



The Impact of Augmented Reality Marketing on Consumer Behavior: An Integrated Marketing and Economic Analysis of Brand Engagement through User Satisfaction

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Abstract

This paper examines how the consumer behavior of people using augmented reality (AR) marketing attributes, namely interactivity, vividness, and informativeness, impacts brand involvement by generating user satisfaction. Using economic concepts, the analysis looks at how AR can make the decision-making process simpler and increase the willingness to pay as well as the overall consumer value. To this end, SEM and econometric models are used to analyze data collected from 384 users who use the AR mobile applications in Cairo. The results also show that the satisfaction of the user with AR is significantly increased, which leads to a way of stronger brand involvement. Economically, the AR lowers the uncertainty and simplifies decision effort; hence, it enhances consumer willingness to pay as well as their satisfaction. The paper has practical suggestions for marketers and policymakers who are keen on using technology to enhance consumer experience and welfare.

Keywords

Augmented Reality, Interactivity, Vividness, Informativeness, Consumer Surplus, Willingness-to-Pay (WTP), User Satisfaction, Brand Engagement

1. Introduction

Augmented Reality (AR) is a technological system that renders digitally modeled material to a real-life scenario, consequently reformulating consumer interaction in situations of marketing by inculcating notably elemental, interactive experiences. With the help of AR, participants can have the possibility to test prototypes virtually, access detailed product information, and use dynamic and unprecedented interactions with brands. Several companies in the world are currently using AR in activities like virtual fitting rooms, interactive ads, and memorable product showings, which are all geared toward an expanded customer

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response. (Mirza, et al.,2025) described the (AR) “an innovative technology that provides enhanced experience by overlaying virtual information on the live real environment of the user.” It also emphasizes combining 3-D virtual objects with real-world surroundings, enabling real-world interaction with virtual elements.”

The recent transition to AR is especially impressive to discuss, as a recent wave of increased investment funds put into the multidimensional development of AR-based applications has occurred, which was fueled by the rapid rise of AR itself as a global phenomenon (Chekembayeva, Garaus & olmidt, 2023). Well-established businesses such as IKEA, Amazon, Sephora, L'Oréal, Nike, Adidas, and Mini are some of the high-profile businesses that have used augmented reality (AR) to increase the level of realism about their products, improve the intensity of marketing and promotion, and generate interest among consumers. (Archer, 2015).

In recent years, Augmented Reality (AR) has shifted from being an emerging novelty to becoming a necessary trend in marketing, retail, education, and cultural heritage applications. This necessity stems from both push and pull factors. In Egypt, emerging evidence suggests that augmented reality is transitioning from an optional innovation to an expected component of consumer engagement, particularly among younger demographics and in cultural heritage contexts. (Ibrahim & Nasr, 2025). Moreover, Egypt's Ministry of Tourism has implemented an AR project in collaboration with Meta at the Egyptian Museum,¹. The adoption of Augmented Reality (AR) faces several barriers (push factors), both globally and locally particularly in Egypt. These include inadequate internet infrastructure², limited access to free AR applications, insufficient training resources, high device and implementation costs, and the perceived complexity of the technology—factors that often lead users to seek alternative solutions or postpone adoption (Maqsoom et al., 2023; Rauschnabel et al., 2022; Alzahrani, 2020). Conversely, rapid advancements in mobile technology, the

¹ [AR technology helps Egyptian museum visitors see what was lost](#)

² American Chamber of Commerce in Egypt

https://www.amcham.org.eg/publications/industry-insight/issue/41/harnessing-digital-egypt?utm_source=chatgpt.com

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rollout of 5G connectivity, and the development of AR platforms have reduced implementation barriers (pull forces), encouraging businesses to adopt AR as a means of gaining competitive advantage (Caboni & Hagberg, 2019; Rauschnabel et al., 2022). The engaging and informative capabilities of AR significantly enhance customer experiences, particularly in retail, by improving decision-making, product visualization, and overall engagement—key factors that strengthen brand loyalty and purchase intention (Ibrahim & Nasr, 2025; Mussa, 2022). Furthermore, the growing expectations of digitally native generations increasingly position AR as a strategic necessity rather than merely a technological enhancement (Ibrahim & Nasr, 2025).

Businesses frequently employ interactive technologies to generate added value and enjoyment by combining virtual and real touchpoints to improve the consumer experience. (Rauschnabel, Rossmann, & tom Dieck, 2017). Old virtual-reality (VR), augmented-reality (AR), and mixed-reality (MR) technologies can significantly influence customers' experiences (Orús, Ibáñez-Sánchez, & Flavián, 2021).and offer different levels of engagement and experiences that lead to user satisfaction. Accessing VR services often requires specialized equipment, which can create a hurdle for users and may result in lower adoption rates for VR services.

