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User perceptions of 3D online store designs: an experimental investigation

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Abstract

The increasing adoption of three-dimensional (3D) virtual reality technologies in business practices requires an interdisciplinary research approach to study their effect. In this paper we investigate the effects of different 3D online store layouts on user perceptions in the e-retailing context. We build on recent research on store atmosphere that classifies store layouts in 3D environments as "avant-garde", "warehouse", "pragmatic", "boutique" and "department". Reflecting the dual identity of individuals as both consumers visiting virtual stores and users interacting with graphical user interfaces, we employ key constructs from both the marketing and the information systems literature to build our research model. The study measures how Perceived Usefulness, Perceived Ease of Use, Merchandise Quality Perception and Store Perception vary across the distinct store layouts. We employ a laboratory experiment in the apparel industry to test our model. Our results show that the layouts lead to different perceptions, although the consumers' Shopping Motivation does not moderate this effect. Building on the differences found on store layout effects on user/consumer behavior in the 3D online context, the paper discusses relevant research and practical implications.

Keywords 3D online store design · Store perception · Electronic retailing · Experimental design

1 Introduction

Three-dimensional (3D) environments constitute "newly deployed systems" (Bououd et al. 2016, p. 1191) that have drawn research attention to individuals' behavior and attitude. As Byram (2021) notes, 3D Virtual Reality (VR) shopping

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is an innovative technology that offers a type of real-store shopping experience that may lead to fast developments in the electronic retailing industry. Luna-Nevarez and McGovern (2021, p. 167) also state that "V-commerce is emerging as a promising technology for a new type of e-commerce application, which can address the critical need for integrating both social and technical aspects of online shopping". Similarly, Wedel et al. (2020) call for research that will investigate consumer responses to virtual reality store environments to assist the development and adoption of these applications.

In this context, the need to apply and test existing knowledge from the two-dimensional (2D) online stores' context in the virtual, three-dimensional (3D) retail setting is increasing, because the virtual shopping environment provides a novel mix of 2D and 3D features and options. Also, while a 3D virtual store may be considered as an evolution and enrichment of a (2D) e-shop, 3D online environments have been found to have more characteristics in common with traditional retail stores than with 2D online ones (Krasonikolakis et al. 2010).

Several researchers (e.g., Krasonikolakis et al. 2014; Kang 2017; Kang et al. 2020) call for research initiatives that will investigate the 3D online retail store design effects on consumer behavior, similarly to extant research on conventional and 2D online retail stores. Such research efforts will contribute to better conceptualize consumer responses to 3D contexts and to provide brands and retailers with implications for the effective use of such technologies (Xue et al. 2020b). Motivated by this research need, the present paper adopts an interdisciplinary research approach to study the 3D online store layout effects on consumer perceptions in the apparel industry.

Positioned in the scientific field of store atmosphere, our research contributes to theory, by studying online store design effects on user behavior in 3D online environments by focusing on store layout as a major store atmosphere determinant. Following theoretical insights from store layout effects on consumer behavior both in traditional and electronic retailing (2D and 3D) and elaborating on a recently developed 3D store layout classification scheme (Krasonikolakis et al. 2018), the study investigates whether there are significant differences among five distinct store layout types (i.e., avant-garde, warehouse, pragmatic, boutique, and department—see "Appendix A") in terms of consumer perceptions. The five alternative virtual store layout types are treated as stimuli in a lab experiment to test their effect on merchandise quality perception, virtual store perception, perceived usefulness, and perceived ease of use. The study also examines the moderating effects of shopping motivation which may determine the degree of the relationships between the manipulated and the dependent variables of the research model. Finally, the paper also contributes to business practice, by providing direct suggestions for the design of 3D online retail store layouts.

The rest of the paper is structured as follows. In Sect. 2 we review the relevant literature, and develop the research model and the corresponding research hypotheses of the study. Then, Sect. 3 presents the research methodology of the study and Sect. 4 the results of the lab experiment. The findings of the empirical research employed by the present study are discussed in detail in Sect. 5. Finally,

the conclusions and the implications of the work reported in the paper are presented in the final section of the paper (Sect. 6).

2 Review of the literature and research hypotheses

2.1 Background

The present study is positioned in the electronic retailing domain and more specifically in the store atmosphere field. According to store atmosphere theory, store layout, as a component of store atmosphere, has been shown to affect various consumer perceptions and behaviors both in traditional and online environments (e.g., Siomkos and Vrechopoulos 2002; Levy and Weitz 2004; Vrechopoulos et al. 2004; Griffith 2005). Krasonikolakis et al. (2010) report that store layout is a key factor influencing consumer behavior in 3D online environments, prompting further research in the 3D online retail context on how store design affects consumer behavior (Krasonikolakis et al. 2014; Kang 2017;). Wu et al. (2017) confirmed that e-servicescape of online stores affects consumer behavior. They adopted the Stimulus-Organism-Response (SOR) model and included as e-servicescape elements the aesthetic appeal, the layout and functionality and the financial security. They also call for further research on this topic.

Research has also confirmed that consumer behavior in 3D online environments is distinct. Recently, Sina and Wu (2019) compared 2D with 3D shopping interfaces of online shopping sites through a between-subjects experimental design. They found significant differences between 2 and 3D online stores in terms of a series of consumer behavior variables (e.g., perceived merchandise quality, patronage intention). Similarly, Jang et al. (2018) measured the visual complexity effects on consumer behavior in fashion retail stores through a between-subjects experimental design. They also found significant differences among the treatments of their experiment in terms of consumer responses. Kim et al. (2020) examined the effects of 360-degree rotatable images as a new form of 3D product display technology on consumer responses. They found that they are superior to static product images but "could backfire when consumers are cognitively busy" (p.7). Also, Park and Kim (2021) conducted two experiments in the apparel industry and found that 3D store experience positively affects consumer engagement and purchase intentions. Similarly, Pizzi et al. (2020) compared physical and virtual reality store environments in terms of consumers' perceptions. They found that virtual reality retail environments lead to higher patronage intentions and WOM referral, when compared to physical ones. The benefits of 3D virtual reality applications in retailing are also demonstrated in the work of Papagiannidis et al. (2017). They conducted a series of experiments, and they report that "the immersive, 3D environment, thus, has the potential to rival traditional shopping in terms of experience, resulting in higher sales for the retailers and satisfaction for the consumers" (p. 180).

Very recently, Wu et al. (2021a) developed a typology of atmospherics for personalizing 3D virtual fashion stores. They note that personalization could act as a persuasive tool for increasing sales in the emerging field of 3D virtual reality. Similarly,

Wu et al. (2021b) conducted an action research study and identified 9 modules and 38 modular options for personalizing 3D virtual stores (e.g., style, product category, color, presence of avatar). However, as reported by Vrechopoulos et al. (2019), personalization in not a panacea and must be treated as a strategic decision in the context of strategic marketing planning under the "standardization vs. adaptation" dilemma. Thus, for companies that follow the "standardization" option (e.g., multinational companies that use the same "look and feel" in their physical and/or online stores globally) it is important to be provided with research insights regarding the store layout that they should adopt in their 3D online retail stores to achieve their objectives. To this end, Kang et al. (2020, p. 82) report that VR "has the potential to revolutionize retail, yet companies are still experimenting with how to best implement VR into their business strategy". Similarly, Xue et al. (2020a, p. 1057) note that "v-commerce designers still lack sufficient guidance to create effective retail environments." Also, Xue et al. (2020b) found that consumers visiting virtual commerce sites expect a vivid shopping experience and thus underline the critical role of store design for virtual reality e-commerce sites. In response to the call for further research in the 3D retail context, in the next section we develop a conceptual model to test the effect of store layout in this environment.

