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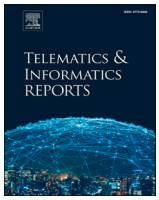

Augmented Reality Versus Web-Based Shopping: How Does AR Improve User Experience and Online Purchase Intention

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ABSTRACT

Augmented Reality (AR) is an appropriate technology that allows users to place virtual products in their physical environment (e.g., a piece of furniture), helping them visualize the products before making a purchase. The objective of this study was to examine the comparison between AR mode and web-based mode in online shopping and the impact of six underlying mechanisms, which we have named AR attributes (interactivity, information, enjoyment, novelty, vividness, intrusiveness), on user experience and online purchase intention. To achieve this, two distinct electronic questionnaires were developed. The first group focused on the web-based mode, and 204 individuals who utilized the IKEA website participated. The second group focused on AR mode and 206 individuals who utilized the IKEA Place app participated. The collected data underwent analysis using structured equation modeling and multi-group analysis techniques, enabling a comparative evaluation of questionnaire outcomes. The comparison of the two modes revealed that when participants use the AR mode, interactivity and novelty have a positive and significant impact, while intrusiveness has a negative and significant impact on user experience and online purchase intention. It is important to note that this research was conducted in a developing country, and understanding people's shopping behavior and habits in such a context can unveil new aspects of the adoption of emerging technologies. These results have significant implications for retailers concerning the practical implementation of AR technology in developing countries, providing insights into its potential to enhance user experience and drive online purchase intentions.

1. Introduction

Over the past few years, the significance of emerging technologies and their applications have grown considerably and is anticipated to continue expanding [1], including health [2,3], marketing [4], engineering design [5], and education [6,7]. Technological advancements are eliminating barriers in the digital domain, leading to a significant increase in online shopping activities. The trend of shopping online via electronic devices, particularly mobile platforms, continues to grow globally [8], especially during the COVID-19 pandemic.[9]. This unusual circumstance has a number of ramifications for customers' day-to-day lives, and it has significantly altered how businesses or organisations control and act as well as consumers react.

In contemporary, diverse, and all-encompassing settings, consumers are inundated with information regarding various products and services. Also, retailers must take into account a range of concerns, including high rates of return, webrooming, leaving the basket in online purchases, and overall customer satisfaction during the process of online shopping [10–12]. Retailers who can engage their customers by providing personalized information and value not only differentiate themselves but also have the potential to foster strong customer engagement. The primary challenges arise from the inability to experience and physically interact with products, which distinguishes online shopping from the tactile engagement available in physical stores [13–16]. Technology is crucial in helping retailers reach their target audience and enabling consumers to make more informed decisions about the consumption of products or services.

Augmented Reality (AR) technology is an appropriate technology to fill the gap between online and offline purchasing as it can deliver a sense of direct shopping [17]. AR represents a highly interactive, advanced, and spatially aware implementation, where digital objects such as videos or 3D models are overlaid onto the real-world view, giving the impression of their physical presence [18]. It enables customers to virtually test products in any physical environment (for

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instance, furniture, clothes, cosmetics, sunglasses) [14,16]. Because AR proposes to "test before you purchase" experience, it has a lot of potential for retailers to make better online changing rates and decrease return rates [8,11]. Companies (e.g., IKEA and ASOS) are experimenting with advanced technology such as virtual reality (VR), and AR to make customer decisions easier which leads to increased customer engagement and shopping intent [19–22].

Due to its surging popularity, extensive research has been devoted to understanding the distinctions between AR-based shopping and other online shopping methods. The primary goal is to identify potential advantages associated with the integration of AR in the realm of online shopping. Noteworthy studies, such as those conducted by Baek et al. [17], Javornik [22], and Verhagen et al. [16] have found compelling evidence supporting the superiority of the AR experience over other online purchasing approaches.

Verhagen et al. [16] contribute to the understanding of AR technology by identifying three key mechanisms: local presence, product tangibility, and product likability. These elements collectively influence consumers' purchase intentions. Conversely, Javornik [22] highlights perceived augmentation, interactivity, and flow as critical mechanisms impacting purchase intentions.

In addition, Baek et al. [17], Hilken et al. [14], and Yim et al. [23] propose an alternative set of underlying mechanisms influencing purchase intent. This includes spatial presence [14], self-brand connections [17], and Yim et al. discovered that AR offers effective communication advantages by eliciting higher levels of novelty, immersion, enjoyment, and usefulness. This leads to more favorable attitudes towards the medium and increased intention to purchase when compared to web-based product presentations [23,24]. Furthermore, Poushneh [25] asserts that AR contributes to increased user satisfaction and willingness to make a purchase [26].

As mentioned previously, several researchers have compared AR experiences to other online shopping experiences that display a product (e.g., furniture, sunglasses) on a model or environment, or only display the product or object [16,17,22,27]. However, there is a gap in understanding the impact of AR technology on both user experience and online purchase intention—both when utilizing AR and when using the website. To address this gap, the research first separately tested the hypotheses related to the two mentioned modes and then employed a multi-group analysis to compare the outcomes of the two modes with each other.

Furthermore, although the underlying mechanisms in this study have been primarily investigated in other studies, our research is unique in that it is conducted in a developing country. Understanding people's shopping behaviour and habits in a developing country can unveil novel insights into the adoption of advanced technology such as AR.

Developing countries face challenges, and individuals there may be less acquainted with new technologies like AR compared to those in developed countries. One of these challenges is related to economic environments. Economic conditions significantly influence innovation assimilation [28], and considerable disparities exist between developed and developing countries. Typically, developing countries exhibit a reduced level of science and technology (S&T) engagement compared to developed nations, primarily attributable to limitations in human capital and infrastructure [29].

Notably, the regulatory environment plays a more prominent role in developing countries than in developed ones [30]. Most developing countries, unlike their developed counterparts [31], feature distinct market environments characterized by imperfections, data asymmetry, and imperfect institutional structures. As highlighted by Zhu et al. [30], government regulation and interventions tend to have a more substantial impact in developing countries.

The differences between developed and developing countries, including factors such as available infrastructure and social and cultural issues, inevitably lead to the conclusion that findings from developed countries cannot be generalized to developing countries [32]. Many developing countries continue to grapple with significant challenges in their efforts to industrialise [33]. This underscores the importance of carefully considering the differential effects of innovation assimilation and the adoption of new technologies across developed and developing countries. Therefore, the findings of this study may diverge from those conducted in developed countries [28,34].

The main objective of this research is to compare the presentation of an online product using AR with the presentation of an online product using the website. We anticipate that online product presentations incorporating AR, in comparison to the website, will either enhance or diminish user experience [35,36] and online purchase intention [8,12,16] via six underlying mechanisms: interactivity [21], information [8], enjoyment [8], novelty [21], vividness [21], and intrusiveness [8,37]. We chose these mechanisms because we focused on three aspects of AR technology: utilitarian aspects (interactivity, information, novelty, and vividness), hedonic aspect (enjoyment), and negative effect (intrusiveness) of AR. These are crucial considerations for the adoption of new technologies and for understanding users' positive or negative experiences. Furthermore, by delineating between these different aspects of AR, we can simultaneously evaluate its hedonic, utilitarian, and negative effects. As mentioned previously, these mechanisms have been tested in other research, and we selected them based on prior studies. It is important for us to examine these three aspects of AR in the context of a developing country. In the next section, we will elaborate further on the distinctions between developing and developed countries.

We expect that AR in online shopping, as opposed to traditional tools like websites, has the potential to reshape the information presentation of online products. By enhancing users' information processing capabilities and mitigating cognitive load, AR enhances the user experience, fostering online purchase intentions.

Considering the preceding discussion, our study seeks to investigate the influence of AR technology on user experience and online purchase intention when consumers intend to purchase a product in online way. Therefore, the research questions guiding this study are:

RQ1: What is the impact, whether positive or negative, of underlying mechanisms on user experience and online purchase intention when consumers use the website?
RQ2: What is the impact, whether positive or negative, of underlying mechanisms on user experience and online purchase intention when consumers use AR?
RQ3: Does the utilization of AR have a greater impact on user experience and online purchase intention compared to the website?

The rest of the paper is organized as follows: First, in the conceptual background and hypotheses section, we provide an overview of online shopping behavior, online shopping with AR and web-based methods, user experience, and online purchase intention. Additionally, we elucidate the concepts of six underlying mechanisms. Second, in Section 3, we outline the methodology employed in the research process and provide detailed explanations of the procedures. Third, in Section 4, we present the results of testing hypotheses for the two distinct conditions of the study. Subsequently, we conduct a multi-group analysis to compare the two methods of shopping. The paper concludes with a discussion in the final section, summarizing the theoretical and practical implications derived from this study and highlighting several potential future directions.