A more accessible alternative is to roll out AR services. Most people can easily use AR applications since they already have at least one mobile device. Plus, using AR can help reduce the cognitive dissonance that sometimes hits customers when they make online purchases (Barta, Gurrea, & Flavián, 2023). This dissonance can lead to buyers regretting their choices or even abandoning their purchases altogether. Customers frequently give up on or regret their purchases once dissonance has occurred (Hasan & Nasreen, 2014) .For instance, AR technology can integrate the display of products into real-world settings and provide consumers with more details about the products they are viewing through AR filters (Lavoye, Mero, & Tarkiainen, 2021) As a result, AR should lessen consumers' perceived risk and cognitive stress (Barta, Gurrea, & Flavián, 2023, enabling them to make better decisions with greater comfort (Wang & Wang, 2022) and confidence (Kowalczyk, Siepmann, & Adler, 2021

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Increased customer engagement will occur because of improved user satisfaction with AR experiences (McLean, & Wilson (2019). Their ongoing rise has been made possible by the growing number of industry participants adopting AR-related technologies as their applications in a variety of industries (such as e-commerce and educational training) have expanded. These technologies can be employed to create new business models, combine online, and offline commerce (Arghashi & Yuksel (2022). As a result, the industry's growth has been impacted by AR's rapid growth, which has motivated businesses to improve their operations using AR technologies to satisfy consumer needs (Jiang, Wang& Yuen, (2021).

The appearance of augmented reality (AR) radically transforming digital commerce and consumer behavior, giving rise to a series of novel and interesting applications and new business models. Among the world-leading brands such as Amazon, IKEA, BMW, LEGO, Target, Nintendo, Starbucks, and Toyota, tools such as AR have been implemented on the platforms, which provide highly advanced, interactive technology spheres bridging the gap between networking and reality. The current research highlights three critical attributes of AR technologies: interactivity, vividness, and informativeness. The use of AR-based commerce applications produces various levels of satisfaction, which is explained by different aspects of experienced quality. The experience of users with AR components is dynamic in that it varies greatly with time. Despite this heterogeneity, the empirical comparisons of the relative importance of various AR attributes are still limited in their structure and generate a visible gap in research. It is crucial to conduct systematic research on the fundamental aspects of AR technology, since they have proven ability to determine the user flow and satisfaction in the digital shopping mediums.

Although improvements in interactivity and novelty have been well-documented, works of scholarship impart scant understanding about the economic implications of augmented reality. This can be achieved by including elements of economics like consumer surplus, willingness-to-pay, and cognitive decision-making in determining the value of AR and its performance. Combining these economic views, marketers can obtain strong reasons to invest in technology, while policymakers can obtain important information regarding the improvement of consumer welfare.

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Previous studies on AR marketing have predominantly examined consumer perceptions, engagement, and experiential value (Javornik, 2016; McLean & Wilson, 2019; Rauschnabel et al., 2022), with relatively fewer investigations into economic outcomes such as sales performance, ROI, and long-term profitability (Caboni & Hagberg, 2019; Scholz & Duffy, 2018; Hilken et al., 2017; Patnaik et al., 2024)

This gap suggests a need for more empirical research linking AR marketing initiatives directly to measurable financial performance, particularly in emerging markets like Egypt.

We can find limitations in Past studies in exploring the AR attributes of interactivity (Ramdani et al., 2022), vividness (McLean & Wilson, 2019) and information content (Orús et al., 2021). Furthermore, there is a paucity of research in applying the effect of augmented reality marketing (AR) attributes on both user satisfaction (US) and brand engagement (BE) particularly in the optics industry. Therefore, the objectives of our current study are:

- (1) identifying the influence of interactive, vivid, and information attributes of augmented-reality (AR) elements of mobile apps on user satisfaction and brand engagement.
- (2) The second purpose was to evaluate the degree in which customer satisfaction interacts with the relationship between augmented-reality attributes and brand engagement. The economic impacts of increased user satisfaction pertaining to consumer surplus and willingness-to-pay, and cognitive ease of choice were further examined through empirical analysis.
- (3) Lastly, the paper identified the individual AR attributes, which have the most relevant effect on satisfaction.

2. Literature Review

Augmented reality (AR) is the modern era of technology, which amalgamates physical reality and virtual objects to create an interactive user experience of high complexity (Carmigniani et al., 2011). An imaginary situation considers the overlapping of digital content information, which can be text, imagery, or video, onto a visible part of the physical world. We can move among this virtual layer with a range of devices: smartphones, tablets, wearable headsets, and even stationary screens and projectors.

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With such flexibility, studies on AR have increased, especially in computer science and human-computer interaction. This increased interest on the part of scholars, as well as the accompanying commercial interest, demonstrates that technology is becoming more important.

Recent market analyses indicate a strong upward trajectory in the augmented reality (AR) software and services sector. the AR software and services revenues will reach approximately US \$33.1 billion in 2024, with continued expansion expected beyond that year (ABI Research, 2024). In parallel, we can forecast growth from US \$28.63 billion in 2024 to an estimated US \$45.14 billion in 2025, (The Business Research Company, 2024). These forecasts highlight the accelerating integration of AR solutions across both enterprise and consumer applications.

