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A Perspective on the Future of the Fashion and Textile Sector in Portugal with the Use of AI, AR and VR Technological Tools

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Abstract. As a result of AI, AR, and VR technologies, consumers can have a multisensory, entertainment-rich experience, which will play a crucial role in the future of fashion, given the current situation - after the COVID-19 pandemic and the economic and climate crisis. For this sector of activity, these technologies will prove to be a profitable investment, as they will provide valuable insight into consumer modifications and fragilities occurring worldwide in different countries - resulting in numerous advantages in product production, communication, marketing, storage, and distribution. Accordingly, a qualitative and quantitative research project was undertaken to examine Portuguese companies and consumers in this sector. These findings indicate that there is little implementation and development of these technologies in Portuguese companies and little knowledge about them among Portuguese consumers. These tools are still largely underutilized in sales and communication channels. Lastly, the advantages and disadvantages of these technological tools are discussed both during the buying process and as they relate to companies and retailers.

Keywords: Design · Fashion · Consumer · Artificial Intelligence · Augmented Reality · Virtual Reality

1 Introduction

Considering the global pandemic and current economic difficulties, technology can be a great opportunity for the fashion industry - resulting in the development of more productive, competitive, and profitable processes. With the advent of virtual technologies, the fashion industry is becoming more flexible and accessible, as well as enhancing a new wave of creativity across the entire supply chain. As a result, companies must rethink their marketing and communication strategies and develop these technologies, such as Artificial Intelligence (AI), Augmented Reality (AR), and Virtual Reality (VR) to address consumer uncertainty, increase sales, and create new digital experiences. In an increasingly digital world, human life is becoming more intertwined, making it essential that the Fashion industry adapts to the latest technological advancements to increase the efficiency of manufacturing, production, marketing, and communication.

To conclude, the topic is relevant to the future strategies of the companies. An initial review of the national landscape revealed a dearth of information on the topic. Therefore, the present study aims to analyze whether technological tools could play a role in the future in the fashion and textile national industry.

2 State of Art

Following the growth of communication, design, and technology, the fashion sector has involuntarily become a mirror of today [5]. It is the fashion industry's responsibility to adapt to new consumer behaviors, from habits to lifestyles, on a continuous basis, thus incorporating society's and the world's current interests.

Currently, after the pandemic, the economies of countries remain fragile and consumers still worry about financial uncertainty, which is a result of geopolitical conflicts that damage the economies of countries, increasing inflation, a lack of raw materials, and an energy crisis [1]. For innovation to develop, it is necessary to implement new technologies that assist companies in understanding the drastic changes in consumer behavior that are being experienced in the textile industry, such as the accelerated adoption of e-commerce, the division of spending between online and offline shopping, and the increased consumption of sustainable brands [7].

In 2021, companies in the fashion sector invested between 1.6% and 1.8% of revenues in technology, while for 2030 this figure is expected to rise to between 3.0% and 3.5%. The increase in innovation results in a competitive advantage for the customer - in creative, sensory, and entertainment activities, as well as in product development and distribution [1]. This industry will be able to reap the benefits of Artificial Intelligence, Augmented Reality, and Virtual Reality because these technologies will aid in understanding consumer modifications and weaknesses occurring worldwide [8].

AI helps companies improve their business models, from forecasting trends to managing inventory to enhancing collaboration between different channels of business [2]. During the forecast period from 2019 to 2027, the global AI market for fashion is expected to grow at a CAGR of 36.9%, according to Statista 2023.

With AR, customers can experience products virtually, increasing post-purchase satisfaction, reducing exchanges and returns, and increasing brand loyalty [9]. By 2020, 32% of consumers used AR while shopping. Technology such as this offers a unique opportunity to engage customers and increase their satisfaction levels [4].

Lastly, virtual reality technology provides a multi-sensory experience that is defined as real-time induction graphics with multidimensional structures, enabling the creation of virtual experiences based on simulated environments [10]. IDC 2020 reports that retail will invest the most in the implementation of this technology until 2024, with \$7.3 billion.

