future. The survey was conducted online from 22nd of April 2021 to 31st May 2021 and distributed via the snowball principle in the network of the authors. A total of 152 respondents took part in the survey. By the end of the survey in this non-representative study, 79 persons (52%) had participated, resulting in a sample of 76 participants. Due to the snowball principle, the external validity of the results is not given.

The survey comprises 39 questions and is thematically divided into four sections. At the beginning, psychographic characteristics are examined, in the second part, general questions regarding fashion in e-commerce and in connection with AR, followed by specific questions on the use of AR in fashion e-commerce.

The questionnaire concluded with the collection of demographic data. The majority of the questions were measured with a five-point Likert scale. The intention to use AR was measured using individual variables and three constructs whose scales can be rated as sufficient to very good due to the Cronbach's alpha value (Kline, 2011). The following chapter is devoted to the results of this study, including hypothesis tests.

4. RESEARCH RESULTS

4.1 Expert Interviews on AR in Fashion E-Commerce

According to the expert interviews, there is an assumption that, due to the **technological innovations** with *AR Kit and AR Core*, the future trend development of AR apps will go in the direction of app-based applications and, in the long term, towards smartglasses. In contrast, no broad application intention in private use can be predicted for AR glasses. With regard to AR in fashion, the shopping experience and the shopping process can be identified as the two trend directions.

From the customers' perspective, the **benefits and value of AR** technology lie in its fast *availability, independence of location, time savings and product presentation at the point of use*. Furthermore, the virtual fitting of garments and the receipt of individualised size recommendations as a result of a 3D body scan are essential. On the part of the fashion online retailers, the benefit or added value lies in particular in the *reduction of returns* and the technical advantage through AR.

From the fashion retailers' point of view, the **problems and challenges** lie in the creation of awareness of AR among customers, in the use of AR and its integration into the corporate strategy. The limitations lie in the current technology, including movements and moods that cannot yet be implemented. In addition, the technological gap of small and medium-sized enterprises (SME), compared to pioneers such as Zalando, is considered a challenge, too.

With regard to the customer journey and the entire **shopping experience**, an optimisation for the user and a higher conversion rate for the fashion online retailer can be assumed. The customer journey is influenced by the medium used, i.e. AR glasses provide a seamless experience when using AR, whereas *smartphones provide a higher immersion*. The AR application will have an impact on other customer touchpoints, such as social media marketing and branding. Furthermore, an individualisation of advertising can be assumed through user-generated content (UGC) and a user approach with concrete product recommendations.

4.2 User Survey on AR Fashion E-commerce

The user survey revealed that the absolute majority of the sample is made up of women (59%) and the main age category is 25 to 34 year olds (59%). The findings of the **reasons for online fashion purchases** showed that they are primarily *location independence* (57% of the respondents totally agree in Figure 2), *time independence* (54%), a *larger selection of products and brands* (47%) and *time savings* (45%).

The individualisation of articles as well as anonymity were seen by the fewest people as reasons to shop for fashion online (34% and 30% did not agree at all respectively). Figure 2 provides an overview of the general reasons for fashion online purchases.

With regard to the **future use of AR for fashion online shopping using the smartphone**, the majority of respondents (57%) stated that they would probably do so, and 11% would definitely do so. On the other hand, 40% of respondents probably do not intend to use AR glasses. The **online shopping experiences** in the fashion sector led to satisfaction for two thirds (63%) of the respondents, and dissatisfaction for seven percent only. The reasons for their dissatisfaction were mainly incorrect purchases corresponding to item returns due to *"it doesn't fit"* (22%), and the general fit of the garments according to the wrong size or wrong cut (21%).

Regarding **privacy and personal data**, 21% named *trust in the company* as the most important aspect. This was followed by the *credibility of the company* (17%), a *confidentiality agreement* (17%) and *trust in the added value of AR* (nine percent). Regarding automatic measurement via an AR app or video camera, for example 3D body scans, the absolute majority (46%) gave partial consent and 24% gave full consent. Additionally, the majority of respondents (41%) said they had confidence in AR features and results. If an AR app is offered for free, 44% would probably download the AR fashion application, and 44% would download it for sure.