The forefront technology-based companies, including Google, Apple, Amazon, and Facebook, have therefore incorporated AR systems to enhance customer interactions, support brand awareness, and build customer loyalty (Guo & Zhang, 2024) .The data provided by consumer surveys also confirms this trend, proving that around 75% of product consumers expect to see the implementation of AR in web-based shopping, and 71% of respondents state that they would shop at retailers using AR more often (Sarkis,et al.,2025) These numbers, therefore, pose an undisputed need for corporate integration of AR in the current marketing approaches (Guo & Zhang, 2024).

Depending on the source, all major scholarly studies prove that augmented reality (AR) is on the brink of booming development, The economic potential of AR is significant, with estimated annual revenue of about \$33 billion in 2019, projected to rise to between \$50 billion and \$100 billion by 2026. (Guo & Zhang, 2024). This growth cannot be restricted to sales volume-driven only; instead, it is supported by a growing tendency within the consumer base to allocate purchasing premiums in favor of goods and services presenting a more comprehensive impact on experiences. As such, AR does not only serve as a highly effective piece of technology but also as a value-creation tool in and of itself, where high-quality experiences of customers cause a firm to opportunistically invest in experiential technology. (Guo & Zhang, 2024).

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The current review synthesizes the literature of marketing science, psychology, and economics to provide a theoretical discussion on the approach to analyzing the mechanism of the impact of AR on consumer behavior. The research interrogates the influence of underlying AR characteristics on preparing the grounds, user gratification, brand involvement, and the advancement of psychological processes in sheer economic terms like consumer surplus and willingness-to-pay. The analytic chain entails the critical evaluation of relevant AR attributes coupled with economic theory, the development of a synthesized conceptual framework, and the expression of a sequence of hypotheses that can be tested empirically.

2.1 Augmented Reality Attributes in Marketing

This section meticulously defines and discusses the core attributes of Augmented Reality (AR) most relevant to marketing and consumer behavior: Interactivity, Vividness, and Informativeness. It then explores how these attributes contribute to user satisfaction and brand engagement. Augmented Reality (AR) is widely recognized in marketing literature for its ability to enhance consumer experiences. AR is defined as an emerging technology that “overlays the real world with imaginary or fantastical elements.” It allows computer-generated content to interact with actual items in real time, bridging the real and virtual worlds. (Angra, et al.,2025). The seminal definition by Azuma et al. (2001) describes AR as the co-existence of virtual and real environments with interactive alignment and synchronized integration of computer-generated content into the physical world—distinguishing it from virtual reality through its embeddedness in real-time contexts. AR devices, being portable and wearable, offer high mobility and adaptability (Reitmayr & Drummond, 2006).

Building on this foundation, AR applications can be understood as software systems that overlay contextually relevant digital content—such as text, images, and 3D models—onto users’ physical surroundings in real time, enabling seamless interaction between virtual and real elements through sensors, computer vision, and display technologies (Azuma et al., 2001; Carmigniani et al., 2011). By merging digital elements with consumers’ perceptions of physical objects and environments, AR enriches product and service information, facilitates effortless interaction, and fosters both online engagement and unique, immersive on-site experiences (Javornik, 2016; Yuan et al., 2021).

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2.2 Strategic Marketing Advantages of Augmented Reality (AR)

Here are some advantages of Augmented Reality (AR) in marketing: it enriches sensory engagement through immersive and informative experiences, fostering stronger consumer participation and deeper emotional connections with brands (Du et al., 2022). It also boosts engagement by enabling interactive, personalized product exploration, which increases attention, extends interaction time, and elicits more favorable responses (Thakkar et al., 2023). Furthermore, AR improves decision-making and reduces uncertainty through realistic, context-specific product previews—leading to fewer returns and higher customer satisfaction (Panzai et al., 2025). Economically, AR generated \$33 billion in net benefits in 2019, with projections of \$338.1 billion by 2025 and \$1.09 trillion by 2030, underscoring its transformative potential (Du et al., 2022). Its adoption across sectors such as retail, tourism, and advertising enhances perceptions, purchase intentions, satisfaction, loyalty, and willingness to pay, while enabling brands to differentiate through innovative experiences that strengthen identity and competitive advantage (Thakkar et al., 2023).

2.1.1 Interactivity

Interactivity of Augmented Reality (AR) involves enabling the possibility of dynamically and in real time interacting with virtual objects placed within real-world environments [1]. The capability enables the users to interactively manage and investigate virtual objects by themselves, hence significantly enhancing their engagement in brand-related online activities (Dong & Wang, 2024). AR apps traditionally make wide-ranging interactive experiences possible, which enable users to search for products imaginatively Yang & Lin, (2024).