2.2 Conceptual model and hypotheses development

2.2.1 The conceptual model of the study

Exploiting store atmosphere theory and relevant research insights, we build our research model drawing primarily from research showing that in the 2D and 3D online contexts the design, atmospherics or layout of the selling outlet play a critical role in the way customers perceive various aspects of a store (Dailey 2004; Griffith 2005; Manganari et al. 2009; Lai et al. 2014; Krishnaraju et al. 2016; Barros et al. 2019; Xue et al. 2020b). These aspects include merchandise quality perceptions (Zeithaml 1988; Kerin et al. 1992; Baker et al. 2002; Ladhari et al. 2017; Lin et al. 2018; Vries et al. 2018), perceived usefulness (Lee et al. 2003; Vrechopoulos et al. 2004; Yang et al. 2019), perceived ease of use (Lightner et al. 1996; Vrechopoulos et al. 2004; Wei and Ozok 2005; Tandon et al. 2018), and overall store perception (Park and Kim 2003; Kim et al. 2007; Hewawalpita and Perera 2017; Loupiac and Goudey 2019; Byram 2021). Our model is based on store atmosphere theory (Manganari et al. 2009; Krasonikolakis et al. 2010), which asserts that offline and online store layout is an important component that influences consumer behavior. We apply this theory in a new context/shopping channel (i.e., 3D online stores) to explore the store layout effects on consumer behavior in this contemporary shopping channel, similarly to what has been studied in traditional retailing several decades ago, and in 2D online retailing during the last two decades. Finally, we measure the determining power of shopping motivation as a moderator on the relationship between the 3D store layout and consumers' perceptions (Lin and Lo 2016; Escobar-Rodríguez and Bonsón-Fernández 2017; Watson et al. 2020; Xue et al. 2020b).

Furthermore, we build on research showing that specific types (or classifications) of stores, based on layout, lead to different customer responses (e.g., Griffith 2005; Vrechopoulos et al. 2004, 2009; Krasonikolakis et al. 2018). Specifically, following a typology that has been suggested by previous research (Krasonikolakis et al. 2018), we use five distinct 3D virtual store layout types as treatments of the research setting (Fig. 1).

These store layouts were designed and developed in the lab to serve the objectives of the study. A visualization of each layout type is provided in "Appendix A", illustrating their distinctive characteristics. We provide a detailed discussion of the layout types in the Research Methodology section, under Experimental Design.

This model positions the present study in the scientific field of store atmosphere, focusing on store layout as a major store atmosphere determinant. To study the effect of 3D store layout on the perception of customers, we draw from both the Information Systems and the Marketing fields. This interdisciplinary approach is required since a 3D online retail store constitutes both an information system and an electronic retail store, while individuals interacting with this store are both users of an information system and consumers visiting the store. Thus, the research model's dependent variables (Fig. 1) are, on the one hand, *Perceived Ease of Use* and *Perceived Usefulness*, as critical indicators of user acceptance of an information system (Davis 1989) and, on the other hand, *Merchandise Quality Perceptions* and *Online Store Perception* which, according to the established Retailing and Consumer Behavior theory (both in offline and online environments), are directly affected by the retail store layout. The moderating factor of the research model, *Shopping Motivation*, was selected in line with findings in
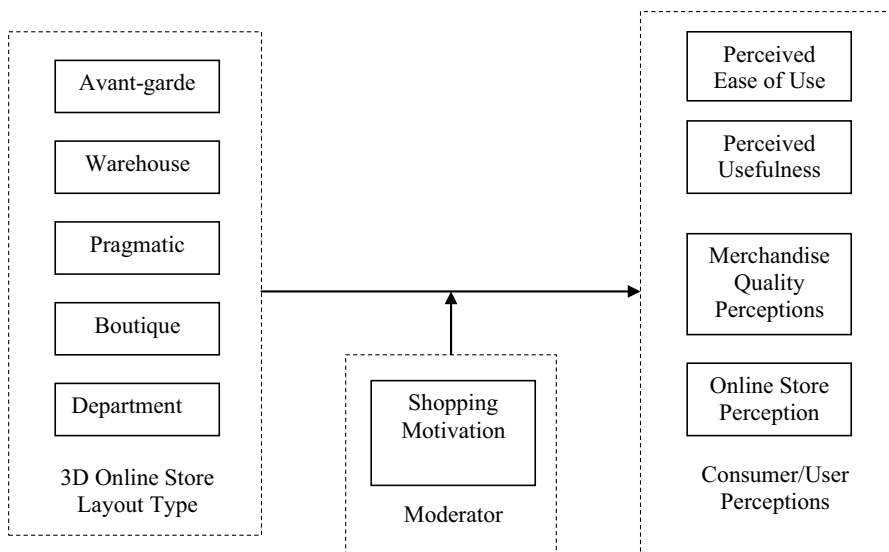

Fig. 1 The conceptual model of the study

earlier store atmosphere studies (see Sect. 2.2.5) both in the offline and in the online shopping environment, to explore its role in this novel context.

The research hypotheses depicted in the conceptual model of the study in Fig. 1 are theorized in the following sections.

2.2.2 3D online store layout effects on perceived ease of use and perceived usefulness

In the seminal work of Davis (1989, p. 320), Perceived Ease of Use (PEOU) is defined as "the degree to which a person believes that using a particular system would be free of effort" and Perceived Usefulness (PU) as "the degree to which a person believes that using a particular system would enhance his or her job performance." According to van der Heijden (2000, p. 417), "the perceived usefulness in a Web site context is defined as the degree to which an individual believes that using the site will contribute to reaching a particular objective."

Although there is no systematic research on e-store layouts, several studies have shown the influence of store layout elements of e-atmospherics on perceived ease of use and usefulness. Recently, Tandon et al. (2018) found that website functionality (e.g., navigation, web site design) is positively associated with customer satisfaction in online shopping. They underline the crucial role of layout design as an influencing factor of online consumer behavioral variables, such as time saving through easily locating desired information. Wei and Ozok (2005) studied the functionality of web sites to meet users' usability needs, while Novak et al. (2000) found a positive relationship between web site characteristics and cognitive states. Navigational cues and screen design characteristics were found to be positively related to perceived ease of use. Wagner (2007) states that ease of use and convenience are influenced by a clearly arranged brick-and-mortar store layout that facilitates searching of products. Titus and Everett (1995) consider store layout as an important influence factor of search efficiency within a physical store. Similarly, Puccinelli et al. (2009) suggest that long stores with long aisles may dispirit customers from searching products in a traditional store, as it is considered an arduous process. Oh et al. (2008), investigating the influence of store atmosphere (i.e., storefront design and information display) on convenience in traditional and online stores, showed that users found the online stores with picture-driven information more convenient than those with text-driven information. Their results are in line with Geissler (2001), who argues that sophisticated online store layouts will probably be more eye-catching at first, but they are not considered convenient for users-consumers. Ahn et al. (2007, p. 263) also found that web quality significantly affects the perceived ease of use, playfulness, and usefulness of a retail web site. Furthermore, Cyr et al. (2006) conclude that design aesthetics affect perceived usefulness, perceived ease of use, and enjoyment in the context of mobile commerce, while Griffith (2005) traced significant differences among different layout types in terms of perceived ease of use. Vrechopoulos et al. (2004) also identified a strong relationship between an online store's layout and ease of use and perceived usefulness. They advise retailers to refrain from adopting guidelines and principles established in conventional retailing if they have not been tested in the online context, signaling the importance of the research

context. Similarly, Vrechopoulos and Atherinos (2009), through an online experiment in the context of web banking, showed that there are significant differences among different layouts in terms of ease of use and perceived usefulness and they also call for further research on that topic. More recently, Lin and Lo (2016) found significant differences among alternative online store layout types in terms of ease of using the online store, while Sohn (2017) reported differences among different shopping touchpoints and product categories regarding perceived usefulness predictors in the context of online mobile shopping. Furthermore, research by Yang et al. (2019) showed the significant effects of content quality (e.g., image and video content) on perceived usefulness in the context of virtual personal assistant devices.