3 Methodologies

For this paper, a case study was selected as the methodology, to understand the consumer behavior towards the concerned technologies: consumer surveys were conducted to assess consumer attitudes toward these technologies. A case study is considered a

scientific research method in which two or more objectives are selected for in-depth analysis [6]. Six brands will be analyzed in the case study, beginning with Wonther brand and Nutch Sustainable Lifestyle which employ AI tools. Next, we will examine the production company Trimalhas and Teresa Cabreira which make use of VR technology as well as the brands Zippy and *As Portuguesas* that have used AR in physical and online shops. By studying how they behave in the companies' sales and communication channels, and by examining how this immersive technology was applied in the company's plan, we can make direct comparisons between collected data.

The multiple case study will analyze two brands in this case rather than one in order to examine the phenomenon of technologies within the context of fashion businesses and compare the results of the two. On the other hand, online questionnaires are generally associated with quantitative research plans. For instance, using an online questionnaire when you want to survey a large number of people in order to characterize a group should be conducted using probable samples [3]. This study focuses on the consumer's perception of how technology is being used in the fashion industry.

4 Results

4.1 Case Studies

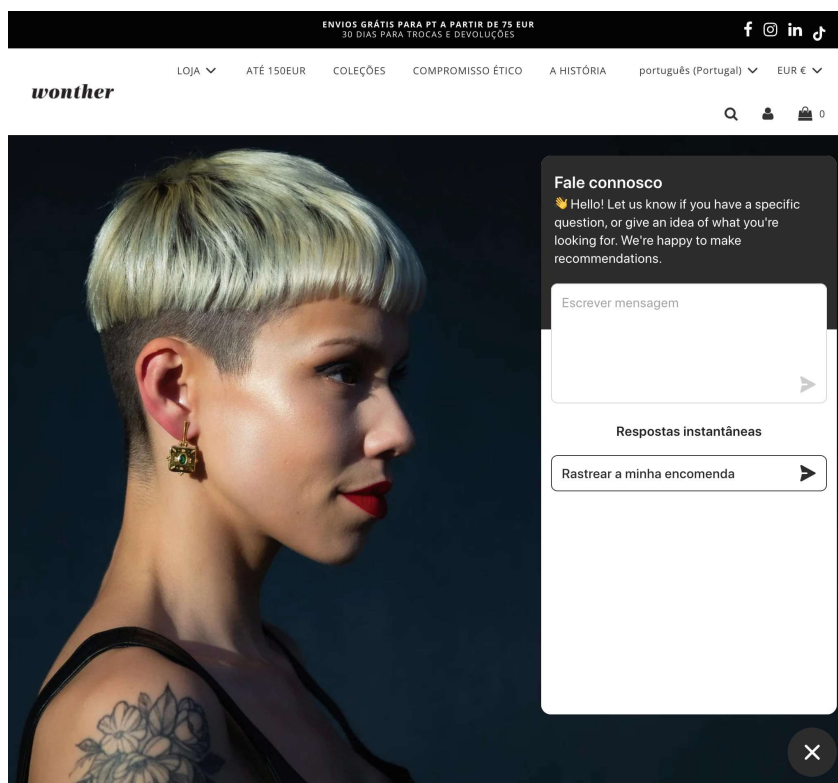
Through the analysis of the case studies, it was possible to determine how these technological tools were incorporated into the marketing strategies of the Portuguese brands, in what contexts they were used, and for what purposes. The following tables provide a summary of the information obtained from each company and the technology used by them.

The impact of AI on two Portuguese brands was examined in a study (Table 1). Wonther is a Portuguese company that produces unisex jewellery that is ethical and sustainable. The brand was founded by Olga Kassian at the end of 2019. Alternatively, Nutch was founded in 2021 by Margarida and Francisca who produce sustainable activewear for women.