Interactivity can be defined in numerous ways; however, Yim et al. (2017) provides an inclusive definition of interactivity that allows understanding of its place in the operationalization of AR effectiveness: (1) as a technology output; and (2) as a user perception. Interactivity is defined by scholars who emphasize the significance of technological characteristics because of the properties of the technology (Downes & McMillan, 2000; Steuer, 1992), as the technology's ability to enable users to interact with and engage with content more easily (Hoffman & Novak, 1996). A prior study has also uncovered a new facet of interactivity that has been dubbed "communication." This facet is defined as the means by which users feel a website is capable of two-way communication (Song & Zinkhan, 2008).

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Research consistently shows that interactive AR experiences positively influence consumer brand engagement (CBE) (Dong & Wang, 2024). This effect comes from AR's ability to enrich interactions between consumers and products, creating stronger emotional connections with brands (Kumar et al., 2024). This interactivity gives pleasurable but useful user experiences that eventually lead to increased user satisfaction, engagement, and improved attitude towards the brand Scholz & Duffy (2018).

Complex empirical research shows that the interactive characteristics of AR contribute significantly to an increase in the perceptions of psychological ownership and attachment to brands, more than CBE. In cases where consumers get to interact with the products in their personalized worlds, e.g., through virtual try-ons, consumers begin to feel like owners in advance (Kumar et al., 2024). This psychological connection goes beyond direct interaction, which gives one a feeling of control and belonging. In theory, psychological ownership turns brief interventions into a long-term affair, thus developing brand loyalty (Yang & Lin, 2024). On the part of marketers, these details allow avoiding buying procrastination, increasing the conversion rate, and reducing buyer's regret. Since consumers tend to associate with products prior to making a purchase decision, the firms must develop the AR experiences that would be proactive in terms of developing a sense of ownership, which would eventually deliver long-run customer loyalty and lifetime value.

The ability to have an AR has taken on a central role in building trust and credibility in a digital setting, and this trend is exacerbated in cases where there is no face-to-face contact. Replicating first-hand experience and creating an illusion of direct, respectful communication, AR facilitates the interaction reminiscent of a face-to-face one, creating a sense of trust and validating brand validity (Kumar et al., 2024). These effects overcome the lack of credibility normally attributed to digital marketing and introduce stronger brand reputation and brand equity in the new media. In addition, augmented trust assures consumers of getting information that is clear, and thus the product information that is obtained can be viewed as conveying to the consumer a lower perceived risk of the product, particularly with high-value or complex products. As a result, the need for post-purchase intensive assistance will drop. (Arya, et al., 2025).

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2.1.2. Vividness

The interesting thing is that the ability to create a rich sensorially mediated environment is how Steuer (1992) conceptualizes vividness, which is the power of a technology to create a rich mediated environment. The vividness by associating the sensory attributes of the existent real-world objects with the no sensory attributes of imagery objects during the establishment of the integrated cognitive representation is characteristically detailed and noticeable. Flavian et al. (2017) push the definition further to suggest that vivid information, which can be represented in visual images, audio-visual stimuli, and colored examples, contains an experiential element that triggers the tangible and embodied dimensions of a buying decision. In the virtual environment, vividness is presented in an aesthetic attraction and the degree of faithful product presentation (Flavian et al., 2017; Griffith & Gray, 2002). By making products eloquent, the consumers are intellectually interested, more information related to products is thought about, and consumers take more time to consider before purchasing them (Jiang & Benbasat, 2007; Keller & Block, 1997; Nisbett & Ross, 1980).

Consumer behavior is attracted by vividness, which is very noticeable. The phenomenon of the virtualization of environments is amplified using Augmented Reality (AR) environments whose graphical stimuli are superimposed on real ones, thus providing consumers with seemingly true-to-life product experiences, as when consumers can apply makeup in the AR environment virtually (McLean & Wilson, 2019; Yim et al., 2017). Richness of senses that come with vividness can support the emotional and hedonic aspects of consumption, create affective commitments and drop out of utilitarianism, increasing brand favorability. Widyastuti, (2024).

Marketers hence need to emphasize high-fidelity visual and sensory design in AR apps. Vividness investment can bring significant payoff in emotional brand attachment and hedonic value, which are strong drivers of brand loyalty, positive word-of-mouth, and brand advocacy and brand engagement. This indicates that the effectiveness of AR marketing is not only dependent on functional utility but also on the excellence of the sensory and emotional experience it provides, possibly warranting increased development and content creation expenses Negm, (2025).

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2.1.3 Informativeness (Information content in AR)

The utility of information is its ability to be utilized by consumers in making purchase decisions (Du & Wang 2022). It has a one-on-one relation to the content-related information or the data-related experience that is illustrated on the screen (Liao, 2019). In the augmented-reality (AR) setting, the term represents the precision, accessibility, and customized and topical product information presented to a user (Yoo, 2020). Studies show that completeness and relevance of the information are both factors that are considered markers of the quality of information content (Mittal et al., 2021) In this regard, the quality of information contained in technology and the usefulness of the means, on the one hand, and precision, timeliness, clarity, and ease of perception, on the other, are optimized by the AR mobile applications (Kim et al., 2016). Proper and relevant information displayed using AR systems makes the deliberations of the customers easy and finally determines the purchasing behavior of the customers.

