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Is Immersive Technology the Next Fashion Brand we Want to Design in a Post-Covid E-Commerce App? Initial Results from a Prototype Analysis

Ioanna Lampaki¹, Athanasios Tsipis¹

¹Department of Digital Media and Communication, Ionian University, Argostoli 28100, Kefalonia, Greece

Abstract

The coronavirus pandemic has brought to light new opportunities regarding the dynamics of e-commerce in facilitating reliable online transactions, boosting customer loyalty and company branding, and ultimately offering an engaging and interactive means of online shopping. Although accurately capturing consumers' satisfaction during the interaction design is still a fundamental problem, as it is affected by various parameters ranging from personal preferences and user idiosyncrasies to technical aspects and technological particularities, this shift has opened new horizons regarding the incorporation of immersive technologies and gamification approaches, in order to complement conventional and novel trends for User Interaction (UI) and User Experience (UX). In this paper, after reviewing the latest innovations in e-commerce, a prototype application of a fashion e-shop, targeted at mobile devices, is presented. The interaction design methodology utilizes a combination of emerging UI/UX methods along with immersive technologies, such as extended reality and gamification, to propose a novel virtual fashion store application. Initial results from a small-scale user evaluation verify its potential in offering exciting sensory experiences and creating the right conditions for the establishment of long-term relationships between buyers and retailers.

Keywords

E-commerce, extended reality, gamification, immersive technologies, fashion industry, UI/UX, user-centered interaction design

1. Introduction

During the pandemic crisis of 2020, as Internet traffic grew substantially, new opportunities arose for a paradigm shift in the general e-commerce domain. The Fashion Industry, being one of the most heavily impacted fields by this digital transformation, has changed significantly, continuously exploring new methods for user engagement. To this end, the adoption of *immersive and three-dimensional (3D) technologies* like Extended Reality (XR) [1], which is an umbrella term encapsulating Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR), as well as new *gamification* approaches, has proven a valuable ally. In fact, in an effort to increase profits, fashion shops are now turning to these technologies to offer novel advertising campaigns and organize entertaining user-centered marketing events that will solidify their online presence and create long-term customer relationships.

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✉ g20laba@ionio.gr (I. Lampaki); atsipis@ionio.gr (A. Tsipis)

🆔 0000-0001-5069-3376 (A. Tsipis)

Past research indicates that sensory approaches, which concern the details of a garment and how it is perceived, in parallel with immersive technologies, effectively bridge the gap between consumers and traders, and come as a strong response to the slowdown in clothing production caused by the coronavirus pandemic [2]. In this paper, we focus on such technologies and how they can be leveraged to pave the way for the new virtual fashion era in terms of both *User Interaction* (UI) and *User Experience* (UX).

For online shopping, however, the purchase of fashion-related products has traditionally been made as easy as clicking a button. Nevertheless, this comes at a cost of distancing customers who are wary of the quality of the promoted goods and wish for personalized engagement. Considering that competition for customer loyalty is incredibly high [3], a fact that was clearly demonstrated during the pandemic, the fashion industry is now adopting new audiovisual merchandising tools, making use of immersive XR and gamification techniques [4]. Still, unlike traditional UI/UX methods, the effects attributed to a combination of immersive approaches have not yet been sufficiently addressed by existing literature. As fashion is made up of two crucial elements, one relating to the general culture and mentality of the market, while the other to the quality of the garment brand and material, designing these aspects in a creative manner can potentially induce high benefits and evoke more sensory experiences. The objective here is to imprint these technologies and study basic psychological theories of human motivation to determine which elements and mechanisms pose a positive impact on fashion e-commerce for the creation of easy-to-use, interactive, and user-centered applications.

To tackle our objective, an application prototype targeted at mobile device/smartphone users, which constitute an increasingly large portion of the fashion market, is designed to facilitate *user-centered interactions* through immersive technologies. In conjunction with the latest UX and UI trends, the prototype aims to exemplify how XR, when combined with other novel interaction design methods and gamification, can create the right conditions for a complete and ready-to-use fashion application that will improve the shopping experience via customized and highly interactive means of engagement. Given that the visual components should be entertaining and accessible, a fact that increases complexity in terms of audiovisual augmentation, the outlined methodology additionally sheds light on possible implementation roads that will mitigate this danger.