For both Portuguese brands, chatbots are an important tool for selling their products online: customers can obtain information about sizes, products, materials, and orders from them. As a result, the customer will be able to complete the purchase process more quickly and efficiently. Chatbots assist these two national brands in clarifying their doubts to their consumers, and both brands are primarily oriented towards the digital market, without having physical stores. Overall, chatbots facilitate the buying process and enhance the relationship between the brand and the client by clarifying doubts in a more personalized manner. It is located on the lower right side of the digital platforms, making it easy for the customer to access (Fig. 1 and 2).

Table 1. IA - Comparative Analysis of Wonther and Nutch Companies

Technology	AI	
Companies	Wonther	Nutch
Objective	To create a tool that could talk to the customer. Facilitating the buying process and helping the interaction between the brand and the customer	The Nutch is an entirely digital brand, the chatbot turns out to be a fundamental element in the online shop, as it helps the customer and is available 24 h a day
Advantages for the company	Reduction of service costs It is immediate and more contextual It creates a more personalised purchasing process	Personalised communication
Advantages for the consumer	Immediate availability Accessibility to information Effectiveness in response Convenience Curiosity for the digital experience	Speed of response Access to all the information required for a better purchasing decision

**Fig. 1.** Chatbot of the Wonther brand website. Source - <https://wonther.com/>

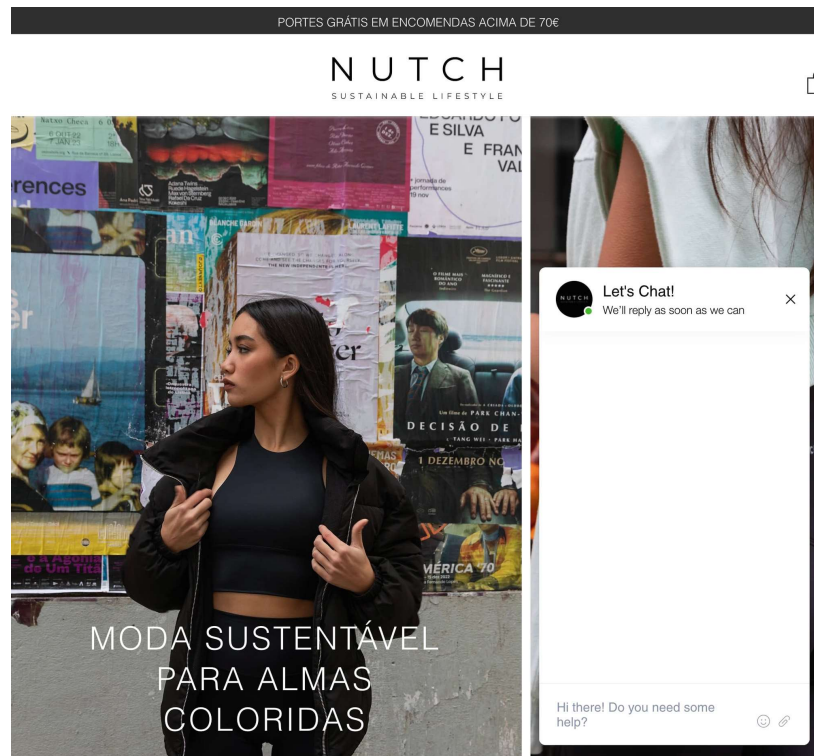


Fig. 2. Chatbot of the Nutch brand website. Source - <https://www.nutch-brand.com/>

For the study of AR in Portugal, Zippy and *As Portuguesas* were selected (Table 2). Zippy is a Portuguese children's brand that was founded in 1996 in Porto. This brand is a member of the Zeitreel group and sells clothing, interiors, footwear, and accessories for children. In 2014, Pedro Abrantes created *As Portuguesas*, a portuguese brand that produces sustainable footwear for women and men.