Additionally, the degree of informativeness will have a heavy bearing on consumer behavior. Information about products delivered through AR reduces the uncertainty of options available and increases familiarity with the existing options, thus leading to making optimal decisions and ultimately increasing customer satisfaction (Candraputri & Tjhin, 2021). At the consumer level, AR is viewed as a resource for decision-making on buying decisions, thus increasing the degree of trust and perceptions of control. This capability is expected to make mobile shopping a much better experience Yoo, (2023).

A critical function of AR's informativeness is its role in reducing product-related uncertainty and instilling purchase confidence. This is beneficial for less popular, or high-priced products. This reduction in uncertainty is a key factor driving increased sales Scholz & Duffy (2018). Furthermore, AR informativeness, alongside vividness and interactivity, contributes to the development of utilitarian values (Kumar et al., 2024).

Information asymmetry refers to the state of the economy in which one party participating in any transaction has a command of knowledge way ahead of the expectations of the other party, thus often creating inefficiencies in the market or low consumer choices. Augmented Reality (AR) technology is ideally placed in

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the position of correcting this imbalance since it is a technology that gives consumers product information in a real-life context, creating an information deficit in the minds of buyers (Sergio et al., 2022; Jung et al., 2021). As a result, the increase in buying confidence and the decrease in the sense of risk are among the typical consequences (Alimamy et al., 2018). The subsequent decrease in information asymmetry should lead to more productive market outcomes because consumers will have better tools to measure the actual value of the product. According to empirical studies, AR can reduce product return frequency, although literature mentions that it leads to a 50-70% reduction, which brings significant financial advantages due to a reduction in logistics, restocking, and refund spending. Also, AR can help resolve the moral hazard by making the nature of products and their usage clear before acquisition, which promotes a more reliable and transparent market space. (Reasor, 2022), (Sergio et al., 2022).

2.1.4 User satisfaction

User satisfaction according to the conceptualization of the scholarly field in question refers to the difference between initial expectations of a user in relation to a product or service in question and the quality or performance of an entity in question observed (Park, 2020). Satisfaction is achieved in the mind that the users have when using the system that the attributes given by the system satisfy their expectations or even exceed them. The construct has also been studied in many different settings, including the use of augmented-reality (Jiang et al., 2021), (Barhorst et al., 2021), wearable technological (Park, 2020), mobile-application (Chekembayeva, et al., 2023), and digital-learning systems and e-book systems (Huang, 2017). On the one hand, in the context of AR settings, the results are consistent in stating that satisfaction acts as a predictor of the retention and further adherence of the user (McLean & Wilson, 2019; Jiang et al., 2021; Barhorst et al., 2021).

2.1.5 Customer Brand engagement (CBE)

Customer Brand Engagement (CBE) is interpreted as a combination of successive customer and organization encounters that enhance the emotional, psychological, and physical investment of the customer in the brand (Harmeling et al., 2017). By adopting the augmented reality (AR) technology, cognitive

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engagement (e.g., feeling of being immersed in the experience) as well as affective engagement (e.g., liking the experience) could be aroused in users (Jessen et al., 2020). The empirical study reveals that the CBE aspects of conscious attention, affection, participation, and social connection have a positive impact on Behavioral Intention to Use (BIU) (Paruthi et al., 2023; Song et al., 2023). In this vein, AR apps allow companies to communicate with customers better and influence their first usage of the technology and their subsequent use of it (Zeng et al., 2023).

2.1.6 Customer Satisfaction and Customer Engagement

Customer satisfaction is referred as the most likely outcome of customer engagement both among new and current customers (Hollebeek, 2011). Some previous studies that have focused on the relationship between customer engagement and satisfaction show that customer satisfaction emerges as a consequence of customer engagement (Brodie et al., 2013; Vivek et al., 2012). According to Kim et al. (2016), customer engagement over mobile technology leads to satisfaction.

Several prior studies have established that customer satisfaction is a result of customer engagement (Brodie et al., 2013; Jones & Suh, 2000; Spiteri & Dion, 2004). Conversely, other research has demonstrated that customer satisfaction can also serve as a precursor to customer engagement (Bowden, 2009; Kim et al., 2016; Van Doorn et al., 2010). Additionally, Sashi (2012) argues that satisfaction represents an overall evaluation of the customer's experiences, rather than being confined to a single transaction.

What makes AR groundbreaking is its ability to move marketing from transactional into deeply relational. The potential of Augmented Reality to create deeper emotional engagement and to drive brand loyalty and connectiveness has changed how companies need to interact with the consumers (Ewis, 2024). The perceived fun experience with AR and games that is also related with positive brand attitude reinforce the shift as well. (Tunnufus et al., 2024).

Prior studies have asserted that customer satisfaction has a relationship with customer engagement (Thakur, 2018; Gopalakrishna et al., 2017; Carlson et al., 2017; Simon and Tossan, 2018). have highlighted that customer satisfaction is a moderate variable of the link between the value in brand experience and customer engagement.