Further, the prototype acts as a use-case for the study of the technologies and their impact on customer perception and pleasure, variables that define their disposition towards long-term brand bonding. Thus, the monitored elements also include human factors and ergonomics [5]. To capture the reactions and emotional imprint, a comprehensive small-scale user evaluation scenario is conducted. The developed User Experience Questionnaire (UEQ) [6] examines usability and satisfaction outcomes, in terms of pragmatic and hedonic experience, to assess past research findings that mention immersive technologies as a wave of transformation in the field of fashion. Preliminary results showcase the potentiality of the embedded 3D content, while separately exploring the effectiveness of the underlying interactive and gamification appliances in providing new ways for graphical user interaction with fashion products and e-commerce services.

The remainder of this paper is organized as follows: Section 2 discusses key challenges and changes generated by the coronavirus pandemic in the general field of e-commerce; Section 3 reviews new UI/UX trends and innovations for e-commerce, with a special focus on the Fashion

Industry; Section 4 presents the developed prototype application along with its interaction design methodology; Section 5 reports on the results from the conducted small-scale user evaluation; and lastly Section 6 concludes the paper. Supplementary material is provided in the Appendices A and B regarding the used abbreviations and the UEQ, respectively.

2. E-Commerce in the Post-Covid Era

A big factor that undoubtedly played a catalytic role in consumer buying behavior was the coronavirus pandemic that started in 2019 and incurred (and still continues to incur) massive losses in the global economy, particularly hurting international trade [7]. As a result of the long-period lock-downs and social distancing, commerce had to change drastically in order to compensate for the strict pandemic mitigation measures and accelerate decision-making processes, offering new technological escape routes towards the international marketplace and ultimately leading to the transformation of the conventional buyers into new digitally immersed consumers.

As visits to physical stores were reduced by the enforced restrictions, consumers increasingly relied on online shopping, causing e-commerce transactions to experience explosive growth [8]. Despite conventional consumers being initially mindful of the rapid changes in their purchasing behaviors, literature has shown that one of the best options to retard the impact of the coronavirus spread on human lives and general lifestyle was indeed the e-commerce [9]. As such, even though some buyers may return to their old shopping habits (e.g., visiting physical stores) after the pandemic is over, the shift towards higher e-commerce activity has become the tipping point for a worldwide *digital transformation*. In fact, there are many who welcome this change, envisioning new marketing strategies with novel technological means that can achieve higher user engagement and long-term customer loyalty [10].

However, winning over customers has traditionally been a devious endeavor for all industries. The need is even more profound when considering new technologies in e-commerce because younger generations are now familiar with new media and communication services and, subsequently, more skeptical about their adoption. Moreover, they are able to critically evaluate elements of the interaction process (such as the ease of use, interactivity, user-friendliness, degree of engagement, data safety/privacy, learning curve, etc.) and recognize whether a particular digital environment is properly configured to accommodate first and foremost their own individual needs and preferences.

Evidently, the effectiveness of the UX/UI design in this matter plays an instrumental role to the end users' choices, overall experience, and hence company loyalty. At the same time, however, from the designers' standpoint, whose normal work has also been greatly interrupted by the enforced confinement policies, the pandemic has revealed a demand for new ways that can boost their productivity and creativity in order to meet their users' expectations. For example, similar to other domains (e.g., in digital culture [11]), one of the main e-commerce technologies, that has continuously evolved and increasingly been utilized more and more by designers since the beginning of the pandemic, is the XR product market. In fact, the adoption of 3D and gamified content has been accelerated to an extent that nowadays a large portion of businesses move their activity purely online and increase their remote-work opportunities in

researching immersive technologies for brand strengthening and advertisement.

The statistics are extremely interesting in this regard, since global spending on XR products, including consumer purchases, rose to \$12 billion in 2020, a rise of over 50% when compared to 2019 [12]. To showcase the benefits for user engagement generated from the audiovisual augmentation of e-commerce products and services, in the upcoming section, we will focus on the fashion industry as a use case, and discuss innovative UI/UX methods that shape the particular sector to provide novel shopping experiences.

3. UI/UX Design in the Fashion E-Commerce

One of the industries that keeps pace with e-commerce trends, which are constantly changing, is that of fashion. While specialists in this sector are constantly adapting to an ever-evolving landscape, the digital transformation, in the wake of the coronavirus pandemic, has led to an unprecedented appearance of a large number of affordable clothing items that push buyers to online shopping. As such, though online purchases are in bloom, users are increasingly expecting better and faster service at any given time or day, causing fashion experts to constantly redesign their apps' interfaces, in order to achieve the best possible user experience, earn their long-time commitment, and stay competitive. As a result, by 2024 an increase in e-commerce penetration of up to 60% is predicted and, within the next five years, the 7.8% annual growth rate of online fashion will add \$1 trillion to the industry [13].