Table 2. Comparative Analysis of the companies Zippy and *As Portuguesas*

Technology	AR	
Companies	ZIPPY	<i>As Portuguesas</i>
Objective	Replacing a traditional fitting room - viewing products virtually in real-time. Captivating the consumer inside the physical shop	Helping customers to visualize the models during the purchase in the online shop Bringing the brand closer to consumers

(continued)

Table 2. (continued)

Technology	AR	
Companies	ZIPPY	<i>As Portuguesas</i>
Advantages for the company	Greater movement in the shop Facilitates the employee's work Enables stock reduction Reduction in returns Positioning Customer loyalty	Innovation in the purchasing process Greater interaction with the consumer Reinforces the brand's presence in the digital world Positioning Consumer loyalty
Advantages for the consumer	Personalised service Creates immersive and complete experiences 3D visualization of the entire collection Comfortable product visualization	Speed in the process of viewing the product Comfortable viewing of the product on the body Reduces displacement New digital experiences Ease in the purchase decision process

AR is a valuable tool for these two brands, particularly in sales and communication of products during a pandemic event. In Zippy's case, the brand created an AR application with 5G internet inside Norte Shopping, where customers were able to visualize the products through AR and try them out (Fig. 3). *As Portuguesas*, on the other hand, has developed an app for the smartphone that enables customers to try on any model of the brand from the comfort of their own homes and place orders online (Fig. 4).

Based on the brands under study, it can be concluded that the implementation of these technological tools provides consumers with the opportunity for a personalized and immersive experience, becoming a competitive advantage against national companies, standardizing digital communication, simplifying the process for both the customer and the company, as fewer stocks will be held in the physical store and fewer returns will be made. From product visualisation to customer service, it facilitates the entire purchasing process.



Fig. 3. AR at Zippy's physical shop, Norte Shopping. Source - <https://www.ntech.news/loja-zippy-usa-5g-para-potenciar-retalho-inteligente/>

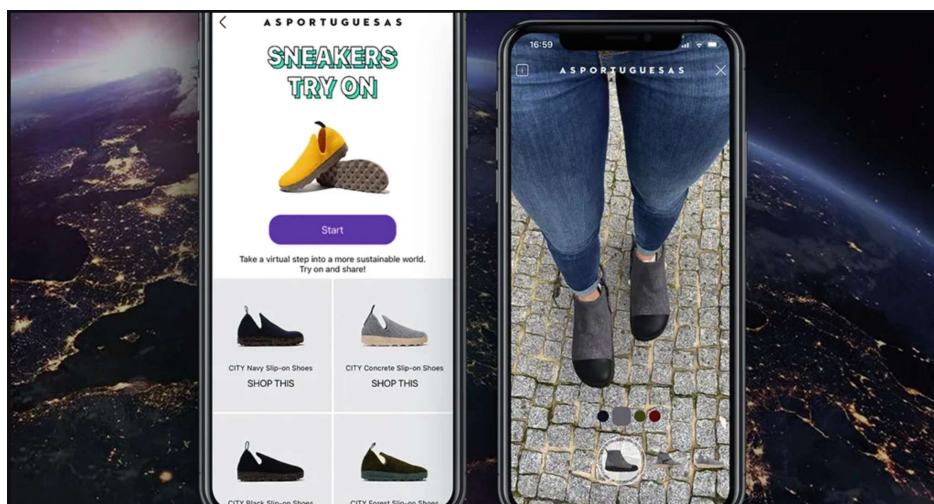


Fig. 4. AR application for smartphone of the brand *As Portuguesa*. Source - Official App

The study on VR technology was conducted on Trimalhas and Teresa Cabreira (Table 3) Trimalhas - Knit Inspiration S.A. from Guimarães is a new and fast-growing company founded in 2002 but with more than 40 years of know how. Teresa Cabreira is a company that emerged in 2002 and has two physical ready-to-wear multi-brand shops in Póvoa de Varzim.