2. Conceptual background and hypotheses

2.1. Online shopping behaviour

Online shopping choices are influenced by consumers' overall attitudes. Some individuals view online shopping as leisurely or enjoyable [38], while others consider it a time-saving option [39]. Concerns about financial risks can deter people from using credit cards for online

purchases [40]. Lee et al. [41] found that attitudes and perceptions significantly impact shopping decisions, with positive attitudes towards technology leading to a higher likelihood of online purchasing.

One of the determinants of online purchase frequency is a consumer's internet experience. Factors such as the duration of internet access, monthly internet usage frequency, and comfort with online search engines have all been identified as influencing consumers' inclination to shop online [42,43]. Farag [44] found that proximity to physical stores increases shopping opportunities and reduces online searching. Additionally, urban residents generally have better internet access, leading to more frequent online shopping [44,45].

As mentioned earlier, this study was carried out within a non-Western country characterized by limited access to international online shopping platforms, heightened government censorship, stringent regulations on popular online apps, and comparatively lower income levels when compared to Western nations [46]. Emerging countries face unique challenges, and individuals in these regions often have less familiarity with emerging technologies than their counterparts in developed nations. In the case of this study, the focus is on Iran, which is classified as an emerging and developing economy according to the World Economic Outlook (WEO) country classification [47]. Additionally, the Global Innovation Index (GII) 2023, published annually by WIPO, places Iran in the category of lower-middle-income economies [48].

Despite this classification, many firms in developing countries lag significantly behind the technological frontier, with micro-enterprises and informal enterprises finding it particularly challenging to adopt new technologies [49]. The impact of COVID-19 has further exacerbated setbacks in education and human capital, highlighting existing skills shortages in these nations [49]. Iran's gross domestic product per capita (GDP) is reported as $4251.67 in 2023, placing it in the emerging and developing economy category [47].

In contrast, according to the WEO, major advanced economies comprise Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States [47]. Among these, the United States holds the first position with a GDP of 80,034.58, followed by Canada in second place with a GDP of 52,722.67.

The GII 2023 incorporates 80 indicators and three types of data, encompassing countries globally. Here, we present illustrative indicators to compare Iran, identified as a lower-middle-income economy, with other nations categorized as high-income by the GII. In terms of Information and Communication Technologies (ICTs), Iran scores at 51 percent, contrasting with 94 percent in the United Kingdom and 90 percent in the United States. Research and Development (R&D) also reflect disparities, with Iran at 14 percent, while the United States and Japan register 77 percent and 71 percent, respectively. In the Online Creativity indicator, Iran scores 16 percent, in contrast to 69 percent in the Germany and 68 percent in United Kingdom. The Creative Goods and Services indicator depicts Iran at 4 percent, whereas the United States records 47 percent, and the United Kingdom, 45 percent [48]. Iran exhibits lower percentages in these indicators, confirming its status as a lower-middle-income economy.

Understanding the shopping behaviours and preferences of people in developing countries provides valuable insights into unexplored aspects of advanced technology adoption. Building upon the preceding discussion, it is essential to recognize that shopping behaviours and preferences within a developing country differ from those in developed countries. Consequently, our research yields results distinct from the latter due to these inherent differences in technology adoption.

2.2. Online shopping with AR and web-based

Azuma [50] argues that AR combines computer-generated objects with the physical realm, offering real-time interactions. A primary capacity of AR is its ability to create a lucid and unambiguous representation of a product that seamlessly blends the physical and virtual domains [20]. Consequently, AR empowers customers to envision a product or experience, facilitating their decision-making process and alleviating the need for mental visualisation [21]. In contrast, web-based shopping, reliant on traditional websites, merely presents two-dimensional images, necessitating users to make choices based solely on visual observation. Regrettably, this approach denies users the opportunity to physically try, touch, or taste items [51].

In recent times, prominent companies and renowned brands have introduced AR mobile applications to facilitate customer information retrieval [21]. Online retailers such as IKEA, ASOS, Wayfair, and Amazon have incorporated a "search by picture" feature into their smartphone applications. This innovative functionality empowers users to employ their mobile cameras to capture images of items or products, which can then be utilized to locate specific products within the mobile application. For instance, IKEA's mobile application enables customers to seamlessly integrate virtual furniture items into their physical surroundings. As a result of the growing adoption of AR among customers, it becomes imperative to comprehend the influence of AR on their behaviour, the immersive experience facilitated by AR and online purchase intention [21,22].

2.3. User experience and online purchase intention

User experience involves the holistic combination of users' feelings, perceptions, and responses during their engagement with a product, service, or system and it is facilitated by technologies like AR and VR [52–54]. It surpasses mere usability, encompassing emotional, aesthetic, and cognitive aspects. Sweller's Cognitive Load Theory [55] delineates the measurement of working memory resources used in the learning process, emphasizing the optimization potential of intrinsic cognitive load associated with learning content [53].

Mayer's cognitive theory of multimedia learning [52,56] posits that individuals process visual and aural information through discrete channels, each handling limited information concurrently. A surplus of information increases cognitive load, affecting a learner's ability to process data. While commonly applied in educational psychology [52, 57], this theory is also relevant to studying website design within the online shopping environment [12].

Cognitive Load Theory posits that individuals possess limited cognitive resources, and excessive cognitive load, often caused by information overload, can negatively impact consumers [12]. In online shopping, customers face challenges visualizing products within their personal environment, contributing to heightened cognitive load [58]. Research by Harper et al. [59] found a correlation between complex website designs, increased cognitive load, and reduced willingness to buy. Zhao et al. [60] demonstrated that the adoption of AR and VR in online shopping affects consumers' cognitive load differently. Additionally, Shin [61] emphasizes the significance of cognitive factors and explains that these can be significantly enhanced by experiential elements or subconscious constructs like immersion and presence [61].

Flavián et al. [62] demonstrated the impact of AR and VR on user experiences. The synchronous interaction inherent in these technologies enhances their allure [63,64]. The feeling of "being there" has been linked to positive behaviours [65]; while user interactions encompassing products, purchases, usage, and brand engagement have been found to influence shopping intentions, attitudes, priorities, utilization, selections, satisfaction, and loyalty [36,66].

In the realm of online shopping, user experience stems from interactions with intelligent objects or items [67]. While the term "consumer" pertains to human entities, the term "object" encompasses a spectrum of nonhuman entities [67]. Within AR and VR systems, user experience becomes an indispensable companion to consumer or customer experiences.

Also, Shin [68] asserts that cues activate underlying beliefs such as interactivity, flow, immersion, presence, and perceived quality, which collectively lead to various behavioral changes in user experience [68].

For instance, in the VR and storytelling industries, it is anticipated that the availability of VR devices will enhance user experiences. Higher levels of immersion and presence will allow users to feel as though they are in another location while watching content and using services [69].

Purchase intention refers to a consumer's aspiration to acquire a product, a sentiment that typically arises from their evaluation and judgment of available options. This evaluative process culminates in a decision to purchase the desired product. Motivated by this desire, the consumer becomes inclined to initiate the purchase [1,70]. Also, purchase intention in social e-commerce suggests that consumers become engrossed in interactive and entertaining experiences, with the desire for sustained immersion driving ongoing shopping activities. When making purchasing decisions, consumers meticulously assess various aspects [71], and it is only through ensuring users' comprehensive understanding and approval of the product that enterprises can instill a strong desire to buy [72], ultimately fostering a desire to stay engaged, which translates into purchase intention. Numerous factors have the potential to influence online shopping intentions. For instance, the information gleaned from websites during online shopping can heighten the inclination toward online purchases. Users construct a psychological model of the anticipated value and then arrive at a purchase decision [73]. If the product's perceived value is substantial, the intention to make an online purchase also increases.

VR and AR technologies have been extensively utilized within the retail industry, demonstrating a strong potential to increase purchase intentions [23,36]. According to Yim et al., AR offers significant advantages in communication by fostering novelty, immersion, enjoyment, and perceived usefulness. These factors contribute to positive attitudes towards the medium and higher purchase intentions, surpassing traditional web-based product presentations [23]. Additionally, AR applications provide consumers with enhanced product information, further bolstering purchase intentions [74]. It is crucial for retailers to understand the implications of integrating AR into the online shopping experience, enabling them to effectively leverage AR technology to attract consumers and enhance their propensity to make purchases [12].