Nonetheless, not all research concurs with these results. For example, Vrechopoulos et al. (2009) conducted an online experiment in the context of 3D virtual worlds and found that store layout does not influence ease of use and perceived usefulness. Similarly, Manganari et al. (2011), through an experiment in the online travel industry, showed that store layout does not affect ease of use, while Visinescu et al. (2015) report that shopping websites using 3D environments are associated with lower perceived ease of use and lower cognitive absorption, compared to traditional 2D ones. Similarly, Pandey and Chawla (2018) found that website navigation and search ease do not have a positive impact on consumer satisfaction and loyalty. Overall, however, the influencing role of store layout on ease of use and perceived usefulness has been thoroughly documented in the literature (e.g., Chen et al. 2002; Lee et al. 2003; Vrechopoulos et al. 2004). The inconsistency of results in online environments suggests the need for further study of this role.

To do so in the context of the 3D online retail stores, we use the typology of five distinct layouts developed in Krasonikolakis et al. (2018): pragmatic, avant-garde, boutique, warehouse, and department. These layouts are presented in detail in the Research Methodology section and depicted in "Appendix A". According to this typology, the *pragmatic* and the *avant-garde* layouts emphasize the functionality of the store (e.g., through the theme-based display of products and the simple product management, highlighting the details of products). For example, the *pragmatic* store layout allows flexibility and ease of navigation due to the simple product management and light graphics requirements, while the *avant-garde* one includes posters that highlight the details of the products, without developing long aisles that may dispirit customers from product search. Therefore, these layouts may be perceived by users as easier to use and useful for finding the desired products, compared to the other three layouts. Thus, hypotheses #1 and #2 are formulated as follows:

H1 Users perceive the pragmatic and the avant-garde 3D online retail store layouts as easier to use compared to the warehouse, the boutique, and the department ones.

H2 Users perceive the pragmatic and the avant-garde 3D online retail store layouts as more useful compared to the warehouse, the boutique, and the department ones.

2.2.3 3D online store layout effects on merchandise quality perceptions

Merchandise quality perceptions and store layout are two of the attributes considered as "value signals" for consumers (Zeithaml 1988). Kerin et al. (1992) have empirically tested and shown their influence on consumer behavior. Gardner and Siomkos (1985), studying the effects of in-store atmospherics, identified that consumers perceived a perfume of a specific brand of higher value in "high image" design store description, compared to the value of the same perfume in a "low image" store design. Baker et al. (2002) also observed a direct effect of design cues of the store (e.g., layout) on merchandise quality perceptions. Similarly, Ladhari et al. (2017) found that store layout positively affects emotional satisfaction, which in turn leads to a high perception of product quality, while Vries et al. (2018) discuss the significant relationships between online shopping interfaces and product evaluations. Recently, Bhandari et al. (2019) found significant relationships between visual aesthetics and users' quality perceptions in the context of mobile apps. Similarly, Piris and Guibert (2019) found significant relationships between digital product assortments and consumers' evaluation of the website. Following these research insights, it is expected that, in 3D online environments, retailers are highly capable of creating or manipulating the perceptions of the products' quality using intelligent technological innovations.

In the context of the 3D online retail stores, the *boutique* layout places emphasis on providing a superior look and feel of the store (e.g., visual interest: interesting architecture, walls of glass, attractive materials that appeal to visitors, limited number of products that are artistic and sophisticated, personalized services and offers). Similarly, the quality of the products displayed in a *boutique* store is considered of high quality (Wang et al. 2011). Conversely, the *department* store layout adopts characteristics of traditional department stores and offers a wide variety of product assortment (either producers' brands or own retailers' brands). Such stores display products of high-end designers embedded within a large space that this *department* layout offers. Therefore, based on the theory presented here (e.g., Baker et al. 2002; Gardner and Siomkos 1985) the products or merchandise displayed in these two layouts may be perceived as of higher quality compared to those displayed in the other three layouts. Thus, the following research hypothesis is formulated:

H3 The users' merchandise quality perceptions are higher in the boutique and the department 3D online retail store layouts than in the avant-garde, the warehouse, and the pragmatic.

2.2.4 3D online store layout effects on online store perceptions

The perceptions of an online store may have a direct strong effect on the attitude towards the store (van der Heijden and Verhagen 2004). Wu et al. (2013) report that the online store layout significantly influences emotional arousal and attitude toward the website, and thus, positively affects purchase intention. Kim et al. (2007), following Mummalaneni's (2005) argument that there is a positive relationship between the design of the store and pleasure and Vrechopoulos et al.'s (2004)

argument that the layout of a store is positively related to entertainment, we hypothesize that the use of interactive technology is positively related to online store perception. Recently, Loupiac and Goudey (2019) found that the store atmosphere of the website affects the consumers' perception of the online store. Also, Hewawalpita and Perera (2017) found through an experiment direct relationships between 3D product presentations and value perception in online shopping environments. Similarly, Algharabat et al. (2017) found that 3D product presentation quality determines consumers' perceptions of attitude toward the website. In the context of 3D online environments, the present study examines whether distinct types of store layout create different perceptions towards the store.

The *boutique* layout includes attributes and characteristics (e.g., emphasis on 3D and luxury, sophisticated architecture and design, selling of unique product assortment and distinct brands, use of attractive materials, virtual try on, artistic items, fitting rooms etc.) that differentiate it from the other layout types in terms of providing a higher online store perception. Similarly, the *department* layout creates a dynamic flow through a range of levels, sections, and multiple configurations. In traditional retailing, multiple-level department stores are considered elite and of high quality. Thus, the following research hypothesis is formulated:

H4 The users' perceptions of the online store are higher in the boutique and the department 3D online retail store layouts than in the avant-garde, the warehouse, and the pragmatic.

2.2.5 Shopping motivation moderating effects on the 3d online store layout: user behavior relationship

Stone (1954) has been one of the early researchers to divide shoppers into "economic" and "apathetic" clusters. Since then, in the traditional and online retail context, there are numerous academic studies suggesting classifications of shoppers in terms of their motivation, patronage behavior and attribute preferences (e.g., Babin et al. 1994; Koutsiouris et al. 2016). In terms of shopping motivation, Westbrook and Black (1985) emphasize the hedonic and utilitarian aspect, showing that in most cases consumers are either more hedonic and less utilitarian, or the opposite. The hedonic and utilitarian dimensions of consumers are essential to interpret customers' behavior processes (Babin et al. 1994).