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Moreover, Simon and Tossan (2018) argue that customer satisfaction is also an antecedent of brand Facebook page engagement. Accordingly, when a customer is satisfied with the product or brand, it will have an impact on his/her engagement with the brand/ product. In addition, Thakur (2018) has examined the positive and significant relationship between customer satisfaction with retailer and customer engagement with the retailer mobile apps. He asserts that customer engagement will increase when the customer is satisfied with the retailer product and service.

This has great economic effects on firms. Elevated brand loyalty impacts directly on the number of repeat purchases and higher customer retention rates, lowering the customer acquisition costs that enhance profitability in a looped way. The more loyal customers are, the more they will positively share word-of-mouth to become advocates of the brand which leads to organic growth and sustainable competitive advantage for the firm. The strategy changes from maximizing conversion rates per transaction to maximizing the whole customer journey and long-term brand equity, hence stable and predictable revenue streams. (Kumar& Reinartz 2016).

2.1.7 Previous Research on Augmented Reality in the Egyptian Context

Although global research on Augmented Reality (AR) has advanced significantly over the past decade, studies examining its application within Egypt remain relatively scarce. Nevertheless, a growing body of work has explored AR's potential to enhance user engagement, education, and commercial activities in the Egyptian setting. Here, we review some of the previous studies conducted in the Egyptian context. Mussa (2022) investigated the influence of AR on customer experience and its subsequent impact on purchase intention, revealing significant mediation effects whereby AR enhanced both experiential value and purchase intention. Similarly, Diaa (2022) applied the Technology Acceptance Model (TAM) to assess a cosmetic AR mobile application, focusing on key attributes such as interactivity, vividness, and novelty. The study found that these attributes positively influenced brand engagement, with perceived usefulness, ease of use, and enjoyment serving as mediating factors. Elsayaf and Barbar (2023) examined a novel Egypt-based AR mobile application that enables customers to virtually try on clothing, thereby addressing the gap in the online fitting

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experience. In another study, Mohsen et al. (2023) explored the effect of AR on purchase intention among online furniture shoppers, demonstrating a significant relationship between AR usage and purchase intention. Their analysis further identified the roles of perceived ease of use, perceived usefulness, perceived enjoyment, and perceived augmentation as key dimensions shaping these outcomes. Attia and Dinana (2024), employing a mixed-methods approach (interviews and surveys), investigated how Egyptian retail brands can integrate virtual commerce and AR alongside physical retail. Their findings highlight the complementary nature of these channels in enhancing consumer behavior and purchase intentions. Ibrahim (2025) targeted Generation Z consumers in Egypt, concluding that incorporating AR into the retail mix significantly improves behavioral intentions, particularly by boosting engagement, informativeness, and playfulness—effects moderated by technology readiness. Lastly, Hassan et al. (2025) examined the impact of AR application features—quality, interactivity, vividness, and novelty—on electronic word-of-mouth (EWOM) behaviors. However, realizing these economic benefits requires overcoming challenges such as limited AR infrastructure, high deployment costs, and the scarcity of specialized human capital. Targeted investment, public–private partnerships, and supportive regulatory frameworks are therefore essential to fully leverage AR’s economic impact in the Egyptian context, specifically opinion giving and opinion passing, among Egyptian AR app users. The study confirmed a strong association between these AR features and EWOM activity. However, realizing these economic benefits requires overcoming challenges such as limited AR infrastructure, high deployment costs, and the scarcity of specialized human capital. Targeted investment, public–private partnerships, and supportive regulatory frameworks are therefore essential to fully leverage AR’s economic impact in the Egyptian context.

2.2. Economic Theory and Consumer Behavior

This section integrates economic theories and concepts to provide a comprehensive understanding of how Augmented Reality influences consumer decision-making and market dynamics.

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2.2.1. Consumer Decision Theory and Cognitive Dissonance

Conventional economic theory, in view of making a model typical of perfectly rational agents, assumes that consumers by default weigh costs and benefits before making any decision. Behavioral economics makes an entry here by deviating from conventional wisdom and shows that decision-making is a product of cognitive biases, emotions, and social environment DellaVigna, (2009). Cognitive dissonance as described by Festinger (1957) is the mental anguish experienced when one's beliefs, attitudes or values are discrepant with one another or when their actions are incongruent with those of their self-concept. People tend to rationalize, justify or change their beliefs, attitudes, values or actions (Harmon & Mills, 1999). Individuals try to rationalize, justify, or even change their beliefs, attitudes, values, or behaviors in the face of what is now termed cognitive dissonance Cooper (2007). The phenomenon has a very important impact on consumer behavior at two stages of the process:

- **Post-purchase dissonance** also known as buyer remorse, refers to a mental and emotional state that arises following a consumption transaction whereby the consumer would question the appropriateness of the purchase or be given negative information about the item or service. Faced with such skepticism, people can consult some outside authorities, suppress or discount the disconfirming evidence, or go through the steps of a return or an exchange to end the conflict (Patnaik et al. (2024). According to empirical evidence, the use of virtual try-on technologies combined with a full product visualization may reduce a return rate by 50-70 % and at the same time increase satisfaction in consumers, thus post-purchase dissonance. (Song et al. (2023)
- **Choice anxiety or pre purchase dissonance** arises when people must cope with a variety of alternatives and they see positive and negative aspects of each choice. They tend to do so in this sense by employing simplifying tactics, e.g., focusing on price or quality or what they perceive to be popular to decide (Sweeney et al.,2000). Augmented reality platforms offer an opportunity to present all the accurate information and provide potential customers with the possibility of trying a product in a virtual world and, as such, reduce perceived risk and pre-purchase dissonance. Hilken et al. (2017).