Effective information management ensures clarity and coherence in presenting information, enhancing users' capacity to comprehend and interpret content. This, in turn, minimizes cognitive load, facilitating smoother information processing and user engagement with the system, ultimately elevating the overall user experience [12]. In this study, we measure the impact of AR technology on online shopping via six underlying mechanisms, and we expect that AR, in contrast to the presentation of an online product on the website, can enhance user both experience and online purchase intention.

In the following section, we delve into the literature concerning the six underlying mechanisms, which we have labeled as AR attributes. (1) AR Interactivity: This refers to the ability to control what the user sees, combining the real world with the virtual world. (2) AR Information: This attribute offers the most direct encounter with products, aiming to provide a comprehensive and informative experience. (3) AR Enjoyment: This attribute creates a more entertaining and pleasant experience during online shopping, leading to increased purchase intention. (4) AR Novelty: This entails distinct and personalized information that integrates the real world with the virtual world every time a user engages with the AR feature. (5) AR Vividness: This characteristic encompasses a sharp and detailed depiction of an image, frequently overlaid in three dimensions, within the context of both the real and virtual worlds. (6) AR Intrusiveness: This attribute requires the provision of personal information. When users feel they lack control over their information, it can lead to feelings of frustration and an increased sense of intrusiveness. While other mechanisms could potentially serve as AR attributes, we specifically selected these for the purpose of this study.

2.4. Interactivity

Yim et al. [23] present two perspectives on interactivity, contributing to a comprehensive understanding of the role that interactivity plays in AR. These perspectives encompass interactivity as both a technological result and a user perception.

Interactivity, as defined by Steuer [75], pertains to the extent to which users can actively engage in real-time modifications of both the form and content within a mediated environment. This characteristic encapsulates the proactive behavioural processing of information, emphasizing the user's capacity to actively shape their experience rather than passively consuming a product or service [76].

Steuer [75] outlines the significance of technological attributes in framing the concept of interactivity that emerges from the utilized technology. Thus, interactivity stems from the capability of technological systems to facilitate individuals' simplified interaction with the technology and their engagement with the content [67]. The user's experience can be influenced by three technology sub-elements, including speed—how swiftly consumers can manipulate the subject matter or content; mapping—the resemblance of manipulation in the virtual world to that in the physical world; and range—the extent of content manipulation by consumers [75]. Newhagen et al. [77] emphasize that understanding interactivity is contingent upon an individual's motivation to engage with interactive technologies; without this motivation, the experience is not attainable. Hence, interactivity materializes only when users are willing to engage with such technologies, as in the case of AR or VR. In AR, the essential aspect is user involvement in controlling their visual integration of the virtual world with the physical world—a distinctive feature of AR technology [21,50]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will create more interactivity. Therefore, the hypothesize:

H1.a) The interactivity provided by the website has a positive and significant impact on user experience.
H1.b) The interactivity provided by the AR technology has a positive and significant impact on user experience.
H1.c) The impact of interactivity on user experience with AR technology is more positive and significant than the impact of interactivity on user experience with the website.
H2.a) The interactivity provided by the website has a positive and significant impact on online purchase intention.
H2.b) The interactivity provided by the AR technology has a positive and significant impact on online purchase intention.
H2.c) The impact of interactivity on online purchase intention with AR technology is more positive and significant than the impact of interactivity on online purchase intention with the website.

2.5. Information

Online retailers have the capacity to provide factual information regarding certain features of a product, such as price or quantity, which can be assessed prior to using the product. However, when it comes to communicating experiential attributes that require direct product interaction, such as texture, fit, and form, more sophisticated strategies are needed, as demonstrated by Overmars and Poels [13]. Research has unequivocally demonstrated that direct engagement with a product yields more vivid and distinct mental imagery of the item, heightened sensory involvement, and enhanced evaluative abilities concerning its attributes [13,78–80]. Hence, direct interactions with products offer a wealth of subjective data compared to indirect encounters.

Due to attributes like real-time and interactive features, AR offers the most direct encounter with products [16], thus aiming to provide the most comprehensive and informative experience [8]. AR delivers a multi-sensory and immersive encounter that allows users to visually explore the distinctive experiential attributes of a product [23,78,80]. The information acquired through online presentations of products can enhance user experience and reduce uncertainties related to product selection.

Furthermore, a significant aspect is that online customers are empowered to make informed decisions, leading to an increase in purchase intention [13,14,81]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will provide more information. Therefore, the hypothesize:

H3.a) The information provided by the website has a positive and significant impact on user experience.
H3.b) The information provided by the AR technology has a positive and significant impact on user experience.
H3.c) The impact of information on user experience with AR technology is more positive and significant than the impact of information on user experience with the website.
H4.a) The information provided by the website has a positive and significant impact on online purchase intention.
H4.b) The information provided by the AR technology has a positive and significant impact on online purchase intention.
H4.c) The impact of information on online purchase intention with AR technology is more positive and significant than the impact of information on online purchase intention with the website.

2.6. Enjoyment

Online product presentations offer dual values: utilitarian value, encompassing information, and hedonic value, associated with enjoyment [14,82,83]. Research has demonstrated that the enhancement of vividness and interactivity during online shopping experiences contributes to the creation of enjoyment [23,27,83]. Vivid and interactive experiences, whether on mobile applications, websites, or purchasing platforms, not only enhance the overall sensory encounter but also create a more entertaining and pleasant experience [23,84–86]. For instance, online presentations of products incorporating vividness and interactivity elements, such as product videos, tend to generate more enjoyment compared to static online product displays [14,27,83]. As previously noted, online presentations utilizing AR facilitate a vivid and lucid experience and allow real-time interaction with virtual products [22,50]. Studies have indeed indicated that heightening enjoyment during online shopping leads to an increased purchase intention [22,23,83,87]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will create more enjoyment. Therefore, the hypothesize:

H5.a) The enjoyment provided by the website has a positive and significant impact on user experience.
H5.b) The enjoyment provided by the AR technology has a positive and significant impact on user experience.
H5.c) The impact of enjoyment on user experience with AR technology is more positive and significant than the impact of enjoyment on user experience with the website.
H6.a) The enjoyment provided by the website has a positive and significant impact on online purchase intention.
H6.b) The enjoyment provided by the AR technology has a positive and significant impact on online purchase intention.
H6.c) The impact of enjoyment on online purchase intention with AR technology is more positive and significant than the impact of enjoyment on online purchase intention with the website.

2.7. Novelty

AR seamlessly blends the boundaries between the tangible and intangible realms, bestowing customers with consistently exceptional experiences. Each instance of employing an AR feature introduces fresh stimuli or incentives into the dynamic interplay between the real and virtual domains. The term “novelty” here does not merely refer to the “newness” of AR technology, but rather to special, customized, and novel content within AR that is presented anew every time.

Massetti [88] explains novelty as a mental state in which individuals perceive something as extraordinary, unfamiliar, and distinct. The content delivered through AR technology takes various forms, encompassing images, text, videos, and virtual objects [22]. AR applications empower users to situate virtual items, such as furniture, within real environments. This unique presentation affords individuals the opportunity to visualize how a piece of furniture, replete with highly personalized and innovative content, would appear in their actual living space [22,89]. Consequently, AR empowers users to personalize content according to their specific preferences, thereby enriching their purchasing performance. This, in turn, streamlines tasks, heightens the effectiveness of purchases, and simplifies the process of envisioning and acquiring commodities [21]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will create more novelty. Therefore, the hypothesize:

H7.a) The novelty provided by the website has a positive and significant impact on user experience.
H7.b) The novelty provided by the AR technology has a positive and significant impact on user experience.
H7.c) The impact of novelty on user experience with AR technology is more positive and significant than the impact of novelty on user experience with the website.
H8.a) The novelty provided by the website has a positive and significant impact on online purchase intention.
H8.b) The novelty provided by the AR technology has a positive and significant impact on online purchase intention.
H8.c) The impact of novelty on online purchase intention with AR technology is more positive and significant than the impact of novelty on online purchase intention with the website.

2.8. Vividness

Steuer [75] defines vividness as “the capacity of a technology to offer a sensational and enriched environment”. Creating a vivid mental image involves blending non-sensory experiences of unreal items with sensory experiences of physical items [90]. Flavián et al. [91] demonstrate that various forms of vivid data (such as audio-visual content, images, and vibrant patterns) enhance both the experiential and practical aspects of the purchasing process. In the realm of online shopping, vividness often correlates with the quality of product visualization and aesthetic appeal [91,92].