The issue of hedonic and utilitarian shopping motivations in e-commerce has been investigated by several studies in the past (e.g., Childers et al. 2001). Recently, Wani et al. (2017) found both utility-based and hedonic measures to be important for the evaluation of information systems by customers in the context of travel company websites. Lin and Lo (2016) found significant differences among alternative online store layout types in terms of impulse shopping behavior, while Lee and Wu (2017) found that the perceived control of flow in an online consumer shopping environment affects utilitarian value. Watson et al. (2020) found that shopping motivation moderates the relationship between augmented reality applications and consumer responses in the fashion industry, whereas Hashmi et al. (2020) also found that shopping motives moderate the relationship between store atmospherics and

consumer behavior. Similarly, Kumar and Kashyap (2018, p. 257) confirmed in their study that "frequent online shoppers are more utilitarian oriented than the occasional visitors. By offering more utilitarian value, online retailers strengthen their claim to be the preferred shopping site". Also, Weathers et al. (2007) report that the communication style of vivid pictures is considered better suited for "experience" products than "search" products. Escobar-Rodríguez and Bonsón-Fernández (2017) highlighted the role of utilitarian vs. hedonic online shopping motivation as a key consumer behavior determinant in online fashion stores and they encourage further research that will treat variables like product type and product categories as moderating factors in experimental research settings. They also report that consumers seeking hedonic motivations for shopping will still buy in brick-and-mortar stores. Finally, a very recent study by Xue et al. (2020b) found that shopping motivation affects consumers' attitudes towards v-Commerce.

Based on the above discussion, the present study aims to investigate whether the online shopping motivation moderates the relationship between the 3D online retail store layouts and consumer behavior. Thus, the following research hypotheses are formulated:

H5.1 Consumers' shopping motivation moderates the 3D online retail store layout effects to users' perceived ease of using the store.

H5.2 Consumers' shopping motivation moderates the 3D online retail store layout effects to users' perceived usefulness of the store.

H5.3 Consumers' shopping motivation moderates the 3D online retail store layout effects to users' merchandise quality perceptions.

H5.4 Consumers' shopping motivation moderates the 3D online retail store layout effects to users' perception of the online store.

3 Research methodology

3.1 Experiment design, sample and design realism

As presented in the Conceptual Model section, the present study uses the typology of five 3D store layouts previously established in the research of Krasonikolakis et al. (2018). According to this typology, the *avant-garde layout* encourages visitors to move around the store to obtain a clear view of the products, which appear on wall posters or on screens in the floor plan. Visitors can easily see the details of the products that are highlighted, and there are signs directing people throughout the store. The stores also feature (virtual) models, positioned in the middle, to display the products. The *warehouse layout* employs long and straight rows to group related products and facilitates product comparison. The layout allows alternative entry points for avatars and offers teleporting services

for moving to specific product-related areas. In a *pragmatic layout,* emphasis is placed on displaying wall-only items and images to reduce lag and dependence on system requirements and offer simple product management. Theme-based products are presented in the same area and visitors are exposed to similar products when they choose a specific one to evaluate. The b*outique layout* features an attractive architecture, allowing demonstration and trial of products. It mimics physical boutique and specialty stores by providing display cabinets, shelves, and fitting rooms. Product range is limited, and products have distinctive names that convey the impression of uniqueness and high quality. Finally, stores with a *department layout* offer numerous products and services. This layout resembles that of traditional department stores in terms of space design, product clustering, and the design of aisles and walls within the store. Visual examples of the five 3D virtual store layout types are presented in "Appendix A".

We follow a laboratory experimental design to investigate the causal relationships among the various store layout types on consumer/user perspectives. All participants in the lab experiment were asked to watch five 2-min videos, each presenting one of the five 3D virtual store layout types. In these videos, emphasis was placed on the layout of the store and subjects were explicitly asked to focus on this particular retail format variable. In order to avoid learning effects and increase reliability, participants were randomly selected and were provided with a list with various combinations of sequence in the order of the treatments at the beginning of the experiment and were asked to select one at random. This served as assurance that the participants would each select to watch the videos in a different order. Then, one of the authors provided each respondent with a video, and a description of the layout/design of a store. The participants were invited to review the layout design and evaluate the characteristics of the store. In the instructional leaflet, participants were asked to concentrate only on the store layout and not on any other external factors such as prices or design of the products. This process was repeated five times, to ensure all participants viewed all store layout types.

We used a realism check to examine the realism of the experimental design. We asked participants whether they believed that the described situation could happen in real life, and whether they could imagine an actual 3D store offering the things described in the situation cited above (items adopted from Wagner et al. 2009). The internal reliability was Cronbach $\alpha = 0.786$ and the means of the two items were 4.4 and 4.6 accordingly in a 5-point Likert scale. Considering both results, a high level of realism of the experiment was achieved.

After distributing the questionnaires, 59 usable responses were collected from two Southern European Universities. The gender dimension of the participants was split roughly evenly (54.23% being male), while most participants were single (94.91%). The majority (91.52%) of the sample was below 29 years old; approximately 52% were aged between 18 and 23 years old and 39% between 24 and 29 years old. About 76.27% of the respondents were students and 8.87% held a master's degree. Participants are experienced Internet users and approximately 90% of them reported shopping online, while 78% of the sample conduct purchases in 3D environments.

3.2 Operationalization, reliability and validity

We measured the five variables of the research model in 5-point Likert Scale constructs (from 1: strongly disagree to 5: strongly agree). For perceived ease of use and perceived usefulness, we used the items used by Vrechopoulos et al. (2004) for online stores that are adapted from Davis's (1989) seminal work on technology acceptance. Baker et al. (2002), investigating the role of store environment cues on perceived merchandise value, used two items to measure the construct merchandise quality perceptions. We adopted the same items as they were also used by Baker et al. (1994), studying the role of ambient, design, and social aspects of store environment on merchandise quality perceptions. To measure online store perception, we adopted the instrument of Kim et al. (2007) consisting of 5 items. The four items used to measure shopping motivations were drawn from Kang and Park-Poaps (2010), as adapted from Babin et al. (1994). Shopping motivation was measured through the utilitarian shopping motivation scale (i.e., low vs. high utilitarian shopping motivation scores) which is also suitable for testing the corresponding research hypotheses through mixed/split-plot ANOVA tests (discussed in the Results section). All items used in our study are presented in "Appendix B".

The reliability and validity statistics performed to ensure the appropriateness of the research model for further analyses are presented in the following Tables (Tables 1, 2). The values of Cronbach's alphas support high reliability of the five constructs for each of the five store layouts accordingly. The values of composite reliability all exceed the threshold of 0.7 (Hair et al. 1998). Then, convergent validity was tested, obtaining adequate values for AVE, all of which were above the cutoff value of 0.5 (Zait and Bertea 2011). In order to confirm discriminant validity, we calculated the maximum shared variance (MSV) and compared them with the AVE scores for all constructs. In all cases, the MSV scores were lower than the AVE. To strengthen discriminant validity, we followed the Fornell and Larcker (1981) technique, and we confirmed that the square root of AVE of each construct is greater than the correlation of the specific construct with each of the other constructs. In sum, the results of these tests, presented in Tables 1 and 2, confirm the appropriateness of the model in terms of reliability, as well as convergent and discriminant validity.

4 Results

Hypothesis#1: Perceived Ease of Use In H1 we investigate the influence of store layout on perceived ease of use. A one-way repeated measures (RM) ANOVA indicated an overall significant difference among the store means [$F(12.664, 131.696) = 5.577$, sig. $= 0.003$]. We used the Bonferroni post-hoc test to uncover the differences among means. The ranking of store layout types in terms of perceived ease of use is: (a) avant-garde ($M = 3.82$), (b) pragmatic ($M = 3.78$), (c) boutique ($M = 3.45$), (d) warehouse ($M = 3.37$), and (e) department ($M = 3.33$). The mean scores that statistically differ are across avant-garde and warehouse, boutique, and department, and between pragmatic and warehouse. Thus, H1 is partially supported.