Despite the fact that consumers' behaviors in the fashion market are controlled by time, money, and other variable factors, their self-attributes and unconscious biases matter as well [14]. Therefore, to better serve online customers and achieve success, it is necessary for businesses to investigate factors that affect consumers' behaviors in the fashion market and follow a corresponding user-centered interaction design methodology for their e-commerce strategy. After researching the relevant literature, we have recognized the following UI/UX factors that play a fundamental role in modern user-centered interfaces for e-commerce applications, including the fashion industry.

3.1. Immersive Technologies

One of the biggest trends in fashion e-commerce, nowadays, is undoubtedly the use of immersive technologies [15]. XR (i.e., VR, AR, or/and MR) is one of the most fashionable and entertaining ways to attract new customers and retain existing ones. The integration of these technologies goes beyond conventional graphics to form a new reality for the users. The design of 3D interfaces creates new conditions for consumers and shapes their buying behavior. Ergo, XR applications have been employed in the retail of various types of products, such as clothes, shoes, cosmetics, jewelry, furniture, etc. It is noteworthy that 50% of buyers would purchase a product that would offer them a 3D immersive experience [16].

3.2. Voice User Interface

According to surveys [17], 46% of users use voice search every day via smart home assistants, such as Siri and Google Assistant. The integration of this technology into e-commerce platforms

is achieved through a Voice-activated User Interface (VUI) that is already popular among smartphone users. The help and service provided to them are quite personalized and create the right conditions for an effective user experience [17]. Although evidence about the use of this particular tool is quite scarce because its integration into e-commerce has only recently begun, relevant research has pointed out that it is an effective medium in terms of usability [18]. The main categories where VUI is being used range from product searches to service reviews, help-desk chats, and cart management [18].

3.3. Animated Graphics

The human eye is attracted to motion and so the use of animated graphics can greatly aid in an innovative user experience [19]. Animations and multimedia-enriched text can be used for many micro-interactions, from changing the color of a button or menu item when clicking on it to playing an animated image when a product is added to the cart. In an effort to increase expected sales, popular fashion companies, such as Gucci and Balenciaga, have adopted this UI design methodology in their online stores with the aim of retaining customers engaged longer. Although its frequent use is generally not recommended, as the user may easily become disengaged and lose interest [20], nevertheless, it is preferred in cases where we need to guide the users' attention to important situations, e.g., a new discount offer or an ad banner.

3.4. Glassmorphism and Minimalism

A UI element that quite recently made its emergence in e-commerce is the so-called glassmorphism, which, in its most general sense, it refers to a design style that comprises opaque (glass) surfaces with a blurred background to display items. It is often utilized as a minimalistic visualization technique to enable the fast perception of the highlighted non-transparent information, avoiding the many elements that exist in the background and circumventing cluttering up the page interface with complex and heavy elements. 3D content can also be accompanied by such presentations, as a result of innovative design [21], however, special care must be placed on accessibility issues, especially in regard to visually impaired people.

3.5. Content Personalization

According to the survey in [22], consumers would easily buy a product if it offered a more personalized interface, via cognitive experiences tailored to their individual needs, mindset, and mentality. This, in turn, creates better prospects for boosting customer loyalty and increasing revenues. In fact, during the pandemic, many large fashion companies adopted Artificial Intelligence (AI)-based user recommendation approaches, which, on the one hand, posed financial benefits and, on the other hand, created a positive impact on the psychology and emotional state of their customers. In conjunction with immersive technologies and 3D graphics, the display of recommended and relevant fashion products can substantially enhance user experience and even enable individual design, where users can design and test their own clothing, in an online mode, by taking visually augmented pictures of themselves wearing the selected items.

3.6. Gamification

Despite the lack of a consistent definition across all literature, gamification is largely described as the selective incorporation of game mechanics into interactive systems, without a fully-fledged game as their end product [23]. In general, the term is used to refer to those features that aim to motivate and engage users through the incorporation of game elements and game-design techniques (e.g., points, badges, contests, achievements, scores, leader-boards, mini-games, etc.) in a non-game context. In e-commerce environments, this approach leads to a rise in customer loyalty and engagement [24]. However, for gamification to prove a successful marketing tool, it is absolutely essential to understand the motivation and expectations of the customers over time and, thus, it essentially involves a continuous process that leverages consumers' emotions to gamify their interaction and deliver a digital luxury experience.