Table 3. VR - Comparative Analysis of the companies Trimalhas and Teresa Cabreira

Technology	VR	
Companies	Trimalhas	<i>Teresa Cabreira</i>
Objective	Replacing a traditional fitting room - viewing products virtually in real-time. Captivating the consumer inside the physical shop	Helping customers to visualise the models during the purchase in the online shop Bringing the brand closer to consumers
Advantages for the company	Greater movement in the shop Facilitates the employee's work Enables stock reduction Reduction in returns Positioning Customer loyalty	Innovation in the purchasing process Greater interaction with the consumer Reinforces the brand's presence in the digital world Positioning Consumer loyalty
Advantages for the consumer	Reduces displacement Presents the collections in an interactive way Creation of digital experience Allows a generalised visualisation of the products Comfortable viewing Greater ease and security in the purchasing process	Reduces displacement Creation of digital experience Comfort in the purchasing process Personalised service

Virtual experiences serve the purpose of creating a virtual space where products can be displayed in a fully digital manner, enabling customers to visualize the products. In the case of Trimalhas the company created a virtual showroom where one can see the materials of the collections, from photographs and videos properly subtitled, thus being allowed to see the colours, textures and thickness of textile materials (Fig. 5). In the case of Teresa Cabreira, while the customer can only see a generalized view of the products, it presents a chatbot which allows the customer to have a more personalized experience while browsing (Fig. 6). By implementing these tools into these Portuguese companies' strategies, they can reap the benefits, taking into account that consumers often use digital channels, reducing the displacement of the same, and finally considering the consequences that the pandemic has brought to the market.

As a result of the Covid-19 pandemic, companies had a difficult time maintaining active sales and communication channels. Creating new digital experiences is essential to replace international fairs and physical points of sale, providing consumers with new ways to view products while maintaining coherence and coordination among digital channels. To conclude, the benefits of implementing these technologies are the possibility of creating digital experiences for consumers, thereby providing a competitive advantage over national competitors. In addition to facilitating the entire purchasing

process, from the visualization of the product to customer service, convenience, and internationalization, it will be possible to standardize digital communication, assuring that the company has a more strategic positioning.