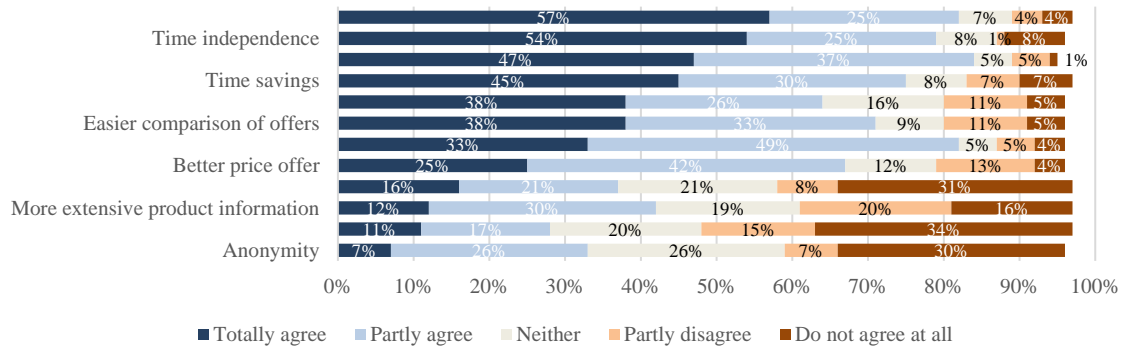


Figure 2. Reasons for fashion online purchases

Figure 3 illustrates the **benefits and added value of AR in fashion online shopping** from the customer's point of view. According to the mean values, the *correct choice of size*, the *reduction of incorrect purchases* due to "doesn't fit", the *fit of the garments* and the *ability to visualise the clothes* on one's own body can be identified as central aspects. 38% would fully agree with a *virtual try-on of glasses* using AR, 32% would agree with a *virtual try-on of clothes*, 16% would agree with a *virtual try-on of sneakers* and 15% would agree with a virtual presentation by models. Overall, 34% of respondents said they find AR *useful* in online shopping.

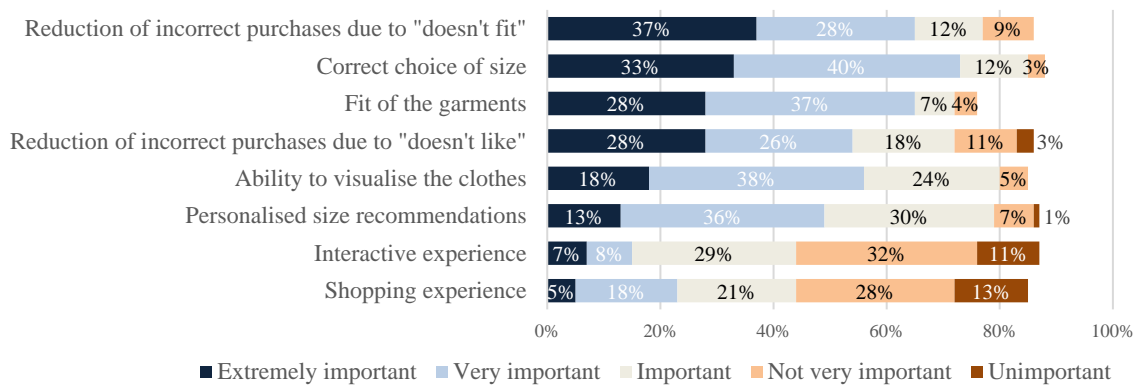


Figure 3. Benefits and added value of AR in online fashion shopping

An expert of the interviews said "*the biggest benefit would be that it reduces the return rate and/or if the company naturally does more business or has more conversions and converts more*".