Hence, a visually striking presentation of products tends to influence customers’ cognitive processing [93,94], as it captures interest and facilitates a more comprehensive evaluation of the product-related information [95]. To enhance vividness, it is essential to improve data quality and increase the representation of sensory dimensions [51].

Similar to interactivity, vividness enables customers to mentally project future interactions with goods or products [96]. AR technology enables users to experience an exclusive, detailed fusion of the real and non-real world [21]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will have more vividness. Therefore, the hypothesize:

H9.a) The vividness provided by the website has a positive and significant impact on user experience.
H9.b) The vividness provided by the AR technology has a positive and significant impact on user experience.
H9.c) The impact of vividness on user experience with AR technology is more positive and significant than the impact of vividness on user experience with the website.
H10.a) The vividness provided by the website has a positive and significant impact on online purchase intention.
H10.b) The vividness provided by the AR technology has a positive and significant impact on online purchase intention.

H10.c) The impact of vividness on online purchase intention with AR technology is more positive and significant than the impact of vividness on online purchase intention with the website.

2.9. Intrusiveness

While using AR apps, users are often required to provide personal information such as email addresses, location data, or camera access to enable the technology. However, users might hesitate to share their data because they lack a clear understanding of how their information will be handled [25]. If users feel that they have no control over the data they are sharing, it can lead to feelings of frustration and an increased sense of intrusiveness [25,97–99].

Primarily, due to the relatively new nature of AR technology, users might not fully grasp the benefits of using it for online shopping, leading them to perceive AR applications that require camera access or webcam usage as invasive [11,100,101]. Reactance theory suggests that users tend to resist persuasion and respond negatively when they feel they lack control over their information [8]. Moreover, according to user surveys, one of the major concerns when using AR applications is the potential exposure of excessive personal data [11]. This study anticipates that online product presentation with AR technology in contrast to the presentation on the website, will evoke a higher sense of intrusiveness. Therefore, the hypothesize:

H11.a) The intrusiveness provided by the website has a negative and significant impact on user experience.
H11.b) The intrusiveness provided by the AR technology has a negative and significant impact on user experience.
H11.c) The impact of intrusiveness on user experience with AR technology is more negative and significant than the impact of intrusiveness on user experience with the website.
H12.a) The intrusiveness provided by the website has a negative and significant impact on online purchase intention.
H12.b) The intrusiveness provided by the AR technology has a negative and significant impact on online purchase intention.

H12.c) The impact of intrusiveness on online purchase intention with AR technology is more negative and significant than the impact of intrusiveness on online purchase intention with the website.

Subsequent the above debates, a visual description of our hypothesised model is displayed in Fig. 1.

3. Methodology

3.1. Participants, procedure, and design

This study employed two distinct online questionnaires distributed through various digital platforms, including Telegram, Zoom, and email. The distribution method was chosen in consideration of the ongoing COVID-19 situation. Both participant groups, during a specific process as determined by the researchers, were previously acquainted with AR technology. They were then assigned the task of virtually selecting an armchair for their homes. We specifically targeted university students as the study's demographic. This choice was made because the research was conducted in a developing country, where we sought a population not only capable of easily becoming acquainted with AR technology but also capable of understanding its advantages and applications. In developing countries, familiarity with emerging technologies like AR is generally lower compared to developed countries, necessitating an educated participant group.

To achieve this, we organized two video conferences on Zoom to provide insights into online shopping with AR technology and websites, emphasizing the research objectives. It should be noted that two supervisors of this project attended these video conferences. The first video conference link was sent to approximately 280 students through their academic email addresses, ensuring that all participants were university students. This video conference was dedicated to the control group, with 244 participants actively participating. During this session, we shared the questionnaire link on Zoom or sent it on various communication channels such as email and Telegram for participants. Finally, 204 participants filled out the questionnaire. The control group was

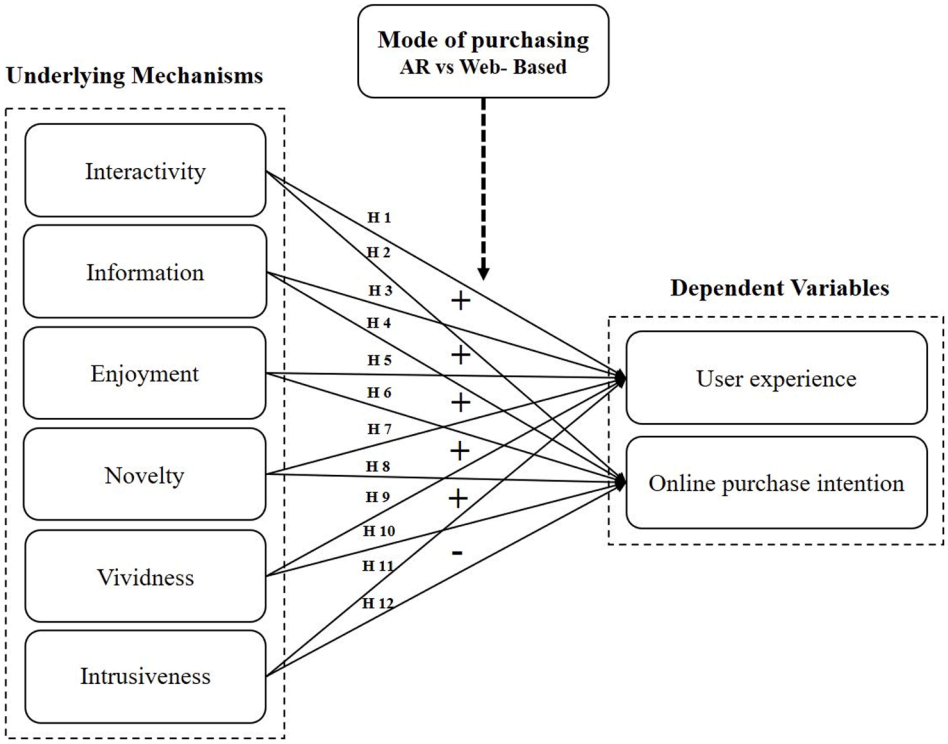

Fig. 1. Conceptual model.

predominantly experienced in web-based online shopping. Their task involved engaging in an imaginative shopping exercise for an armchair using the IKEA store website (refer to Appendix A).

To address concerns regarding data validity and accuracy, we collected the initial set of questionnaires before conducting a second video conference for the experimental group. Once again, the link for the second video conference was sent to approximately 280 students through their academic email addresses. It should be noted that the link for the second video conference was sent to a different set of students. This video conference was dedicated to the experimental group, with 233 participants actively participating. Ultimately, 206 participants completed the questionnaire. This group was instructed to download and install the IKEA Place app on their smartphones, which is available on the App Store for iOS devices and the Play Store for Android devices. Subsequently, participants were asked to use the app to select and position an armchair within their living spaces before proceeding with the questionnaire.

Table 1 presents the participant demographics for the research. Both groups included several control variables. Participants were queried about their prior online shopping experiences as well as any encounters with AR-assisted shopping. The frequency of smartphone app usage was gauged, alongside the motivation underlying their app usage. Furthermore, background variables such as gender, age, and educational level were assessed.

The scales of the questionnaires were extracted from previous literatures to measure interactivity [21], information [8], enjoyment [8,21], novelty [21], vividness [21], and intrusiveness [8,37] with the user experience [35,36] and online shopping intention [8,12,16]. Thus, 34 items were measured on a five- point Likert scales (1 = Strongly disagree; 5 = Strongly agree).

Table 1
Characteristics of respondents.