Table 1 Measures of reliability, convergent and discriminant validity

Construct	Cronbach's α	CR	AVE	MSV
Avant-garde				
Perceived ease of use (PEOU)	0.927	0.925	0.674	0.312
Perceived usefulness (PU)	0.918	0.936	0.709	0.430
Merchandise quality perceptions (MQP)	0.862	0.857	0.751	0.378
Online store perception (OSP)	0.872	0.925	0.712	0.430
Shopping motivation (SM)	0.868	0.866	0.618	0.311
Warehouse				
Perceived ease of use (PEOU)	0.945	0.946	0.743	0.637
Perceived usefulness (PU)	0.947	0.948	0.754	0.637
Merchandise quality perceptions (MQP)	0.870	0.882	0.791	0.337
Online store perception (OSP)	0.944	0.945	0.775	0.634
Shopping motivation (SM)	0.869	0.869	0.625	0.054
Pragmatic				
Perceived ease of use (PEOU)	0.925	0.925	0.674	0.312
Perceived usefulness (PU)	0.934	0.936	0.709	0.430
Merchandise quality perceptions (MQP)	0.848	0.857	0.751	0.378
Online store perception (OSP)	0.926	0.925	0.712	0.430
Shopping motivation (SM)	0.865	0.866	0.618	0.311
Boutique				
Perceived ease of use (PEOU)	0.934	0.934	0.701	0.529
Perceived usefulness (PU)	0.915	0.915	0.643	0.588
Merchandise quality perceptions (MQP)	0.801	0.808	0.680	0.607
Online store perception (OSP)	0.885	0.888	0.617	0.607
Shopping motivation (SM)	0.864	0.865	0.615	0.085
Department				
Perceived ease of use (PEOU)	0.913	0.914	0.641	0.526
Perceived usefulness (PU)	0.926	0.920	0.657	0.526
Merchandise quality perceptions (MQP)	0.827	0.832	0.714	0.424
Online store perception (OSP)	0.843	0.850	0.547	0.424
Shopping motivation (SM)	0.877	0.878	0.643	0.203

Hypothesis#2: Perceived Usefulness Results of one-way repeated measures (RM) ANOVA show that the mean scores for usefulness are *not* statistically significantly different. The value of the F statistic of the overall model is not significant [$F(13.092, 180.027) = 4.218$, sig. $= 0.12$]. In this regard, as there are no significant differences among the layout means as far as the perceived usefulness is concerned, H2 is rejected. In terms of the mean scores, the avant-garde elicited the highest score ($M = 3.73$), and the pragmatic ($M = 3.50$), boutique ($M = 3.27$), department ($M = 3.24$) and warehouse ($M = 3.15$) follow accordingly.

Table 2 Discriminant validity and matrix of correlations

Construct	PEOU	PU	MQP	OSP	SM
Avant-garde					
Perceived ease of use (PEOU)	0.821				
Perceived usefulness (PU)	0.558	0.842			
Merchandise quality perceptions (MQP)	0.291	0.569	0.867		
Online store perception (OSP)	0.238	0.656	0.615	0.844	
Shopping motivation (SM)	0.377	0.558	0.258	0.280	0.786
Warehouse					
Perceived ease of use (PEOU)	0.862				
Perceived usefulness (PU)	0.798	0.868			
Merchandise quality perceptions (MQP)	0.480	0.317	0.890		
Online store perception (OSP)	0.645	0.796	0.581	0.880	
Shopping motivation (SM)	0.176	0.231	0.069	0.030	0.791
Pragmatic					
Perceived ease of use (PEOU)	0.821				
Perceived usefulness (PU)	0.558	0.842			
Merchandise quality perceptions (MQP)	0.291	0.569	0.867		
Online store perception (OSP)	0.238	0.656	0.615	0.844	
Shopping motivation (SM)	0.377	0.558	0.258	0.280	0.786
Boutique					
Perceived ease of use (PEOU)	0.838				
Perceived usefulness (PU)	0.693	0.802			
Merchandise quality perceptions (MQP)	0.569	0.446	0.825		
Online store perception (OSP)	0.727	0.767	0.779	0.785	
Shopping motivation (SM)	− 0.090	− 0.292	0.064	0.028	0.784
Department					
Perceived ease of use (PEOU)	0.801				
Perceived usefulness (PU)	0.725	0.811			
Merchandise quality perceptions (MQP)	0.333	− 0.013	0.845		
Online store perception (OSP)	0.577	0.528	0.651	0.739	
Shopping motivation (SM)	− 0.450	− 0.241	0.187	0.031	0.802

Hypothesis#3: Merchandise Quality Perceptions In H3 we investigate the influence of store layout on merchandise quality perceptions. A one-way repeated measures (RM) ANOVA confirmed the influence of layout type on merchandise quality perceptions [$F(2.93, 169.90,) = 47.986$, sig. $= 0.000$]. We used the Bonferroni post-hoc test to determine the layout types' means that differ in terms of merchandise quality perceptions. The merchandise quality perceptions elicited a higher score for the boutique layout ($M = 4.34$) with the department layout ($M = 4.14$), the avant-garde ($M = 3.31$), the pragmatic ($M = 3.24$), and the warehouse ($M = 2.75$) following, respectively. In terms of significant differences between layouts, the avant-garde differs from the boutique, the warehouse and the department, the warehouse from the

pragmatic and the department, and the pragmatic from the boutique and the department. Thus, H3 is accepted.

Hypothesis#4: Online store perceptions A one-way repeated measures (RM) ANOVA was used to test the influence of the five distinct layout types on online store perception. The M scores for online store perception were statistically significantly different [F(36.997, 150.587) = 14.250, sig. = 0.000)]. In order to discover where the differences occurred, the Bonferroni post-hoc test was used. The first place in terms of *mean* scores corresponded to the boutique layout ($M = 3.89$), and the second place to the department layout ($M = 3.79$). The third place is held by the avant-garde layout ($M = 3.49$), with the warehouse ($M = 2.91$), and the pragmatic ($M = 3.28$) layouts following. The warehouse differs significantly from the avant-garde, the boutique and the department, and the pragmatic differs from the boutique. Thus, H4 is partially supported.

Table 3 summarizes the hypotheses' testing results for H1-H4, while a detailed discussion of the results is provided in Sect. 5.

5 Hypothesis#5: Shopping motivation as moderator

This hypothesis tests the moderating role of the shopping motivation on the causal relationships between the independent variable (i.e., store layout) and the four dependent variables of the research model. Results of between-subjects effects for shopping motivation of the mixed/split-plot ANOVA were used to test the hypothesis and are presented in Table 4. The outcome indicates that in all cases there was a non-significant main effect of raters (i.e., high utilitarian shopping motivation vs. low utilitarian shopping motivation) and, thus, H5 is rejected.