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The marketers can also employ the concept of cognitive dissonance in an effective manner. It can be done through pre-purchase creation or enhancement of the dissonance; by emphasizing the positives of their offer and the negatives of those of competitors to make up the non-purchasers (Sweeney et al.,2000). Marketers can alternatively alleviate or avert dissonance after making a purchase by enhancing consumer satisfaction and loyalty since most purchases made by consumers are because of feedback, testimonies, guarantees, or even good after-sales service Javornik (2016). To this end, the power of AR to foster satisfaction and give a buyer more informed and confident buying experience is effective. Moreover, when guided by the knowledge of cognitive dissonance, the AI technologies will be more effective in finalizing the product choice to consumers with the variety of offerings and time of offering, resulting in higher returns.

AR functions as a proactive tool for mitigating post-purchase dissonance and enhancing customer retention Javornik (2016). Post-purchase dissonance, commonly known as buyer's remorse, often leads consumers to seek external validation, disregard negative information, or return products (Sweeney et al.,2000). AR virtual try-ons and realistic visualizations directly address this by reducing return rates and improving satisfaction. This signifies that AR does not merely facilitate a purchase; it actively pre-empts a common post-purchase problem. By providing a highly realistic and informative pre-purchase experience, AR minimizes the discrepancy between expectation and reality, thereby significantly reducing the likelihood of regret or dissatisfaction after the transaction Javornik (2016). This shifts the focus from reactive customer service, which involves handling returns and complaints, to proactive customer satisfaction and confidence building. This has direct and substantial economic benefits for businesses: lower return rates translate into significant reductions in operational costs, including logistics, restocking, and processing refunds, thereby improving profitability. It also strengthens customer loyalty and reduces churn, directly impacting customer lifetime value. This positions AR as a strategic investment in long-term customer retention and operational efficiency, rather than simply a marketing tactic for immediate sales. Patnaik et al. (2024).

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Furthermore, AR is critical in changing the heuristics of the consumer whose choices are based on external stimuli to internal processes. Choice anxiety often makes consumers use mental shortcuts to make complicated decisions, including using price, quality, or popularity, as the criteria of choice. AR however is more accurate hence it allows consumers to literally see what they are buying which they cannot with normal websites, allows consumers to see what they are buying online. This is the real change of the decision-making process. The heuristics of the past rely on signals that are extrinsic and usually very shallow referencing the value of a product. AR, in its turn, enables consumers to experience the product internally even before buying it. People do not have to depend on the popularity of a particular brand or high price as a sign of quality rather they would just be able to test product fit, look and functionality directly in their own setting. This transforms the system of making the choice based on external indicators, to an experiential and educated process of making a choice which is based on personal utility and situational compatibility. This may give rise to more rational purchasing choices, in the behavioral economics meaning (i.e., more-informed and utility-maximizing), which eliminates the excessive influence of marketing manipulation of marketing solely on price or popularity. It equally suggests that a less popular brand that has better quality products or special features that it offers can also use AR in displaying their value effectively which may also break the market chains. To the consumers, it will enable them to make reasonable choices as per their actual needs and tastes, as opposed to being influenced by market cues Hilken et al. (2020).

2.2.2. Behavioral Economics: Risk Reduction and Cognitive Cost

The basic premise of behavioral economics is that the traditional approach to decision-making is based on rationality, which is overly simplistic and does not consider substantial impact of cognitive biases, heuristics, and emotions on consumer behavior Thaler. (2016). It recognizes recognizing that in practice decision making often falls short of purely logical constructs of economics. Cognitive biases were systematic and non-rational deviations in judgment, and it tended to cause consumers to make poor decisions often Tversky& Kahneman (1974). The most important ones are:

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Loss Aversion: It is the tendency to minimize losses as compared to the acquisition of similar gains. According to experimental studies, people tend to be more responsive to possible losses than they are to similar gains and are likely to behave in risk-averse (which is not likely to be optimal) ways consequently Kahneman & Tversky (1979). It is observed that loss aversion has the biggest impact on consumer choice of 40 % Tversky & Kahneman (1991).