Characteristics	Control Group Number (n)	Percentage	Experimental Group Number (n)	Percentage
Gender				
Male	68	33.3	90	43.7
Female	136	66.7	116	56.3
Age Group				
18–24	69	33.8	45	21.8
25–34	106	52	120	58.3
35–44	24	11.8	32	15.5
45–54	5	2.5	9	4.4
Education				
Bachelor student	91	44.6	54	26.2
Master student	89	43.6	125	60.7
Ph.D. student	24	11.8	27	13.1
General App Use Frequency				
Multiple times daily	173	84.8	162	78.6
Once daily	11	5.4	11	5.3
Multiple times weekly	11	5.4	26	12.6
Once weekly	9	4.4	5	2.4
At least once a month	0	0	2	1
Motivation for Using the App				
Browsing	15	7.4	16	7.8
Information Search	184	90.2	178	86.4
Purchasing products	5	2.5	12	5.8
Online shopping experience				
Yes	184	90.2	198	96.1
No	20	9.8	8	3.9
Shopping experience with AR				
Yes	2	1	7	3.4
No	202	99	199	96.6

3.2. Measures

For each study a lot of preliminary analyses were conducted before the structural equation modeling (SEM) to test the hypothesised model in Fig. 1. In the assessment of scale reliability, Cronbach's alpha coefficient was calculated for each scale used in the study as shown in Table 2 and exceeding the critical value of 0.7. Also, the mean and standard deviation were calculated for each group. Factor loading for each question in questionaries can be seen in Table 2. In this research, a confirmatory factor analysis (CFA) ran for each group. Thereafter, Structural Equation Modelling with the use of AMOS was used to test the hypothesised relationships sketch in Fig. 1. Results of the First order confirmatory factor analysis about the control group display goodness of fit: X2/ DF = 1.040; RMSEA = 0.014; IFI = 0.995; TLI = 0.994; CFI = 0.995.

Confirmatory Factor Analysis was calculated which outlined about experimental group display goodness of fit: X2/ DF = 1.166; RMSEA = 0.028; IFI = 0.975; TLI = 0.971; CFI = 0.975.

Following the confirmatory Factor Analysis, further analysis for both groups satisfied discriminant and convergent validity as the results shown in Table 3 (Control Group) and Table 4 (Experimental Group) indicate convergent validity was satisfied following the average variance extracted (AVE) values above 0.50 and construct reliabilities (CR) above 0.70. Additionally, the AVE values were greater than the Average Shared Squared Variance (ASV) and Maximum Shared Variance (MSV), supporting discriminant validity. The square roots of AVE values were greater than their correlations.

4. Results

Following the goodness of fit of the CFA and satisfying the subsequent tests, the structural equation model was then estimated based on the hypothesised model in Fig. 1. The results are shown in Table 5 illustrate that the information, enjoyment, novelty and provided by the IKEA website as well as the vividness of the content has a positive influence on the user experience and online purchase intention, supporting H3a, H4a, H5a, H6a, H7a, H8a, H9a, H10a. Interactivity was therefore rejected for both user experience (H1a) and online purchase intention (H2a). Additionally, the effect of intrusiveness on user experience and online purchase intention was also rejected (H11a and H12a).

The results are shown in Table 5 and illustrate that the interactivity, information, enjoyment, and novelty provided by the IKEA Place application as well as the vividness of the content has a positive influence on the user experience and online purchase intention, supporting H1b, H2b, H3b H4b, H5b, H6b, H7b, H8b, H9b, and H10b. Also, intrusiveness has a negative impact on online purchase intention and user experience, supporting H11b and H12b.

Moreover, the study directed multi-group analysis in the evaluation of hypotheses H1c, H2c, H3c, H4c, H5c, H6c, H7c, H8c, H9c, H10c, H11c, and H12c regarding the use of AR mobile application (IKEA Place) in comparison with the image of the IKEA website. The multi-group analysis enabled comparison between the two groups.

Based on this method of multi-group analysis and using standard regression values of the hypothesis in two cases (IKEA Place app and IKEA website), this value has been calculated and the value obtained is compared with the critical value of chi-square with an error of 5 % and a degree of freedom (df) of 1 (3.841) and if the value of the statistic is greater than the critical value, the hypothesis of difference between the two groups (experimental group ($n = 206$) and control group ($n = 204$)) will be confirmed. Based on this, it is observed that hypotheses H1c (Interactivity → User experience), H2c (Interactivity → Online purchase intention), H7c (Novelty → User experience), H11c (Intrusiveness →

Table 2
Reliability, descriptive and measurement items of variables.

Variables	Control Group			Experimental Group		
	Cronbach's Alpha	Factor Loading	Mean (SD)	Cronbach's Alpha	Factor Loading	Mean (SD)
Interactivity [21]	**0.915**		**2.87 (0.92)**	**0.850**		**4.01 (0.64)**
Control of my navigation.		0.811	2.90 (1.06)		0.741	3.95 (0.81)
I saw what I was expecting.		0.845	2.87 (1.05)		0.725	4.04 (0.81)
Ability to respond to my specific needs quickly and efficiently.		0.803	2.82 (1.05)		0.740	4.02 (0.80)
Able to freely choose what I wanted.		0.846	2.88 (1.08)		0.728	4.03 (0.81)
Able to easily interact with the environment.		0.826	2.89 (1.08)		0.711	4.01 (0.85)
Information [8]	**0.905**		**2.76 (0.81)**	**0.880**		**3.70 (0.74)**
Providing complete and detailed information		0.837	2.72 (0.98)		0.759	3.75 (0.86)
Providing information that was helpful in decision making		0.778	2.74 (0.93)		0.780	3.80 (0.90)
Making possible to compare products		0.818	2.81 (0.92)		0.832	3.68 (0.94)
Getting information is very fast		0.796	2.75 (0.95)		0.694	3.65 (0.85)
Finding the answers about the colour and type of furniture		0.821	2.79 (0.98)		0.791	3.66 (0.94)
Enjoyment [8]	**0.880**		**2.67 (0.84)**	**0.826**		**4.02 (0.66)**
It is very enjoyable		0.780	2.71 (0.96)		0.711	3.97 (0.79)
It is fun and entertaining		0.797	2.68 (1.00)		0.731	4.02 (0.82)
It invites me to discover new home furniture catalogs		0.797	2.65 (0.98)		0.764	4.06 (0.80)
It is a good and pleasant tactic		0.847	2.68 (0.96)		0.744	4.05 (0.83)
Novelty [21]	**0.901**		**2.81 (0.89)**	**0.814**		**4.11 (0.57)**
Presenting something new every time		0.835	2.81 (0.99)		0.706	4.17 (0.73)
Providing unique and fresh information		0.844	2.82 (1.04)		0.724	4.12 (0.73)
It is different each time		0.833	2.82 (1.01)		0.753	4.09 (0.67)
Providing specific content		0.821	2.80 (1.02)		0.707	4.08 (0.71)
Vividness [21]	**0.889**		**3.09 (0.91)**	**0.824**		**4.12 (0.63)**
It is very clear to me		0.815	3.11 (1.03)		0.786	4.14 (0.79)
It has detailed		0.837	3.05 (1.11)		0.726	4.17 (0.76)
It is vague to me		0.815	3.09 (1.04)		0.742	4.07 (0.79)
It is well defined		0.799	3.12 (1.02)		0.681	4.12 (0.76)
Intrusiveness [8,37]	**0.813**		**3.58 (0.94)**	**0.792**		**2.21 (0.63)**
It is annoying to me		0.851	3.50 (1.11)		0.717	2.23 (0.74)
It is created an unpleasant feeling		0.763	3.69 (1.11)		0.761	2.19 (0.75)
Uploading the home environment annoyed me		0.695	3.58 (1.10)		0.767	2.22 (0.77)
User experience [35,36]	**0.893**		**2.57 (0.86)**	**0.832**		**4.08 (0.66)**
I am satisfied with my experience		0.820	2.58 (0.96)		0.684	4.08 (0.80)
This experience is exactly what I wanted		0.815	2.59 (0.96)		0.733	4.11 (0.81)
This experience is as good as I thought		0.840	2.54 (1.01)		0.832	4.06 (0.83)
It is just like the real experience of home furnishings		0.818	2.57 (1.03)		0.720	4.07 (0.82)
Online purchase intention [8,12,16]	**0.886**		**2.70 (0.79)**	**0.845**		**4.19 (0.59)**
Buying with more confidence		0.796	2.66 (0.93)		0.727	4.20 (0.76)
Making decisions more easily		0.836	2.81 (0.97)		0.687	4.22 (0.72)
Able to shop online		0.768	2.69 (0.93)		0.767	4.17 (0.79)
Reducing the cost of searching		0.778	2.64 (0.98)		0.759	4.18 (0.78)
Online shopping makes shopping and life easier		0.725	2.70 (0.98)		0.663	4.21 (0.73)

User experience), and H12c (Intrusiveness → Online purchase intention) are supported. The values of the hypotheses are shown in Table 5. The hypotheses are tested according to the following steps:

1. Calculate the Fisher Z of each of the model coefficients based on the following equation:

$$Z_k = \frac{1}{2} Ln \frac{1-r}{1+r}$$

2. Calculate the weighted average of Z_r:

$$Z_0 = \frac{n_1 Z_{r1} + n_2 Z_{r2}}{n_1 + n_2}$$

3. Calculate the amount of chi-square observed and the amount of chi-square in the table based on the following formula:

$$Chi^2 = \sum_{k=1}^{k} (N_k - 3)(Z_k - Z_0)^2$$

Which in this formula:

Z_k: Amount of Z fisher r_k
N_k: k Subgroup sample size
Z_0: Sample weight average - size of values of Z_k
Chi^2: Approximate distribution of chi-square with the degree of freedom k-1

4. Comparison of the value of chi-square's observed and chi-square's tables: If the value of chi-square observation is greater than the value of the chi-square table, it indicates the moderating role of the relevant variable.