6 Discussion

In our model, perceived ease of use was measured in terms of ease of use, operation, interaction, understandability, and skillfulness. As expected in H#1, the avant-garde and the pragmatic store layouts were ranked in the first and second place respectively, with no significant differences observed between them. Significant differences were observed between the avant-garde and the warehouse, boutique, and department store layouts. However, since significant differences were not observed between the pragmatic and the boutique and department store layouts, H#1 is partially supported. To explain these results, we note that the pragmatic store layout type (ranked in the second place) emphasizes simple product management for the end user and displays wall-only items to keep the systems requirements lower and avoid lag of the store. To achieve this, it does not support complicated services and, thus, users do not need to have sophisticated skills. However, this layout lacks interaction, and this could be the reason for its second place in the ranking out of the

Table 3 Hypotheses testing results

Research hypothesis	Statistical method	Results	Ranking of Store Layouts for H#1–H#4 (in terms of average scores of dependent variables)
H#1 (effect on PEUO)	One-Way Repeated Measures ANOVA	$F(12.664, 131.696) = 5.577$, sig. = .003 Statistically Significant Differences: Avant-garde ≠ Warehouse, Avant-garde ≠ Boutique, Avant-garde ≠ Department, Warehouse ≠ Pragmatic *H#1 is Partially Supported*	1st. Avant-garde, 2nd. Pragmatic, 3rd. Boutique, 4th. Warehouse, 5th. Department
H#2 (effect on PU)	One-Way Repeated Measures ANOVA	$F(13.092, 180.027) = 4.218$, sig. = .12 Statistically Significant Differences: – *H#2 is Not Supported*	1st. Avant-garde, 2nd. Pragmatic, 3rd. Boutique, 4th. Department, 5th. Warehouse
H#3 (effect on MQP)	One-Way Repeated Measures ANOVA	$F(2.929, 169.895) = 47.986$, sig. = .000 Statistically Significant Differences: Avant-garde ≠ Boutique, Avant-garde ≠ Warehouse, Avant-garde ≠ Department, Warehouse ≠ Pragmatic, Warehouse ≠ Boutique, Warehouse ≠ Department, Pragmatic ≠ Boutique, Pragmatic ≠ Department *H#3 is Supported*	1st. Boutique, 2nd. Department, 3rd. Avant-garde, 4th. Pragmatic, 5th. Warehouse
H#4 (effect on OSP)	One-Way Repeated Measures ANOVA	$F(36.997, 150.587) = 14.250$, sig. = .000. Statistically Significant Differences: Warehouse ≠ Avant-garde, Warehouse ≠ Boutique, Warehouse ≠ Department, Boutique ≠ Pragmatic *H#4 is Partially Supported*	1st. Boutique, 2nd. Department, 3rd. Avant-garde, 4th. Pragmatic, 5th. Warehouse

Table 4 Test of between-subjects effects for "shopping motivation"

Moderating role of shopping motivation on causal relationships	F Statistic	Sig
Store Layout → Perceived Ease of Use	0.001	0.970
Store Layout → Perceived Usefulness	0.994	0.323
Store Layout → Merchandise Quality Perceptions	0.458	0.501
Store Layout → Online Store Perception	1.041	0.312

five layouts, without, however, significant differences observed between this and the avant-garde layout, as previously reported. The avant-garde store layout (ranked in the first place) differs from the warehouse, from the boutique and from the department store layouts. This difference can be attributed to the fact that a characteristic of avant-garde stores is the insertion of screens and of highlighted signs in the floor plan. Prior knowledge (e.g., Wei and Ozok 2005) confirms that similar kind of design characteristics positively influence perceived ease of use. Similarly, the significant difference between the warehouse and pragmatic stores could be attributed to the teleporting stations that exist in the warehouse stores. A user who is not familiar with operating teleporting stations may find this functionally difficult to use.

The non-significant differences of perceived usefulness observed among the 5 layouts were unexpected as there has been considerable research in traditional and online retail environments highlighting the influencing role of store layout on perceived usefulness (e.g., Chen et al. 2002; Lee et al. 2003; Vrechopoulos et al. 2004; Yang et al. 2019). In our case the construct was measured in terms of usefulness, effectiveness, easiness, and improvement on searching and buying products. The characteristics of each store layout type in terms of searching and buying products was expected to differently influence the evaluation of users. For example, in the pragmatic stores, product management is quite simple for the end-consumer whereas in the avant-garde stores several features (e.g., signs that direct people throughout the store) support users in reaching a particular objective (e.g., finding desired products). Given that perceived usefulness in an online context has been defined "as the degree to which an individual believes that using the site will contribute to reaching a particular objective" (van der Heijden 2000, p. 417), these results may be attributed to the fact that subjects participating in the lab experiment were not asked to search for and buy specific products from the stores (e.g., according to a "shopping list"). In other words, subjects did not have a specific objective to accomplish when visiting the 3D online store. However, in line with our study and in contrast to the extant literature, Shang et al. (2005) found that perceived usefulness was not a predictor of online shopping. Furthermore, Visinescu et al. (2015) argue that cognitive absorption is in some cases a stronger predictor of consumer behavior than perceived usefulness. These conflicting findings suggest that this result merits further investigation.

In H#3, the boutique and the department store layouts were ranked in the first and second place respectively, with reference to perceptions on merchandise quality, with no significant differences observed between them. Instead, significant

differences were observed between the boutique and the warehouse, avant-garde, and pragmatic store layouts. Similarly, significant differences are observed between the department and the warehouse, avant-garde, and pragmatic store layouts. Thus, H#3 is supported. The influence of the five layouts on merchandise quality perceptions is in line with prior knowledge regarding traditional and online retail stores. The boutique store layout emphasizes interesting architecture, attractive materials, appealing allocation, and display of products, and gives distinctive names to products to help customers differentiate among them. In this regard, one would expect that the quality of products displayed in a boutique store would be considered of high quality (Wang et al. 2011). The non-significant difference observed between the boutique and the department store layouts could be attributed to the fact that the department layout type is similar to traditional department stores, and consumers are familiar with the quality of products in such stores. Moreover, consumers today are familiar with department stores of multinational companies that offer high quality products either offline or online (e.g., Sears, John Lewis). These stores employ a department layout and follow a *standardization* instead of an *adaptation* approach in terms of marketing mix strategies (i.e., same store layout design, same products, etc.). Thus, business practice and corresponding consumer behavioral patterns may also support our findings. In the same vein, we anticipated that the products displayed in warehouse stores (lowest M value) would not be considered of high quality, as this layout type does not emphasize the quality of the products. Regarding the non-significant difference observed between the avant-garde layout and the pragmatic one, their main difference in terms of product display is that avant-garde stores use models to display the products, while pragmatic stores only use images. Thus, according to the study's results, the use of models does not seem to affect the perception of product quality.

As expected in H#4, the boutique and the department store layouts were ranked in the first and second place, respectively, with reference to online store perceptions, with no significant differences observed between them. Significant differences were observed between the boutique and the warehouse and pragmatic store layouts and between the department and the warehouse layouts, also in line with our hypothesis. However, since there are no significant differences observed between the boutique and the avant-garde and between the department and the avant-garde and pragmatic store layouts, H#4 is partially supported. The store perception construct measured how each layout was evaluated in terms of navigation, browsing, attractiveness, and the interesting character of the store. One of the components of the boutique store layout is the interesting architecture, walls of glass, and attractive and appealing materials. In this regard, one would expect that the boutique store layout would obtain a high value in relation to the other store layout types. Also, one would expect that the boutique layout would be considered differently from the warehouse and the pragmatic ones. The former is characterized by a large variety of products rather than design, while the latter by the simplicity of images of the products to keep the system requirements much lower. On the other hand, the dynamic flow created by

the department layout (e.g., range of levels, sections, and configurations) seems to effectively contribute to store perception. Also, the use of interactive technology by offline department stores today (e.g., in the case of multinational companies in the apparel industry) is positively related to online store perception (Vrechopoulos et al. 2004). Thus, prior knowledge and experience of the subjects may also explain H#4 testing results. In sum, based on this discussion, we could assume that the influence of the five layouts on store perceptions is partly in line with prior knowledge regarding traditional and online retail stores.