Overall, the application of gamification in e-commerce seems to have a positive impact so far, with many studies (e.g. [25]) pointing to rewards being the most frequent gamification mechanism applied by entrepreneurs, including the fashion industry, as a traditional customer loyalty strategy. Still, psychological theories of human motivation should be better understood to determine which game elements work best in e-commerce in order to design friendly, interactive, and useful systems [4]. And because the psychological needs of users change constantly, as stated earlier and clearly exemplified by the coronavirus pandemic, the gamified ecosystem must be redefined in conjunction with the technological requirements and advances.

4. Prototype Design Methodology

Since the beginning of the corona pandemic, an upward trend has been observed regarding the use of mobile devices (e.g., smartphones or tablets) in online shopping [26]. Mobile commerce (m-commerce in short), as it is often called, offers many advantages. Most of the available e-commerce platforms have either mobile-optimized versions or native applications that shorten the number of steps required to place an order and complete a transaction [27]. Some of them include reduced loading speeds and VUI searching capabilities, while generally following a simpler set of usability rules to offer a user-friendly environment. XR technologies are also easily simulated on mobile devices, leveraging their sensors (e.g., GPS, cameras, accelerometer, gyroscope, etc.) and creating, in this way, immersive virtual stores that provide a unique shopping experience by enabling consumers to interact directly with 3D content. M-commerce is empowered further by adopting an omnichannel design approach which, according to [28], relies on an integrated sales experience that melds the advantages of physical stores with the information-rich experience of online shopping. In this way, it allows consumers and retailers alike to enjoy on-the-fly, even when located at physical stores, valuable tools that are often only available to solely e-commerce environments.

In this particular study, all user-centered UI/UX factors, that were reviewed in Section 3, along with emerging technologies that are now used in the field of e-commerce (e.g., XR and gamification) were examined and adapted with the goal of designing a high-fidelity m-commerce prototype for the use-case of a fashion e-shop. The prototype application was created on the

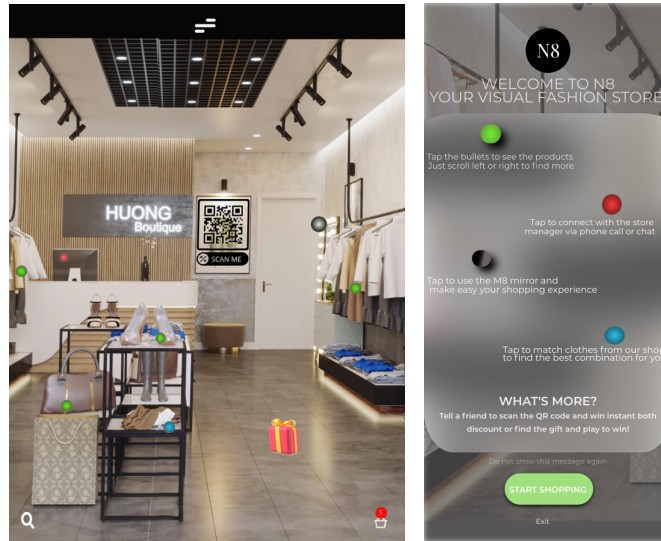


Figure 1: On the left, the main page of the virtual store “N8”; on the right, the tutorial screen for the colored bullets.

Adobe XD¹ and is suitable for both Android and iOS mobile devices.

Following an omnichannel design approach, the prototype application places the user in a purely virtual store, named “N8”, which perfectly mimics the experience of its physical store counterpart, by displaying the Graphical User Interface (GUI) as a virtual space in 3D format with 360° viewing perspective (Figure 1 - left side). As such, it creates the illusion of an actual fashion store, allowing mobile users to feel like they visited a physical store when, in fact, they can proceed to online shopping from anywhere (e.g., the comfort of their living room) and anytime. The GUI of the application is supplemented by appropriate modern music themes and lighting effects, accurately resembling physical stores where music and light are central aesthetic agents for driving the visual merchandising process.