In contrast, 32% said they would *not buy fashion online via a smartphone using AR*, due to **data protection** issues. Other reasons given by customers were a **lack of trust** in AR technology for 26% and a **lack of affinity for technology** for 17% of the respondents. In addition, 42% of respondents shared their satisfaction with fashion online shopping without AR. Therefore, the biggest potential challenges and problems in fashion online shopping are technical issues, data security and a lack of trust in AR technology.

Regardless of this technical **concern**, one expert of the interviews believes in additional five percent of the return quote due to this technical advance, as well as a *stronger customer retention*.

Finally, it should be noted that the absolute majority of consumers (53%) gave their partial consent to a fundamental improvement of the shopping experience by means of AR applications, while 21% gave their full consent. While 43% agreed that they would buy more fashion online thanks to AR applications, 32% would not prefer fashion online purchases via AR to fashion shopping in physical shops.

In the following chapter, the hypothesis model is statistically tested and discussed.

4.3 Hypothesis Model

The hypothesis testing is carried out using a multivariate regression analysis in SPSS. The dependent variable (DV) *intention to use AR* represents a construct from the variables *intention to use a smartphone* and *to use AR glasses*. Since the use of AR for fashion online shopping via a smartphone and via AR glasses are independent of each other, the two variables were examined as a construct. The DV implies the customer intention to use or not use AR for fashion online shopping in the future under the drivers and barriers of AR used (in Figure 4). Table 1 shows an overview of the independent variables (IV) and of the ten hypotheses (H).

Table 1. Overview of variables and hypotheses

#	Variable	#	Hypothesis
IV1	Size selection as a challenge	H1	The more problems customers have with size selection due to different size systems in fashion online shopping, the more likely they are to use AR.
IV2	Usefulness of AR	H2	Overall, the more useful customers find the use of AR in fashion online shopping, the more likely they are to use AR in fashion e-commerce.
IV3	Convenience	H3	The more comfortable customers are with online fashion shopping, the more likely they are to use AR in fashion e-commerce.
IV4	Time independence	H4	The more important time independence is to customers when shopping online, the more likely they are to use AR in fashion e-commerce.
IV5	Location independence	H5	The more important location-independence is to customers when shopping online, the more likely they are to use AR in fashion e-commerce.
IV6	Dissatisfaction due to incorrect purchases	H6	The more dissatisfied customers are due to fashion online shopping mistakes, the more likely they are to use AR in fashion e-commerce.
IV7	Frequency of fashion online	H7	The less often customers have shopped online for fashion since Covid-19, the less they use AR in fashion e-commerce.
IV8	Technical challenges	H8	The more customers agree that there are technical challenges in the use of AR in fashion online shopping, the less they use AR in fashion e-commerce.
IV9	Lack of confidence	H9	The greater the lack of trust in AR technology, the less they use AR in fashion e-commerce.
IV10	Gender	H10	Women show a higher willingness to use AR in fashion e-commerce than men.

Table 2. Overview of the standardised regression coefficients

Variable	Beta	T	Significance
Size selection (IV1)	-0.001	-0.006	0.996
Usefulness (IV2)	0.257	2.263	0.027
Convenience (IV3)	0.517	3.351	0.001
Time independence (IV4)	-0.309	-1.827	0.072
Location independence (IV5)	-0.163	-1.115	0.269
Dissatisfaction due to mispurchases (IV6)	0.083	0.699	0.487
Frequency (IV7)	0.061	0.535	0.595
Technology (IV8)	-0.064	-0.532	0.597
Trust (IV9)	0.200	1.693	0.095
Gender (IV10)	-0.232	-2.012	0.048