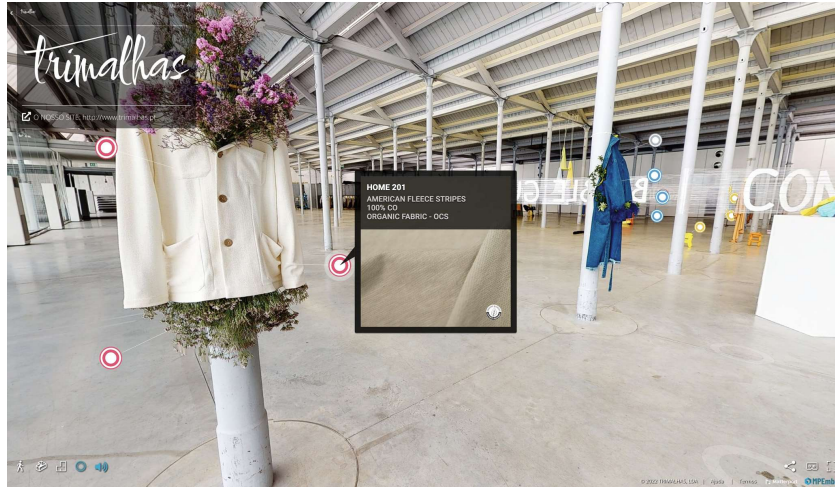


Fig. 5. Trimalhas 2021 Virtual Showroom. Source - <https://mpembed.com/show/>

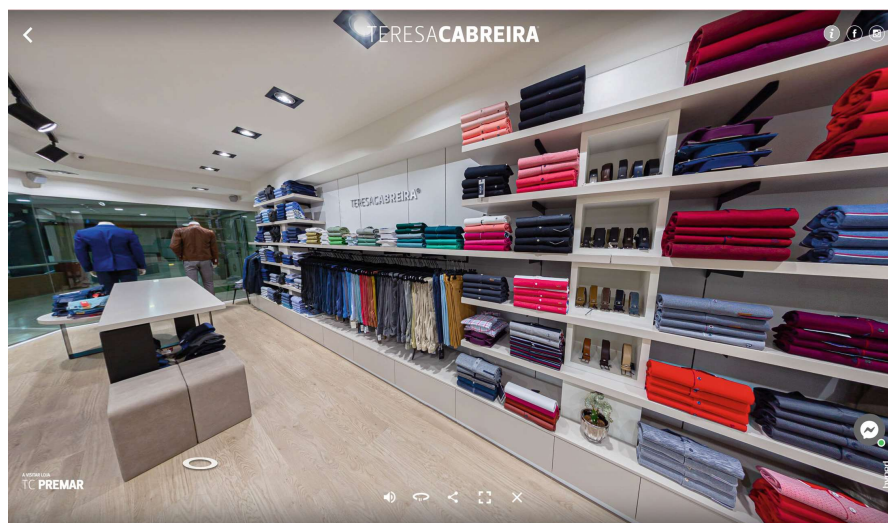


Fig. 6. Teresa Cabreira 3D Website. Source - <https://www.teresacabreira.pt/>

4.2 Consumer Questionnaire

Based on Raosoft, Inc's 2004 Sample Size Calculator software, 377 participants answered the questionnaire, which is a significant sample. We conducted this survey over a period of two months, starting in June and going through July 2022, taking into consideration a population of 20000 people with a margin of error of 5% and a confidence level of 95%. In this survey, the majority of respondents are between the ages of 20 and 30, are enrolled in higher education, and reside primarily in the northern region of Portugal, in Porto and Braga.

Regarding the use of technological tools, specifically the use of Augmented Reality (AR) in immersive experiences while shopping in fashion brands, it was determined that about 80.1% ($n = 302$), or more than half of the sample, had never experienced AR in fashion brands, whether in real-life shops or online. Thus, a large percentage of Portuguese consumers have not experienced the benefits that this technology can offer in the purchasing process and in visualizing products. Moreover, 19.9% ($n = 75$) have already used this technology to visualize how the product would fit them. Following this technology, only with respondents who had used AR, the question was asked, if AR affected the decision to purchase fashion products. In the sample, 75.7% ($n = 56$) of respondents responded positively, while 24.3% ($n = 18$) said it did not influence their purchasing decisions. All the answers of the questionnaire regarding AR is in the Table 4.

Table 4. AR - questions about this technology to the Portuguese consumer

Augmented Reality (AR) - Questions	N° Respondents	YES	NO
Have you ever used Augmented Reality in your online shop?	377	19.9%	80.1%
What role has Augmented Reality (AR) played in your decision to purchase fashion products?	75	75.7%	24.3%
Would you like to experience MORE products from Augmented Reality (AR) technology?	377	86.5%	13.5%

Based on the answers in this table, there is no doubt that consumers are interested in experimenting with AR products. The following table 5 describes an important factor that companies in this industry should consider, which is the consumer's curiosity about experiencing new immersive experiences that will enable them to read and visualize fashion products in a different manner.

In the first question regarding Virtual Reality technology (Table 5), the respondent is asked whether or not they have ever watched a virtual fashion show. In this sample, it is evident that most consumers are unfamiliar with such digital events. Eighty-three percent ($n = 313$) of respondents do not know and seventeen percent ($n = 63$) do. Even though -most fashion shows during the pandemic were broadcast via digital media, most Portuguese consumers did not watch them.

Table 5. VR - questions about this technology to the Portuguese consumer

Virtual Reality (VR) - Questions	N° Respondents	YES	NO
Have you ever seen a Virtual Fashion Show?	377	17%	83%
Have you ever visited a Virtual Showroom of Fashion/Textile Brands?	377	15.4%	84.6%
Have you ever bought digital clothing just to use in an avatar or a digital character?	377	5.1%	94.9%

In the digital showroom section, we first questioned the respondent if he had ever seen a virtual showroom of Fashion/Textile brands, which we found to be the majority, representing 84.6% ($n = 319$) of respondents never saw and 15.4% ($n = 58$) states had already experienced this type of event. By analyzing in detail, the responses of those respondents who said they had already experienced a virtual showroom, it can be concluded that the majority of these respondents are Portuguese, with ages between 20 and 30, and working in this field at a professional level, including Product Designers, Fashion Designers, Online Traffic Managers, Computer Engineers, Designers, Projectionists, Motion Designers, as well as students and researchers. Accordingly, it is evident that most respondents who recognize this type of technology are directed towards areas where these tools are used; on the other hand, the general public is not aware of these virtual experiences. To expose consumers who are not familiar with this area to these digital events, it will be important to communicate these events and advertise them.