Colored navigation bullet points, coupled with appropriate learning tutorials (Figure 1 - right side), are embedded in various parts of the virtual store, each one incorporating a different and innovative functionality that makes use of the reviewed UI/UX elements to provide a complete and thoroughly engaging experience (Figure 2). These mainly include the following:

- **Red bullet:** It concerns the available customer service. This bullet was intentionally placed in front of the virtual office area so that the user understands that it refers to the “Help-Desk”. By tapping this element, a 3D figure of the store assistant is presented to assist the user. The conventional text-based support is enriched with VUI functionality, where the user can issue voice commands and participate in an audiovisual conversation with the chatbot of the 3D assistant.
- **Green bullet:** It concerns a specific product category. For instance, the bullet placed in front of a bag stand redirects the user to the “BAGS” category, whereas the bullet that is

¹Available at: https://www.adobe.com/gr_en/products/xd.html

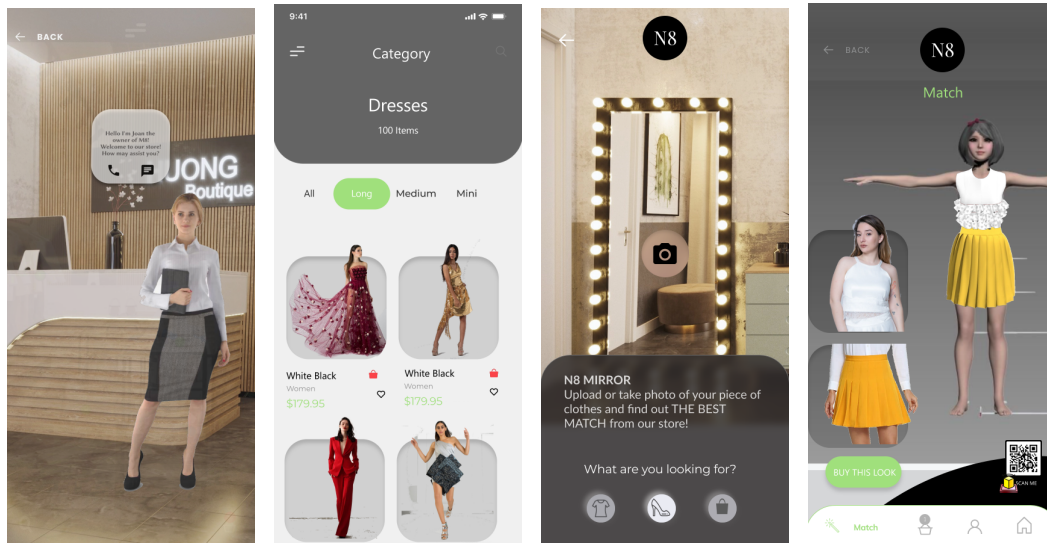


Figure 2: The colored bullets options. From left to right: the red bullet “Help-Desk” VUI; the green bullet for the “DRESSES” category; the black bullet “Mirror” recommendations system; and the blue bullet for the XR “Match Clothes” functionality.

displayed over the wardrobe leads to the corresponding “DRESSES” category. In any case, when the user selects a category he/she is then presented with multimedia (e.g., images, videos) or animated graphics (e.g., an actual human model that wears the outfit) regarding the available items and their details. An additional function is provided to allow users to digitally try the products themselves, utilizing AR via their mobile devices’ camera input. The presentation of the products is made without a background, aiming to emphasize the product itself and avoid any unnecessary attention distractions. Noteworthy is also the fact that each product is accompanied by customer reviewing tools since these are still considered one of the most valid ways for assessing the reliability of any product in the e-commerce ecosystem.

- **Black bullet:** It concerns a “Mirror” recommendations system for content personalization. The application advises the user about available products based on the user’s own clothes. To this end, the user can upload his/her photo wearing a specific outfit, and the application (via AI) will subsequently suggest pairing items (e.g., shoes) that can be combined to match the particular clothing set. In essence, it resembles a mirror that offers smart and customized suggestions, specially tailored to the fashion style of each user.
- **Blue bullet:** It concerns an XR matching item functionality, called “Match Clothes”. The particular tool allows the user to select different items from the store and pair them. After the user selects the desired set, a 3D VR model appears, wearing the particular set. Moreover, an AR Code is also provided which can be printed and scanned by the user’s phone camera to get an idea of how the garment will look like when worn by the 3D model in AR mode. In this way, it becomes easier for the user to perceive and visualize the characteristics of the clothes, such as their dimensions, material or color variation,