Based on the multi-group analysis, there is a significant difference in the three hypotheses between the two groups. The multi-group analysis highlights that the interactivity, novelty, and intrusiveness of the AR technology in comparison with the web-based has a more significant influence on user experience and online purchase intention. The degree of interactivity and intrusiveness in the AR experience exhibited a significant influence on both user experience and online purchase intentions. Furthermore, the impact of novelty with AR on user experience is more than web-based shopping.

Table 3
Convergent and discriminant validity (Control Group).

	CR	AVE	MSV	ASV	INT	UX	OPI	INS	VIV	NOV	ENJ	INF	GEN	AGE	EDU	GAU	MUA	OSE
Interactivity (INT)	.91	.68	.03	.01	**0.82**													
User Experience (UX)	.89	.67	.10	.05	0.05	**0.82**												
Online Purchase Intention (OPI)	.88	.61	.14	.07	0.17	0.20	**0.78**											
Intrusiveness (INS)	.81	.59	.03	.01	−0.03	−0.08	−0.12	**0.77**										
Vividness (VIV)	.88	.66	.08	.02	0.02	0.28	0.22	0.03	**0.81**									
Novelty (NOV)	.90	.69	.14	.05	0.12	0.26	0.38	−0.17	0.17	**0.83**								
Enjoyment (ENJ)	.88	.64	.08	.03	0.14	0.28	0.29	−0.17	0.10	0.07	**0.80**							
Information (INF)	.90	.65	.12	.05	0.16	0.31	0.35	−0.17	0.03	0.25	0.15	**0.81**						
Gender (GEN)	–	–	–	–	0.00	−0.05	−0.05	−0.01	0.05	0.01	−0.04	0.13	**1**					
Age (AGE)	–	–	–	–	−0.02	−0.04	−0.13	−0.01	0.00	−0.03	0.10	−0.14	−0.03	**1**				
Education (EDU)	–	–	–	–	−0.02	−0.06	−0.13	0.13	−0.01	−0.05	−0.00	−0.13	0.00	0.57	**1**			
General App Use Frequency (GAU)	–	–	–	–	−0.03	−0.05	−0.01	−0.07	−0.09	−0.01	0.00	0.02	−0.09	0.37	0.17	**1**		
Motivation for Using the App (MUA)	–	–	–	–	−0.02	0.04	−0.06	−0.11	0.03	0.12	0.04	0.05	0.15	0.20	0.16	0.22	**1**	
Online Shopping Experience (OSE)	–	–	–	–	0.00	−0.06	−0.01	−0.08	−0.07	−0.07	−0.01	0.07	0.00	0.08	−0.01	0.18	−0.04	**1**
Shopping Experience with AR (SEAR)	–	–	–	–	0.00	−0.04	0.05	−0.06	−0.04	0.04	−0.08	−0.02	0.03	−0.09	−0.09	−0.22	−0.01	0.03

CR - Construct Reliability; AVE - Average Variance Extracted; MSV - Maximum Shared Variance; ASV- Average Shared Squared Variance.

Table 4
Convergent and discriminant validity (Experimental Group).

	CR	AVE	MSV	ASV	INT	UX	OPI	INS	VIV	NOV	ENJ	INF	GEN	AGE	EDU	GAU	MUA	OSE
Interactivity (INT)	.85	.53	.43	.27	**0.72**													
User Experience (UX)	.83	.55	.47	.39	0.66	**0.74**												
Online Purchase Intention (OPI)	.84	.52	.46	.36	0.60	0.54	**0.72**											
Intrusiveness (INS)	.79	.56	.36	.19	−0.36	−0.60	−0.55	**0.74**										
Vividness (VIV)	.82	.54	.46	.32	0.60	0.68	0.65	−0.33	**0.73**									
Novelty (NOV)	.81	.52	.47	.30	0.48	0.69	0.67	−0.41	0.57	**0.72**								
Enjoyment (ENJ)	.82	.54	.35	.25	0.46	0.58	0.59	−0.38	0.52	0.49	**0.73**							
Information (INF)	.88	.59	.34	.24	0.41	0.58	0.57	−0.34	0.54	0.48	0.47	**0.77**						
Gender (GEN)	–	–	–	–	0.14	0.02	0.03	−0.28	0.23	0.21	0.19	0.21	**1**					
Age (AGE)	–	–	–	–	−0.10	−0.07	−0.12	0.03	−0.17	−0.00	−0.04	−0.16	−0.06	**1**				
Education (EDU)	–	–	–	–	−0.12	−0.03	−0.11	0.00	−0.16	0.23	−0.07	−0.03	0.12	0.55	**1**			
General App Use Frequency (GAU)	–	–	–	–	−0.10	−0.01	−0.00	−0.17	−0.13	−0.15	−0.06	−0.01	0.02	0.15	0.08	**1**		
Motivation for Using the App (MUA)	–	–	–	–	−0.06	−0.02	−0.09	−0.10	−0.12	−0.05	−0.07	−0.06	0.08	0.12	0.20	0.16	**1**	
Online Shopping Experience (OSE)	–	–	–	–	−0.17	−0.21	−0.19	0.20	−0.19	−0.10	−0.16	−0.19	−0.07	0.23	0.11	−0.03	0.01	**1**
Shopping Experience with AR (SEAR)	–	–	–	–	0.10	0.07	0.04	−0.07	0.11	0.09	0.02	−0.05	0.05	0.00	−0.05	−0.00	−0.01	0.03

CR - Construct Reliability; AVE - Average Variance Extracted; MSV - Maximum Shared Variance; ASV- Average Shared Squared Variance.

Table 5
Overview of accepted and rejected hypotheses per study and multi-group analysis.

	Path	AR		Website		Multi-Group Analysis	
		K_1	ZK_1	K_2	ZK_2	Z_0	Chi^2
H1	Interactivity → User experience	0.335 ***	−0.348	0.043 ns	−0.043	−0.194	9.421**
H2	Interactivity → Online purchase intention	0.257 ***	−0.262	0.066 ns	−0.066	−0.164	3.911*
H3	Information → User experience	0.216 **	−0.219	0.273 ***	−0.280	−0.249	0.371 ns
H4	Information → Online purchase intention	0.219 **	−0.222	0.238 ***	−0.242	−0.232	0.040 ns
H5	Enjoyment → User experience	0.179 *	−0.180	0.212 **	−0.215	−0.198	0.118 ns
H6	Enjoyment → Online purchase intention	0.211 **	−0.214	0.242 ***	−0.246	−0.230	0.107 ns
H7	Novelty → User experience	0.352 ***	−0.367	0.149 *	−0.150	−0.259	4.782*
H8	Novelty → Online purchase intention	0.362 ***	−0.379	0.285 ***	−0.293	−0.336	0.748 ns
H9	Vividness → User experience	0.277 ***	−0.284	0.225 **	−0.260	−0.272	0.056 ns
H10	Vividness → Online purchase intention	0.213 **	−0.216	0.164 *	−0.165	−0.191	0.260 ns
H11	Intrusiveness → User experience	−0.341 ***	0.355	−0.004 ns	0.004	0.180	12.458***
H12	Intrusiveness → Online purchase intention	−0.231 **	0.235	−0.012 ns	0.012	0.124	5.033*

*** $\rho < 0.001$,.
** $\rho < 0.01$,.
* $\rho < 0.05$,.
ns = not significant.

5. Discussion

5.1. Theoretical implication

Our findings consist largely of three parts: (1) the mode of purchasing plays a moderating role in the impact of six underlying mechanisms, named AR attributes, on user experience and online purchase intention; (2) a comparison between two modes (AR versus web-based) assessing the positive or negative, as well as significant impact of AR attributes on user experience and online purchase intention; and (3) consideration that our research was conducted in a developing country.