In addition, the respondent was also asked if he/she/it has acquired any digital clothing, either as an avatar or as an AR filter. Among the samples obtained in this case, 94.9% ($n = 357$) had never purchased a product of this type, whereas 5.1% ($n = 19$) had previously purchased a digital fashion product.

The use of Artificial Intelligence, specifically chatbots, in the fashion brand's online shops can be observed in Table 3, where approximately 71.4% ($n = 269$) of the sample does not use a chatbot to inquire about their doubts when browsing the online shops; 28.6% ($n = 108$) of the sample uses a chatbot to access the fashion brands' websites.

Lastly, to conclude the theme of chatbots in online stores, 95.4% ($n = 103$) agree that the use of chatbots is usually effective in answering questions they have during the purchase process, while 4.6% disagree websites (Table 6). According to the study conducted by Deriva (2021), most consumers (87.2%) report neutral or positive experiences with chatbots, while only a small percentage (12.8%) report negative experience. An additional 45.9% of consumers said they used chatbots for immediate responses in the same study.

Table 6. AI - questions about this technology to the Portuguese consumer

Artificial Intelligence (AI) - Questions	N° Respondents	YES	NO
Is it common for you to use chatbots on the websites of fashion brands when browsing fashion online shops?	377	28.6%	71.4%
Are chatbots usually effective at answering questions at the time of purchase?	163	95.4%	4.6%

As a conclusion, do you believe that the technological tools discussed in this survey are necessary for the current fashion industry?

As this question presents a direct approach, the purpose is to obtain a sample that is defined in exact values, identifying whether the consumer considers it appropriate to use these technologies in the Fashion/Textiles industry. As a result, 80.9% of the respondents (n = 305) consider the technologies addressed in this survey to be necessary for the current fashion market, whereas 19.1% (n = 72) do not. These results indicate that the majority of respondents think that the use of these tools is indispensable for the future of fashion, thus making the consumer one of the most important pieces of the future for fashion. When the customer experiences this type of digital interaction with the brands, as well as through the online and physical channels, it can be realized that they will be curious and willing to do so.

5 Conclusions

Even though the study area is relatively new and there are a limited number of studies, this study aims to contribute to the development of knowledge about the use of these technological tools in the fashion industry and its impact on sales channels and product communication. The purpose of the study was to identify and analyze technologies such as artificial intelligence, augmented reality, and virtual reality and how they can be implemented in this field. Companies must often invest significantly to implement these technologies, making them a very complex strategy. It is usually necessary for a company to invest significant human, financial, and technological resources in the development of these technologies; these technologies can, however, have several benefits for the organization's customers as well as for its long-term success. Since these tools were used in the sales and communication channels, these six companies were able to provide a more personalised approach to the customer in a more digital way, considering the pandemic situation. Even so, these technologies are still in their infancy when it comes to the use of sales and communication channels in the industry, especially at the national level.

On the other hand, from the consumer's perspective, the use of these technological tools is still very low, because there is still little widespread use of AR, VR, and AI in direct contact with customers via sales and communication channels. As can be seen, consumers consider the use of these technologies to be important, since they provide

extraordinary convenience, facilitate the purchase process, and enable businesses to gain and retain new customers. The national consumer, however, continues to use traditional methods of purchasing and only a small percentage has turned to online shopping, but due to the pandemic, there has been a noticeable change in consumer behavior.

Finally, by analyzing these two methods of data collection, it is possible to verify that national brands invest minimal resources in adopting these technologies, which results in consumers having a limited immersive experience.

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