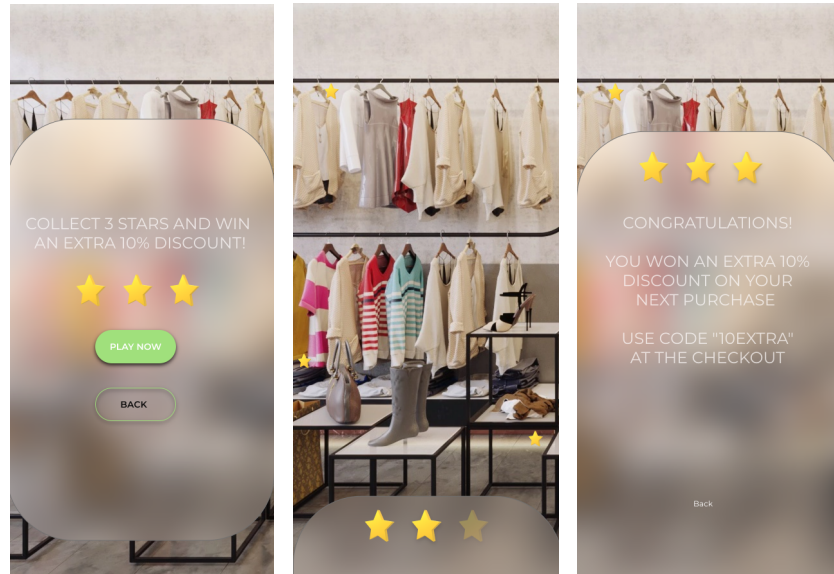


Figure 3: The “Gift” gamification mechanism. The user plays a mini-game of collecting stars while exploring the virtual wardrobe to earn purchase discounts.

before proceeding to purchase.

Besides the novel interactive bullets, the user has the option of traditional navigation through carefully designed menus, filters and transaction options that make use of minimalistic UI and glassmorphism to offer a safe and familiar e-commerce environment, with special emphasis on ergonomics. Further, to increase interest and entice users into buying products, various gamification approaches have been implemented in key locations within the GUI. For example, in the central virtual store, a discreet Quick Response (QR) code is placed on some wall that perfectly blends with the surrounding virtual elements. The QR code acts as a social sharing challenge, motivating customers and their friends to scan it in order for both of them to receive an additional discount on their future purchases. Likewise, on the right side of the virtual store, a gift icon directs the potential buyer to an entertaining mini-game, wherein the goal is to gather digital stars by exploring the virtual wardrobe in order to win an additional discount reward. Through the “Gift” gamification functionality (Figure 3), the traders are able to enhance usability and satisfaction, as well as to create a more pleasant experience by using the application to produce a positive business impact.

5. User Evaluation Results Analysis

To investigate whether the integration of 3D technologies is ideal and capable of generating new ideas and conditions for enhancing experiences in e-commerce, especially in the field of fashion, a small-scale user evaluation of the “N8” application was conducted. To contextualize the evaluation, a variation of the UEQ [6] was utilized, which evaluates the UI/UX interaction

Table 1

User evaluation results from the prototype analysis following a Likert Scale (1-7).

Factor	Question	Score (%)						
		1	2	3	4	5	6	7
Attractiveness	Q1	0	0	0	2.33	37.21	30.23	30.23
	Q2	0	0	0	6.98	23.26	34.88	34.88
	Q3	0	0	0	9.30	23.26	34.88	32.56
	Q4	0	2.33	4.65	9.30	32.56	34.88	16.28
	Q5	0	0	0	6.98	20.93	37.21	34.88
	Q6	0	0	0	6.98	11.63	25.58	55.81
Perspicuity	Q7	0	0	0	2.33	39.53	34.88	23.26
	Q8	0	0	0	6.98	13.95	20.93	58.14
	Q9	0	0	0	6.98	13.95	30.23	48.84
	Q10	0	0	0	16.28	6.98	27.90	48.84
	Q11	0	0	0	18.60	18.60	34.88	27.92
Efficiency	Q12	0	2.33	0	11.63	27.90	34.88	23.26
	Q13	0	0	0	11.63	23.26	46.51	18.60
	Q14	0	0	2.33	9.30	20.93	27.91	39.53
	Q15	0	0	0	6.98	13.96	39.53	39.53
Dependability	Q16	0	0	0	11.63	9.30	34.88	44.19
	Q17	0	0	0	9.30	18.61	34.88	37.21
Stimulation	Q18	0	2.33	0	2.33	18.60	39.54	37.20
	Q19	0	0	0	4.65	11.63	27.91	55.81
	Q20	0	0	0	9.30	18.60	30.23	41.86
	Q21	0	0	0	9.30	11.63	23.26	55.81
	Q22	0	0	0	9.30	9.30	32.56	48.84
	Q23	0	0	0	6.98	16.28	34.88	41.86
	Q24	0	0	0	6.98	18.60	34.88	39.54
	Q25	0	0	0	6.98	18.60	27.91	46.51
	Q26	0	2.33	0	9.30	20.93	30.23	37.21
	Q27	0	2.33	0	6.98	20.93	20.93	48.83
Novelty	Q28	0	0	0	6.98	13.95	32.56	46.51