To begin with, both modes of purchasing unequivocally underscore the influential role played by four distinct attributes of AR—namely, information, enjoyment, novelty, and vividness—in fostering a positive and significant impact on both user experience and online purchase intention. Additionally, in AR mode, two AR attributes—interactivity and intrusiveness—have different impacts compared to the web-based mode.

The theoretical foundation of this research is rooted in Cognitive Load Theory. Due to the infancy of research on AR, especially in a developing country, the cognitive load theory provides a useful theoretical foundation. According to Fan et al. [12] perspective, Cognitive Load Theory suggests that people have finite cognitive capacities, and an excess of cognitive burden, often resulting from information overload, can have adverse effects on consumers. In the context of online shopping, customers encounter difficulties in mentally visualizing products in their personal spaces, leading to an increased cognitive load [58]. Zhao et al. [60] illustrated that the incorporation of AR and VR in online shopping has varying effects on the cognitive load of consumers. This, in turn, minimizes cognitive load, facilitating smoother information processing and user engagement with the system, ultimately elevating the overall user experience [12].

Interactivity refers to how technology facilitates user interaction with content [102]. It has been shown to increase product knowledge [51], user engagement [103], and purchase intention [104] while decreasing consumers' cognitive load [60]. Our study supports the idea that the interactivity provided by AR technology has positive and significant impact on both user experience and online purchase intention. Additionally, our study found that when people used the IKEA website for online shopping, they did not perceive interactivity. As discussed by Hoffman and Novak [67], in the context of online shopping, user experience is influenced by interactions with smart objects. This implies that the level of interactivity in AR mode plays a significant role in users' preference over the web-based mode for online shopping.

AR can enhance consumers' processing of product information by offering virtual representations of how products may appear in reality. Consequently, this approach aligns the information users interact with more closely with their own physical environment, reducing reliance on imagination [12]. In line with prior research by Smink et al. [8], and Verhagen et al. [16], which assert that AR provides the most direct interaction with products, aiming to deliver a comprehensive and informative experience, our study supports the idea that the information provided by AR technology enhances both user experience and online purchase intention. In our study, we observed that individuals using the IKEA website expressed satisfaction with the information provided. However, when it came to the AR mode, they did not perceive a substantial increase in information. This observation can be attributed to the fact that when consumers decide to purchase an armchair, they often seek to physically touch and feel the fabric to assess its quality. Additionally, they may have uncertainties about the precise color of the armchair. Consequently, the information presented on both the website and the app remains consistent.

Numerous research studies consistently demonstrate that enhancing the vividness and interactivity of online shopping experiences contributes to the generation of enjoyment [23,84–86]. These vivid and interactive encounters, whether occurring through mobile applications, websites, or purchasing platforms, not only enhance the sensory aspect but also lead to a more engaging and pleasurable shopping experience. While we had anticipated that AR would augment enjoyment compared to the web-based, our study indicates that AR did not significantly heighten the level of enjoyment. As discussed by Etminani-Ghasrodashti and Hamidi [46], individuals' perceptions and attitudes toward shopping play a crucial role in determining their shopping preferences and frequency. Various motivations underlie individuals' decision-making processes when making purchases. For example, as pointed out by Lee et al. [41], some people find enjoyment in traditional in-store shopping experiences, while others choose online shopping for its time-saving convenience. In our study, the reported level of enjoyment remained relatively consistent both on the website and in the AR app. Given the challenges associated with internet access in developing countries, there exists a noteworthy disparity in how people engage in online shopping. We attribute these challenges to the overall experience of enjoyment during online shopping. Using the AR app requires a high-speed internet connection; otherwise, virtual furniture cannot be placed in our environment. Sometimes, it takes a long time to position an armchair in the house using the AR application, or there may be issues with the presentation, resulting in incomplete visuals. All these challenges are attributed to the internet and impact enjoyment during online shopping, as users become tired and confused.

In this context, novelty, referring to the unique and exceptional content generated by AR, has a positive and significant impact on user experience and online purchase intention. Aligned with the findings of

Javornik [22] and Preece et al. [89], we propose that novelty provides individuals with the opportunity to visualize how a piece of furniture, enriched with highly personalized and innovative content, would integrate into their actual living space. However, in the context of our study, it appears that AR did not significantly heighten the level of novelty. We attribute this to the fact that there is less familiarity with AR technology in developing countries, where people may not comprehend the term novelty because AR technology itself is new, and understanding novelty in content requires more information and time.

Vividness, within the technological realm, refers to its capability to construct an environment that is perceptually rich and heightened [75]. As noted by Flavián et al. [91] and Griffith and Gray [92], vividness is often associated with the quality of visualizing products and their aesthetic appeal. Initially, we anticipated that AR would provide more vividness compared to the web-based. However, no significant distinction was observed between the two conditions. This lack of distinction again can be attributed to the challenges associated with internet accessibility in non-Western countries, which impeded AR from delivering a vivid and explicit encounter. In line with Keller and Block [94], Jiang and Benbasat [105], and Nisbett and Ross [93], a visually captivating presentation of products is inclined to influence customers' cognitive processing and facilitate a more thorough assessment of product-related information. However, as the quality of devices and internet connectivity assumes a pivotal role in the provision of vividness, we realized that consumers may not possess a clear understanding of the concept of vividness.

With regard to intrusiveness, the introduction of AR increased the level of intrusiveness compared to the web-based. This outcome contradicted our initial expectations, as we anticipated, in line with Smink et al. [8], whose study showed that intrusiveness did not have negative impacts on consumer reactions (brand attitude, purchase intention, and willingness to share personal data), that in our study it would not adversely affect both user experience and online purchase intention. This observation can be attributed to the complex interplay of various factors influencing online purchasing behaviour, particularly in non-Western countries. Numerous studies have developed theories and models concerning how individuals adopt and accept advanced technologies. Among these, the Technology Acceptance Model (TAM) [106, 107] is noteworthy as it addresses issues related to the adoption and acceptance of technology. Our study draws a conclusion regarding intrusiveness and its negative impact on both dependent variables based on this theory. TAM relies on two primary factors: perceived usefulness (PU) and perceived ease of use (PEOU), alongside attitude. Perceived ease of use relates to the extent to which an individual believes that utilizing a specific system would require minimal effort, while perceived usefulness relates to the extent to which an individual believes that using a particular system would enhance their job performance. In light of this, we found that limitations in accessing international online shopping platforms may lead to less familiarity with technology adoption among individuals in developing countries and they find it difficult to use. Consequently, they reported a higher level of intrusiveness in AR mode compared to the web-based mode.

Our second finding, regarding the comparison of the two modes, reveals a significant difference in five hypotheses (H1c, H2c, H7c, H11c, and H12c), highlighting a noteworthy discovery: AR attributes exert a considerably stronger influence on enhancing user experience and online purchase intention. This phenomenon stems from AR applications' unique capability to empower users by visualizing products within their immediate physical surroundings. The multi-group analysis further illustrates that the impact of interactivity on user experience and online purchase intention with AR technology is more positive and significant compared to its impact via traditional web-based platforms [108]. In AR mode, interactivity provides consumers with opportunities to explore diverse product designs and visualize how well they integrate into their living spaces—a feature not available in conventional web-based e-commerce [108].

Furthermore, the multi-group analysis shows that the impact of novelty in AR mode on user experience is positive and significant compared to the web-based. These results confirm that the novelty of the content presented through AR plays a pivotal role in shaping the user experience and stimulating consumers' information processing. As discussed by Kover and James, this characteristic has the potential to capture users' attention, arouse curiosity, and foster engagement.

Lastly, the multi-group analysis indicates that the impact of intrusiveness on user experience and online purchase intention with AR technology is more negative and significant than the impact of intrusiveness on user experience and online purchase intention with the website. Using the website for online shopping does not lead to the negative impact of intrusiveness because users do not need to provide too much information to buy a piece of furniture. In line with theories of body image [108–110] and according to Yim and Park [27], consumers with an unfavorable body image will prefer AR to traditional web-based media, while no preference is expected from those consumers with a favorable body image. We attribute these findings to our study and conclude that most users are not comfortable uploading their environment for using the AR app. In contrast to Yim and Park [27], we realize that users with an unfavorable house would not prefer to use AR technology, while those with a favorable house would prefer to use it.