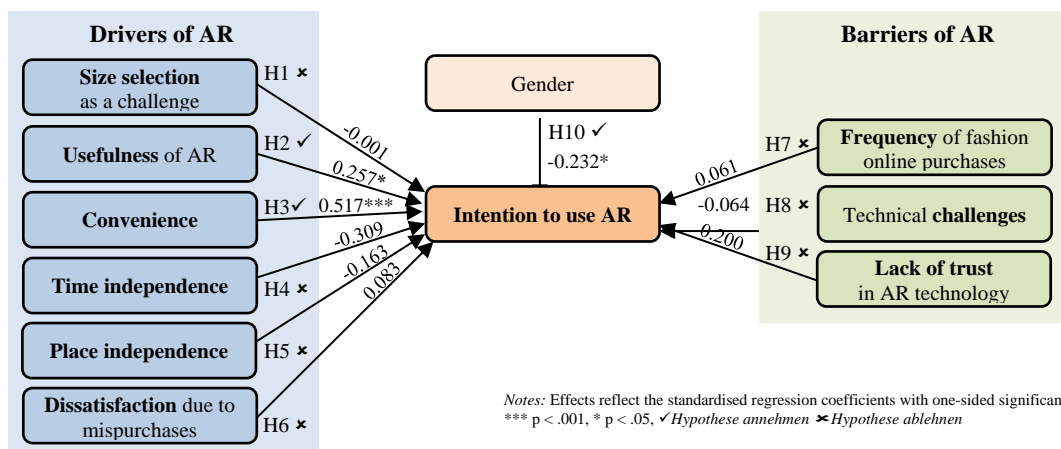


Figure 4. Hypothesis model with effects

According to the **mean values**, the variables IV3 ($M = 4.05$, $SD = 0.985$), IV4 ($M = 2.21$, $SD = 1.174$) and IV5 ($M = 4.32$, $SD = 1.038$) can be identified as the *most important model predictors*.

The statistical testing of the **individual regression coefficients** of the model shows that there are two significant regressions, *usefulness* (IV2) and *gender* (IV10), and one highly significant regression, convenience (IV3). The other variables tested have no significant influence on the intention to use AR in fashion e-commerce. Table 2 shows the effect size of all model variables.

5. DISCUSSION

The main objective was to identify the drivers and barriers of AR in relation to the intention (willingness) to use AR in fashion e-commerce. According to the regression analysis, **convenience** ($\beta = 0.517$) has the strongest influence on the intention to use AR. This is followed in descending order by time independence ($\beta = -0.309$), usefulness ($\beta = 0.257$) and gender ($\beta = -0.232$). The lowest influence on the intention to use AR is the frequency of fashion online purchases since Covid-19 ($\beta = 0.061$), dissatisfaction due to incorrect purchases ($\beta = 0.083$) and size selection ($\beta = -0.001$).

Although size selection was identified as the second strongest aspect according to the mean statistics ($M = 3.97$, $SD = 0.984$) and as a decisive challenge in fashion e-commerce as a result of the desk research and expert interviews, this effect on the intention to use AR is the smallest and at the same time negative. This means that a higher number of size selection problems in fashion e-commerce correlates with a lower intention to use AR in fashion e-commerce. The contradiction could be attributed to the fact that the hypothesis test only included size selection as a challenge due to different size systems, and excluded other influencing factors, such as missing retailer information regarding size and fit.

Gender has a significant influence on the intention to use AR in fashion shopping ($\beta = -0.232$, $t = -2.012$, $p = 0.048$), i.e. *women's willingness* to use AR is higher than men's willingness to use it. This corresponds to the researchers' expectations. Since the proportion of women in the sample is 59%, it is obvious that this is an influence and it is questionable whether the result would be identical with a different gender distribution. There is a negative but non-significant correlation between dissatisfaction through incorrect purchases due to "not fitting" as well as "not liking" and the willingness to use AR. This could be due to the *free shipping and returns policy* of the fashion online retailers. Time independence shows no significant but positive correlation with the willingness to use AR in fashion e-commerce. Consequently, an increasing importance of time independence for customers can be associated with an increasing willingness to use AR in fashion e-commerce. The mean comparisons ($M = 4.05$, $SD = 0.988$) and expert interviews support this finding. The effect of the two variables is positive, i.e. a higher frequency of fashion online purchases since Covid-19 correlates with a higher willingness to use AR in fashion e-commerce. It can be assumed that this is due to the convenience for consumers and the change in purchasing behaviour with regard to online shopping.