design and overall user satisfaction on the basis of six different parameters, following a Likert Scale that ranges from one (1) to seven (7), where higher scores indicate higher satisfaction and acceptance. In terms of Pragmatic Quality, these parameters include: i) Attractiveness; ii) Perspicuity; iii) Efficiency; and iv) Dependability; whereas, in terms of Hedonic Quality, they include v) Stimulation; and finally vi) Novelty. The UEQ consisted of 35 questions (Table 3) regarding the aforementioned parameters, as showcased in Appendix B. Then, 43 users (women and men) of diverse backgrounds and ages, from different regions of Greece, were called to participate, after they have used the prototype for some reasonable period of time. The score results of the evaluation are encapsulated in Table 1. While most scores lie within the range of five (5) to seven (7), we can conclude the following.

The general impression of the respondents regarding the Attractiveness of the application is highly positive, with most UI elements being easily perceived by the users. The color palette, which was chosen according to the *colors psychology*, generally evoked pleasant feelings that were consistent across all interfaces. A minor drawback referred to the scrolling feature (Q4) with the part that needs improvement being the best adjustment in terms of smooth navigation of the main page of the virtual store.

Similar results are observed in the Perspicuity parameter, with the largest percentage of respondents being exceedingly satisfied. Some modifications may be required to render the products' details more lucid (Q10) to all users, where the emphasis should be placed on the augmentation of accessibility. It is, also, noteworthy that while the use of QR codes is quite frequent today, its operation is still not familiar to all mobile users (Q11), especially to the elderly, and thus additional ways of engagement must be explored to offer alternative means of information retrieval.

In terms of Efficiency, which concerns the performance and correct organization and structuring of the application, it is reported that most questions were answered with a largely positive inclination. Some deviations regarding operability are observed for Q12 and Q14. For the first, which refers to the "Match Clothes" (blue bullet) option, there exists a small percentage (2.33%) of participants who faced difficulties in understanding its operation, however, this can be tackled with a more sophisticated support system. The second, which relates to the "Help-Desk" (red bullet) customer service option, was also met with mixed feelings (although generally positive), a fact that is most likely attributed to VUI's relatively unclear presentation through the prototype. This observation paves the way for the further study of this attribute in a real application with realistic voice support, where at the same time a traditional way of interaction will be provided for an accurate comparison of the two approaches.

As for the Dependability parameter, the evaluation results are very promising since the sense of security of the transactions was evident to all users and created ideal conditions for making purchases, a factor that is crucial for the success of any e-commerce platform. The track order options were met with great satisfaction, making the whole process transparent and user-friendly.

For the Stimulation parameter, which shows the degree of tendency and arousal towards completing purchases, as well as the users' disposition towards recommending the e-shop to other people, the acquired results present a positive impact across all questions. However, it is noteworthy that the selected music theme seems to not be equally appealing to all users. As such, in analogy to physical stores, special attention must be paid to the music design, and strategically integrate it into digital shopping services. On the other hand, although backgroundless product photos, adopting a glassmorphism design, are new to e-commerce environments, they seem to have generated assertive emotions, facilitating a better understanding of the displayed content.

Regarding Novelty, it is the parameter with the highest overall score, reporting a total percentage of 88% of appeal. Evidently, the combination of immersive and conventional technologies along with gamification techniques is considered innovative, with the UX being successful in terms of ergonomics and attracting customers. Actually, it is worth mentioning that 53% of ages over 40 found that the application has an original design, even though they were less familiar with XR. These results were even more encouraging at younger ages, a fact that testifies to its potentiality in yielding exciting sensory experiences. In parallel, a percentage of over 90%

enjoyed the gamification discount mechanisms, provoking users to engage with the application and share their rewards with their friends.

6. Conclusions

In this paper, we investigated novel approaches relating to the “marriage” of immersive XR technologies with gamification interactive services for user experience enhancement in the online fashion industry. However, due to the ongoing socio-economic conditions caused by the coronavirus pandemic, these technologies are still in their infancy and face various challenges. Therefore, after acknowledging the general UI/UX principles for designing interactive and friendly e-shops, a corresponding mobile application was prototyped and evaluated to further explore their impact on sensory attitudes. The results verified the literature findings and showed a positive correlation between the incorporated immersive technologies and user satisfaction, allowing entry into a metaverse era that creates new perspectives for fashion vendors while contributing positively to customer loyalty and profit growth. Still, a more comprehensive study of the agents affecting both UI and UX is demanded, under realistic deployment conditions that go beyond the limitations of the application prototype. We leave the detailed analysis of these aspects and their impact on end users’ behavioral characteristics for future work.