Finally, shopping motivation was not found to significantly moderate the relationships between 3D virtual store layout and the dependent variables of the research model. According to relevant research insights (e.g., Lin and Lo 2016; Lee et al. 2017), one would expect that shopping motivation would determine the store layout effects on consumer perceptions. Reviewing the shopping motivation constructs' items ("Appendix B"), similarly to the perceived usefulness case discussed above, we may attribute this finding to the fact that subjects participating in the lab experiment were not asked to search for and buy specific products from the stores. In other words, these two variables, i.e., shopping motivation and perceived usefulness, derived from the Marketing and Information Systems literature respectively, seem to operate in a similar pattern, at least in the context of the present study. This pattern suggests that store layout may significantly affect perceived usefulness and be moderated by shopping motivation only when consumers visit retail stores to conduct planned purchases (e.g., to find their "shopping list" products). In other words, in a scenario of planned shopping behavior, one would expect to observe significant differences among the 3D store layouts combined with the low–high utilitarian shopping motivation cases (i.e., 5 X 2 = 10 treatments for each dependent variable) at least for the ease of use and the perceived usefulness variables. In sum, hypotheses #5.1 to #5.4 testing results merit further investigation both in an alternative experimental setting (e.g., one that explicitly tests for planned shopping behavior, field experiments) and in different shopping contexts (e.g., grocery retailing vs. fashion industry).

7 Conclusions and implications

7.1 Theoretical implications

In view of earlier research in store atmosphere and consumer behavior in traditional and 2D online retailing environments on the one hand, and the rise of academic and business interest in 3D online environments on the other, this study set out to investigate the influence of store layout on user perceptions in 3D online retailing. This is one of the first pieces of research work to apply existing knowledge of store layout design in the 3D online retail context.

The present study results illustrate the critical and influencing role of store layout on consumer behavior. The study shows that different layout types cause different effects to consumers/users interacting with them. However, compared to similar research efforts in the context of conventional and 2D retailing, results show that existing theory cannot be fully applied in its present form in the context of 3D retailing. Significant differences are observed in this new context as far as specific store layout effects on consumer/user behavior are concerned. Thus, while store layout is shown to affect consumer behavior in line with existing theory, several aspects concerning the effects of specific store layout types on specific consumer/user behavior dimensions deviate from extant theory, at least in the context of the specific research hypotheses testing results. Specifically, merchandise quality perceptions, store perception and perceived ease of use are influenced by the store layout types of 3D online environments, while perceived usefulness is not influenced by the store layouts. In the same vein, the moderating effect of shopping motivation is not confirmed.

7.2 Managerial implications

Brand holders and retailers initially experimented in virtual stores by simulating or extending established practices from traditional and 2D online retailing. However, business practice over the years indicated that these environments should be treated as different. The cases of large multinational companies failing to exploit 3D Commercefollowing strategies that were successful in other retailing channels, particularly in virtual worlds, are quite enlightening. Even though the reasons for such failures are complex, a clear conclusion is the lack of appreciation of how consumer behavior is influenced by contextual differences (e.g., Computer Weekly 2008; BBC News 2009). This has prompted several researchers (e.g., Sharma et al. 2013, Kang 2017) to call for further research on the 3D context, to understand consumer behavior and find business opportunities.

When designing 3D online stores, retailers should be informed by relevant theory and corresponding research insights to develop appropriate retail mix strategies (e.g., treating store layout as a major element of store atmosphere) and, thus, effectively meet their strategic marketing planning objectives. The results of this study provide relevant implications for such design efforts as they generally show that alternative store layout designs lead to different consumers' reactions. The tested layouts constitute a point of reference that retailers can use to decide on the form of a virtual store. Depending on the specific product assortment and brands they offer (see Dou and Tanaka 2020), retailers should focus on the consumer responses that are more important to target, exploiting the results of the present study (e.g., the ranking of 3D virtual layouts in terms of each of the dependent variables). For instance, perceived merchandise quality may be a more important dimension if the virtual store sells brands that are not well known (either the retailers' own brands or brands by other producers) and may have limited relevance if the products sold are of

leading brands. Perceived ease of use and perceived usefulness would be important in most cases, as consumers seek convenience, but they could play a significant role for searching products, especially when the assortment is large, and the customer has to spend a lot of time navigating inside the store. Once these customer reactions are captured, managers need to identify the specific elements that are most suitable to trigger these reactions, such as store architecture, navigation options, virtual assistants, try-on options etc. To this end, the present study offers some direct implications related to store architecture and store layout design in particular. In terms of technology, the implementation of these options should balance the richness of visuals and functionality against system requirements, keeping in mind restrictions in the access equipment of potential customers (devices, connection speed). In these decisions, it becomes obvious that experts from different areas such as Information Systems, Informatics, Marketing, Architecture, and Graphics Design should all collaborate to develop 3D online stores that follow the guidelines and perspectives of current business practice and effectively fulfill consumer needs.

7.3 Limitations and future research

A methodological limitation of this study is that the participants in the laboratory experiment did not fully interact with the features of each store layout type; instead, they were presented with a description and a video of each layout. It should be noted, however, that several other studies in the past have adopted a similar research approach (e.g., see Jang et al. 2018; Sina and Wu 2019). Considering this limitation, a realism check was included in the study's design which revealed that all participants could imagine an actual 3D online store operating as described in the experimental design. A second limitation is that the study participants were students. However, the use of student samples constitutes widespread practice in many research studies focusing on technology or innovations, as in this case (e.g., see Sina and Wu 2019). This is because this population is more familiar with the latest technological developments and are early adopters of innovative services (e.g., 3D online games, 3D Virtual Worlds, etc.).

Further research can entail field experiments where the subjects are immersed in a virtual world or may take the form of a survey following an individual's actual shopping experience in a virtual world (or 3D virtual web stores). Although these methods are also exposed to a set of limitations (such as, for example, brand effects), they can provide complementary evidence and enhance our understanding of the user/consumer experience in virtual worlds or 3D online stores.

At a conceptual level, the effect of virtual store layout can further be tested against other behavioral variables. Different product categories and services could also serve as alternative research contexts, since there is strong evidence that product type is related to store layout selection and its atmosphere (Levy and Weitz 2004). Such extensions can establish a robust conceptual framework of consumer behavior in virtual retail context.

While the study focuses on store layout as an essential element of store atmosphere—servicescape, future research can elaborate on the role of other store atmosphere elements (e.g., color, music, social presence, etc.—cf. the call for such research in Zhang et al. 2020), similar to the research practice in conventional and 2D retailing. Future research can also investigate causal relationships between the 3D retail mix elements (e.g., promotion) and consumer behavior (cf. Siomkos and Vrechopoulos 2002). Furthermore, future research can investigate the effects of producers' and own retailers' brands on consumer behavior in the presence of different 3D online store layouts (e.g., factorial design: 5 layouts×2 brands=10 cells).