The analysis of the technical component as a potential challenge in fashion e-commerce using AR leads to discrepancies in the statements of the interviewed experts. On the one hand, the technology is not considered a future barrier, but must function without problems for customer use and to guarantee a satisfactory customer shopping experience. According to the user survey, the **technical challenges** on the part of consumers are to be identified as the strongest challenges.

In addition, the test of the 3D body scan using the meepl app revealed measurement inaccuracies on the part of the researchers, which led to a reduction in satisfaction. Consequently, the technical component is seen as a challenge until new usage studies of AR argue to the contrary.

According to the results of the expert interviews and user survey, the customer journey is positively changed by AR, especially through a *virtual dress fitting, the 3D body scan and personalised size recommendations*. The AR applications increase the time customers spend on the website, which leads to a higher conversion rate for fashion online retailers and a reduction in the number of returns. Contrary to the authors' expectations, customer touchpoints will not be completely digitised, but a combination of physical and digital touchpoints, such as product purchase by advertising posters and AR codes on the street, is a conceivable possibility.

Both the expert interviews and the user survey have shown that AR glasses will not be the common form of AR use for private customers, despite higher immersion. In the future, it is expected that customers will be much more likely to use AR applications in fashion e-commerce *via a smartphone* than AR glasses.

6. CONCLUSION

6.1 Recommendations for Fashion Online Shops

Based on these findings, the following five general implications arise for **fashion online retailers**:

1. **Alternative option for AR applications:** SMEs should offer customers an alternative to AR use for fashion online shopping in order to strengthen their market position against large fashion online retailers, such as Zalando.
2. **User survey:** Before implementing AR technology, SMEs should conduct a user survey on the specific intention to use AR applications. This should provide fashion online retailers with information on whether the absolute majority of their customers would only claim AR applications from the pioneers in the online fashion industry and whether this would consequently be unprofitable for them.
3. **Pilot project:** If the user survey shows a demand for AR applications, a pilot project of six to twelve months would be recommended in order to test fashion online shopping operationally and to optimise it.
4. **Joint venture with software companies:** SMEs should enter into a joint venture with a software company in, for example, the Indian or Chinese market that provide the AR technology, in order to benefit from their industry knowledge and technological edge.
5. **Cooperation with Zalando & Co.:** Instead, a cooperation with a large fashion online retailer, such as Zalando, H&M or Zara, which already has AR technology, would be conceivable. Possible points of negotiation would be a share of the profits when selling garments via AR as well as an image enhancement through the positive sustainability policy of the SME.

6.2 Further Research and Outlook

It is recommended that future research be conducted based on this research. As a priority, the study should be repeated in an international context with a representative sample to generalise the findings and increase external validity. The hypothesis model could be expanded with additional predictors from the user survey regarding the drivers and barriers of AR in order to substantiate the understanding of the willingness to use AR in fashion e-commerce. Furthermore, a mediation analysis would be useful so that in addition to gender, the moderating effect on the willingness to use AR in fashion e-commerce of other demographic variables, such as age or education, could be examined. In addition, based on the survey, hypotheses should be derived in relation to the customer journey and the shopping experience on the part of the customers and then tested for statistical significance.

The following **research questions** serve as suggestions for future studies:

1. Is there a significant positive correlation between the effective use of AR in fashion e-commerce and customer satisfaction with fashion online shopping using AR?
2. What factors influence the use of AR, such as smartphones, in fashion e-commerce?
3. To what extent does a higher intention to use AR in fashion e-commerce increase the conversion rate of fashion online retailers?
4. To what extent does the integration of AR technology influence the strategy of fashion online retailers?
5. How much do AR services like 3D body scans or avatars decrease the return rate of online retailers?
6. What influence does the emerging AR market and thus the intention to use AR have on the e-commerce market in general or on other industries?

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