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A. List of Abbreviations

Here, all used abbreviations are listed (i.e., Table 2) in alphabetical order for quick reference.

Table 2

The main abbreviations used throughout this paper.

Abbreviation	Description	Abbreviation (cont.)	Description (cont.)
3D	Three-dimensional	UEQ	User Experience Questionnaire
AR	Augmented Reality	UI	User Interaction
AI	Artificial Intelligence	UX	User Experience
GUI	Graphical User Interface	VR	Virtual Reality
MR	Mixed Reality	VUI	Voice-activated User Interface
QR	Quick Response	XR	Extended Reality

B. User Experience Questionnaire

In this appendix section, we include the UEQ (i.e., Table 3) used for the evaluation of our app.

Table 3

The UEQ used for the “N8” prototype evaluation.

Parameter	Notation	Question
Attractiveness	Q1	What is your overall opinion on the ease-of-use of the “N8” app?
	Q2	How satisfactory did you find the navigation speed of the N8 application?
	Q3	Did you find the product categories’ colored dots (dresses, bags, etc.) easy to understand?
	Q4	Did you find the scroll functionality on the app’s home page easy to navigate?
	Q5	Did you find the used colors pleasing?
	Q6	Did you like that the home page is illustrated via a 360° photo of a physical store?
Perspicuity	Q7	Did you find the search function clear?
	Q8	Did you find the pricing function clear?
	Q9	Did you find the product details clear in the “Dresses” category?
	Q10	Did you find the products’ information clear and sufficient?
Efficiency	Q11	Did you find the QR code functionality clear?
	Q12	Did you find the “Match Clothes” functionality efficient and easy to operate?
	Q13	Did you find the “Mirror” functionality efficient and easy to operate?
	Q14	Did you find the “Help-Desk” functionality efficient and easy to operate?
	Q15	Did you find the “Reviews” functionality efficient and easy to operate?
Dependability	Q16	Did you find the transaction (“Add to Cart”) functionality reliable and safe;
	Q17	Did you find the track order functionality reliable and safe;
Stimulation	Q18	Did the backgroundless product photos motivate you to make a purchase?
	Q19	Would you recommend the app to other people?
	Q20	Did the app motivate you to complete purchases?
	Q21	Did you find the discount gamification functionality interesting?
	Q22	Did you find the discount QR code functionality interesting?
	Q23	Did you find the Mirror functionality user-friendly?
	Q24	Did you find the “Try On” functionality user-friendly?
	Q25	Did you find the AR functionality interesting?
	Q26	Did you find the Music functionality interesting?
	Q27	Did you find the “Help-Desk” audio assistant functionality interesting?
Novelty	Q28	What is your overall assessment of the app’s innovation?

Information About the Authors

Ioanna Lampaki received, in 2011, her B.Sc. degree from the Economics and Administration School of the Technological Institute of Central Macedonia, Serres, Greece. In 2022 she received her M.Sc. in New Media Communication and Digital Marketing from the Dept. of Digital Media and Communication, at Ionian University. Over the past few years, after attending various courses, which delve into specific issues of communication science, business administration, and photography, she runs her own business as an Art director, where she creates/provides digital content, according to client needs. Currently, she is pursuing her research interests in user-centered interaction design, focusing on new efficient and emerging UI/UX approaches, and specifically on how immersive technologies and gamification can contribute positively to the new virtual fashion era and the metaverse e-commerce.

Athanasios Tsipis received his B.Sc. and M.Sc. from the Dept. of Informatics of Ionian University, Greece, in 2015 and 2017 respectively, for which he was awarded scholarships for academic excellence. In 2021, he received his Ph.D. in Informatics with honors, from the same Department. His research interests lie at the intersection of digital cultural heritage and networked immersive systems, extended reality and 3D technologies, cloud/edge gaming, multi-media network optimization and performance issues, metaverse applications, gamification and interaction design, etc. Since 2015 he is a member and researcher of the “Networks, Multimedia and Security Systems Laboratory” (NMSLab), participating in various EC research and local development projects. Currently, he serves as an adjunct lecturer at the Dept. of Digital Media and Communication, as well as an academic scholar at the Dept. of Tourism, at Ionian University. He is a reviewer of numerous conferences and journals, and in 2021 he was the recipient of the best paper award from the 26th IEEE Symposium on Computers and Communications (IEEE ISCC 2021).