Our final discovery relates to developing nations, where the utilization of existing technologies for their economies is hindered by various barriers. Developing economies must adopt a tailored approach to assimilate these technologies. The acute challenges faced in these countries, such as funding constraints for both public and corporate Research and Development (R&D), pose a significant concern [49]. Additionally, according to Global Innovation Index (GII), limitations in entrepreneurship and innovation within the business sector are apparent. Skills are pivotal, extending beyond technical or research abilities to encompass marketing and managerial skills [49]. Government investments in science and technology in developing nations commonly prioritize agriculture over engineering or industrial research. These economies suffer from a shortage of applied research, a deficiency in skilled engineers and scientists, limited technological capability, and predominantly insufficient scientific and technological infrastructures [29]. While some economies, notably in East Asia, have successfully caught up through technology adoption, the majority of developing country firms lag behind the technological frontier, facing challenges in adopting technologies, especially in micro-enterprises and informal sectors [49]. Overcoming numerous obstacles, particularly in technology adoption and diffusion, is essential. The Digital Age demands increased sophistication in innovation and advanced ICT solutions to significantly enhance productivity in industries.

5.2. *Practical implication*

Throughout history, advancements in technology have consistently brought about positive changes in people's daily lives, contributing to elevated living standards, improved health outcomes, and sustained economic growth [49]. The value of investments in science, innovation, and technology adoption becomes evident when these advancements translate into tangible economic benefits, such as increased productivity, elevated well-being measured by GDP per capita, and broader welfare improvements, including a robust and enduring population and a healthy environment. It is essential for local governments and companies to actively guide the development of innovations tailored to local contexts instead of relying solely on diffusion. The process of technology adoption, distinct from simple diffusion, remains challenging and time-consuming, particularly in the context of the second wave of ICT and the emergence of the Deep Science wave [49].

This study furnishes retailers and marketers with valuable insights for the implementation of AR technology in developing countries. It underscores a key message to retailers and managers: AR technology has the potential to significantly impact both user experience and online

purchase intention. For developers and retailers aiming to navigate challenges such as the pandemic successfully, rapid adaptation is crucial. This adaptation entails swiftly acquiring new knowledge about shifts in consumer behaviour [111], given the changing landscape of consumer needs [99,100,112].

In light of the impact of the Coronavirus, users now perceive online shopping as more practical and compatible. As a result, contactless shopping channels have gained heightened trustworthiness [113]. The utilization of AR offers a fresh perspective on online shopping, fostering a logical and personalized encounter. Additionally, AR has the potential to enhance both user experience and online purchase intention.

Interactivity empowers users to manipulate products in a three-dimensional manner, engaging them actively within this immersive experience. Moreover, the novelty inherent in AR technology bestows users with special, customized, and novel content and it is presented anew every time, thereby profoundly shaping their overall experience.

Developers and managers should be particularly attentive to the notion of intrusiveness and its adverse consequences on user experience and online purchase intention. Intrusiveness can evoke a sense of loss of control over personal information or environment. Consequently, it is imperative to prioritize consumer privacy during the software design phase. This not only diminishes uncertainties but also fosters positive user reactions.

Consequently, it is essential for developers to effectively communicate the various factors and variables that AR applications bring to the table. This includes empowering users with the ability to interact and exert control over their shopping experiences through the utilization of these apps and the integration of the technology. Managers should, in turn, ensure that AR apps are designed to be responsive to users' specific needs. It is also important that AR technology affords users the freedom to make choices and facilitates seamless interaction with their surroundings. Considering the impacts of enjoyment and utility on the adoption of AR technology, it is suggested that developers prioritize enhancing aesthetic elements, color schemes, and user-friendly features [24].

These applications enable marketers and retailers to deliver a distinctive experience tailored to meet users' needs, thereby shaping users' experience and online purchase intention. Therefore, this technology is not a momentary mode, and investment in AR results in successful outcomes.

5.3. Limitations and future research

Certain limitations need to be taken into account while interpreting the findings of this study. The research primarily focused on a younger demographic, comprising individuals who were either undergraduate or postgraduate students. Therefore, the study sample was restricted to the academic population. It is important to recognize that older individuals might produce distinct results due to varying levels of familiarity with technology such as AR. Thus, for a more comprehensive understanding, future studies should encompass a broader spectrum of age groups and generations.

Future studies could explore consumer behaviour post-purchase, particularly examining how it is influenced by the positive or negative impacts of user experience associated with the use of AR technology. In this study, the mode of purchasing (AR vs. web-based) serves as a moderator variable. Future studies could explore additional types of moderating variables, such as internet speed or availability, in both developed and developing nations.

Moreover, given the increasing prevalence of AR usage, conducting studies in developing countries would be particularly intriguing. Such studies could control for various variables, including technology adoption challenges specific to these regions. Notably, considering the case study was conducted in Iran, a country subject to unique political and economic sanctions [114] impacting AR acceptance [24], it becomes imperative to address these constraints. Sanctions have posed challenges such as restricted internet access, and limited availability of international brands and AR applications.

To address these complexities, qualitative methodologies could be employed to gain deeper insights into the challenges faced in developing countries like Iran. Future research could involve expert interviews to explore the factors influencing technology adoption in such regions. Subsequently, employing quantitative methodologies to analyse the impacts of these challenges, whether positive or negative, on user experience, would be beneficial. By integrating qualitative and quantitative approaches, researchers could enhance the validity and generalizability of their findings.

While our study may have overlooked the inclusion of manipulation checks, we emphasize the significance of this aspect in refining experimental methodologies and strengthening the validity of research findings. In light of this limitation, we encourage future researchers to prioritize the implementation of manipulation checks and thorough assessments of experimental conditions to advance the quality and reliability of empirical investigations in this domain. Implementing manipulation checks allows researchers to ascertain the effectiveness of experimental manipulations and ensure the validity of collected data. Additionally, controlling for extraneous variables and carefully monitoring the environmental setup are essential steps to minimize potential biases and enhance the rigor of experimental procedures.

Lastly, the study faced constraints related to the challenges posed by the Covid-19 pandemic. Access to university students was notably challenging, often requiring electronic distribution of questionnaires. Future research endeavors can overcome this by incorporating a more diverse range of examples, perhaps by conducting demonstrations of AR apps in a controlled university lab setting before participants complete the questionnaires.

CRediT authorship contribution statement

Fatemeh Zare Ebrahimabad: Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Conceptualization. **Hamidreza Yazdani:** Supervision, Methodology. **Amin Hakim:** Supervision. **Mohammad Asarian:** Software.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Stimuli: AR mode vs. Website mode

Fig. 2

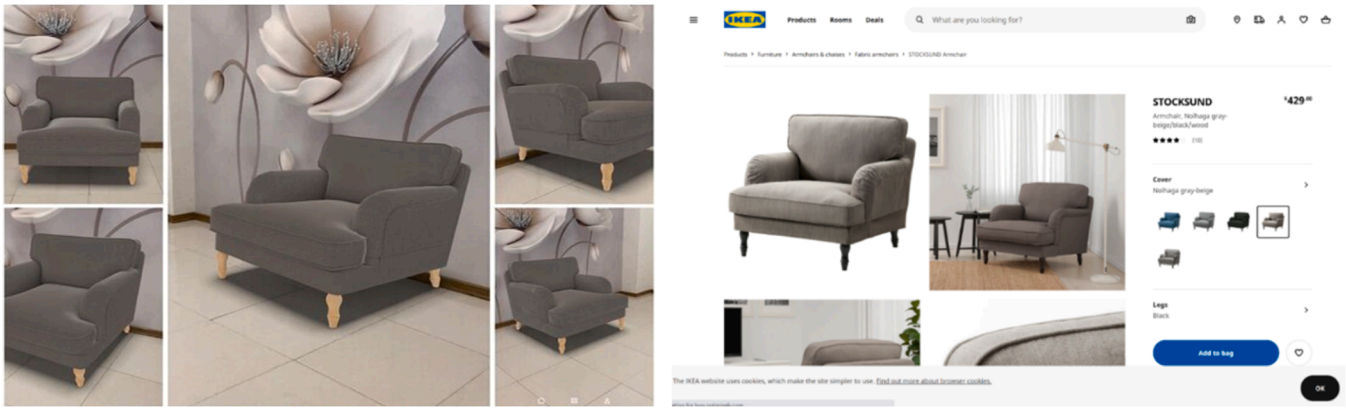

Fig. 2. The IKEA AR product vs. the IKEA Website product.

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