Finally, in this study we addressed the case of virtual stores explicitly designed for virtual shopping online (either in the context of virtual worlds or in 3D online retail stores). Yet, advances in technology allow several—and will certainly allow for even more in the future—types of virtual shopping experiences, various virtual retail forms and applications in the evolving context of omnichannel retailing: virtual visits and shopping in an existing brick-and-mortar shop, using a mobile app or 3D glasses; virtual enhancements in a brick-and-mortar store via augmented reality features (product descriptions, instructions for use, availability of information and so on); virtual catalogues (e.g., see Garnier and Poncin 2019); virtual showrooms; augmented reality mobile apps used in the customer premises or outdoors (e.g., Elias 2017; Petroff 2017; Porter and Heppelmann 2017; Bonetti et al. 2018; Kim et al. 2020, Li et al. 2020). In this context, quite recently, Perannagari and Chakrabarti (2019) examined the impact of augmented reality in retailing and provide a detailed list of future research perspectives in this context. Also, Caboni and Hagberg (2019) reviewed the features, applications, and value of augmented reality in retailing and outline areas for further research. Similarly, Mikalef et al. (2017, p. 1308) report that "little is known about how consumer behavior is influenced by characteristics on social commerce platforms". To this end, future research could investigate through factorial designs the effects of 3D online store layout and social density in social commerce 3D online stores on consumer behavior. Additional research opportunities arise from recent work in the virtual reality context, as shown, for example, in Loureiro et al. (2019) who conducted a thorough review of the virtual reality role in Marketing and provide several implications and directions for future research or Hollebeek et al. (2020) who reviewed virtual reality through the customer journey and report important theoretical, practical and research implications. Thus, the constant evolution of virtual and augmented reality in retail environments will offer many opportunities to study how customer behavior may be influenced.

Appendix A: Visual examples of the five 3D virtual store layout types
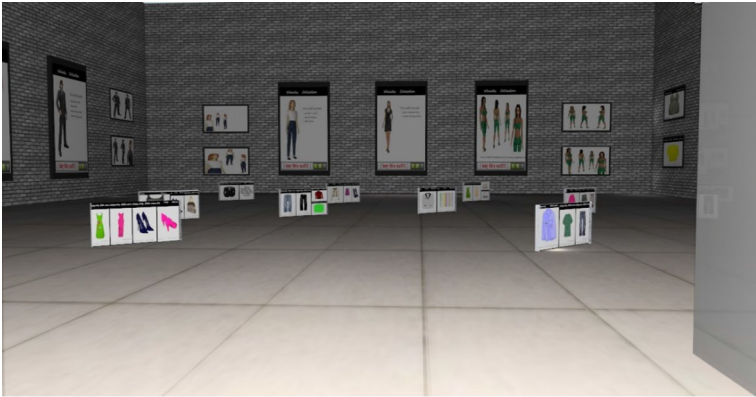
Appendix A1: 'Avant-garde' store layout
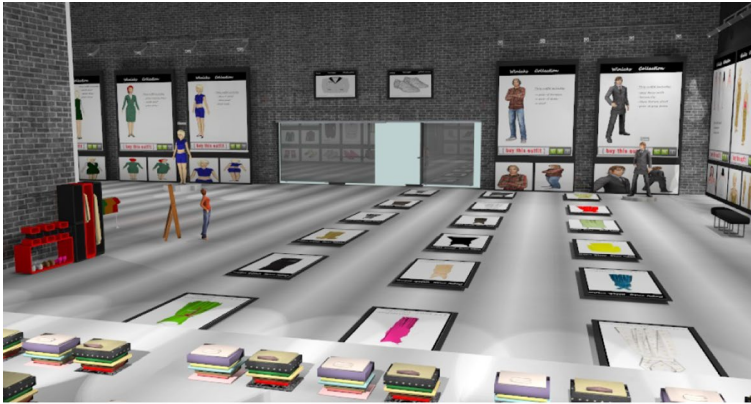
Appendix A2: 'Warehouse' store layout
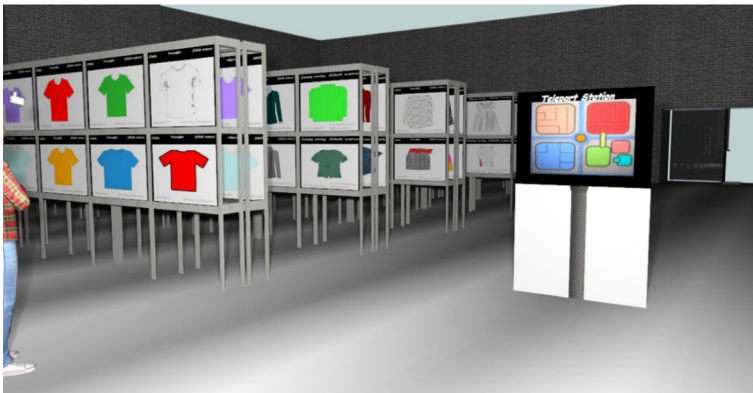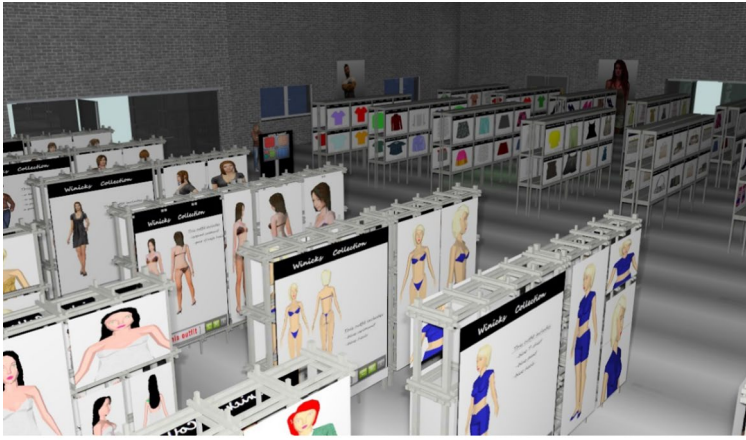
Appendix A3: 'Pragmatic' store layout

Appendix A4: 'Boutique' store layout

Appendix A5: 'Department' store layout

Appendix B: Measurement tool

Hypothesis	Coding	Items	References
H1 Perceived Ease of Use (PEOU)	EOU1	The store would be easy to use	Vrechopoulos et al. (2004) as adapted from Davis (1989)
	EOU2	It would be easy to become skillful at using the store	
	EOU3	Learning to operate the store would be easy	
	EOU4	The store would be flexible to interact with	
	EOU5	My interaction with the store would be clear and understandable	
	EOU6	It would be easy to interact with the store	
H2 Perceived Usefulness (PU)	PU1	The store would be useful for searching and buying products	Vrechopoulos et al. (2004) as adapted from Davis (1989)
	PU2	The store would improve my performance in product searching and buying	
	PU3	The store would enable me to search and buy products faster	
	PU4	The store would enhance my effectiveness in product searching and buying	
	PU5	The store would make it easier to search for and purchase products	
	PU6	The store would increase my productivity in searching and purchasing products	
H3 Merchandise Quality Perceptions (MQP)	MQP1	The store gives the impression that would provide high quality gifts	Baker et al. (1994)
	MQP2	The store gives the impression that provides high workmanship	

Hypothesis	Coding	Items	References
H4 Online Store Perception (OSP)	OSP1	This 3D store has an attractive character	Kim et al. (2007)
	OSP2	The color schemes of this 3D store are attractive	
	OSP3	The overall design of this 3D store is interesting	
	OSP4	The layout of this 3D store would make it easy to browse for the product you want	
	OSP5	Overall, the layout of this 3D store would make it easy to navigate this store	
H5 Shopping Motivation (SM)	SM1	It is important to accomplish just what I had planned on each shopping trip for clothing	Kang and Park-Poaps (2010) as adapted from Babin et al. (1994)
	SM2	While shopping for clothing, I would find just the items I was looking for	
	SM3	I would be disappointed if I have to go to another shop to complete my shopping of clothing	
	SM4	A good store visit is when it is over very quickly	

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