- **Anchoring Bias:** This bias happens when consumers become excessively dependent on the first information given to them as in alluring first price offer which then makes them make decisions Tversky & Kahneman (1974).
- **Framing Effects:** The way a choice or information is aired may have significant influence on the taste of the consumers, despite the same underlying membership Levin et al. (1998)
- **Mental Shortcuts (Heuristics):** Human beings are likely to make decisions through mental shortcuts instead of undertaking long rational, optimal thoughts Gigerenzer & Gaissmaier (2011).

Behavioral economics highlights that mental biases and framing effects play a key role in determining risk (Levin et al., 1998). The implications that loss aversion has on risk assessment is that one becomes more sensitive to losing than to gaining which can cause a person to make risk-averse decisions when that is not the most rational regardless of the situation Tversky & Kahneman (1991). Cognitive costs or cognitive loads are also applicable; when there is too much information, the consumer is more likely to become overloaded and then turn to heuristics and biases and make poor decisions Sweller (1988).

AR is also an essential way of addressing risk and cognitive cost. It greatly minimizes uncertainty about the product and creates confidence in buying especially high-priced, less sought out or niche products, as well as, to people who are new to a set of online channels or a product type (Hilken et al. ,2017). This refers directly to consumer risk aversion. AR will allow the consumers to see the product almost in their houses without any doubt concerning the appearances of the product or its size (Javornik, 2016). In turn, the main advantages of AR include the following: "better decision-making opportunities," "saving time," and "decreasing risks". The decisions also improve the decision

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comforting, as the decision has less burden and is easy to make (Rese et al.,2017). Moreover, the AR offers online buyers to conceptualize their purchasing and remove the doubts left about online shopping and increase consumer trust (Pantano & Servidio, 2012).

AR leads to a behavioral nudge that hibernates risk averse consumers, enabling new segments of the market. It is true that loss aversion is one of the crucial factors, which are driven by behavioral economics and thus people are more frightened by the risk of loss compared to that of similar gain achievement (Kahneman & Tversky,1991).AR can directly reverse this in that it offers a sense of safety when undergoing a virtual trial; it is essentially like removing the high risk of an unpleasant buying experience, i.e. a piece does not fit and/or look as if it appears on the screen (Hilken et al., (2017). This is a potent behavioral nudge, and it makes purchases that were unsafe initially, such as furniture or luxury cosmetics purchased online, become more digestible and lower the psychological price of such purchases. This capability of de-risking enables companies to enter new market segments, or to make more sales in established ones, hitherto limited by consumer fear. It can liberalize the growth of products with high levels of inability of information where difficult markets become lucrative possibilities as an example, a client who would not dream of ordering a piece of furniture online because they must worry about how it fits, would be ready to do just that with AR. This increases the overall addressable market and causes a major competitive advantage to the brands that can use AR to de-risk the buying process, which could result in a large amount of revenue and market share. Javornik (2016).

Moreover, AR proves to be efficient in load reduction of the mind and makes the decisions satisfyingly and quicker. AR provides more "decision comfort," time savings, and better decision-making by decreasing cognitive load. Conventional online purchasing can also be mentally taxing, prompting custom practice, decision-making, and the ability to pick out objects inside of two-dimensional photos contrasted with complicated specifications or visualize the fit. AR makes this easy by being able to easily answer many questions that people commonly want to answer, like, "How will this couch fit in my living room?" This considerably cuts the intellectual stress and mental work involved in making the

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decision; it makes the whole stress-free shopping process a little easier. A decrease in the cognitive load might result in a shorter time of making conversion rate (Rese et al., 2017). It also leads to increased satisfaction of the users, seeing how much easier and more efficient the process is. This means that it reduces friction in the sales process as far as businesses are concerned, there are chances of increased levels of sales since the rate of abandonment at the decision stage is lowered, and there are better customer experience scores. It means that the utility of AR goes further than just depicting products; rather, it concerns the optimization of a decision-making process in the mind of a consumer. (Rauschnabel et al., 2019).

2.2.3. Market Dynamics: Information Asymmetry, Competitive Advantage

When one party in the economic transaction has more important material knowledge than the other or when one party is suspected to have material information not known to the other is called information asymmetry or information failure Akerlof (1970). Such asymmetry normally arises when a seller of a commodity or a service possesses more information compared to the buyer, though an opposite relationship may also be found.⁹ This is the case in almost all the transactions in economics. (Stiglitz, 2000)

The consequences of asymmetry regarding the information in the market are immense. This asymmetry of the information causes inefficiency in the market and inefficient decision-making, an issue notoriously brought into the forefront in George Akerlof classic of the lemon market Spence (1973). In a condition of asymmetric information, a seller and a buyer can misrepresent the price by not revealing important information about the product in terms of quality or risk, which may lead to inefficient or unethical distribution of resources. There are two typical issues created by information asymmetry:

Adverse Selection: This is the biases where one party to the transaction tries to make use of asymmetric information and typically this happens by one of the parties hiding vital datum concerning risk. One of them is where a patient conceals health conditions when applying a policy Stiglitz (2000).

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Moral Hazard: Moral Hazard is described as those events wherein actions or behavior undertaken by one party of a transaction or a transaction change after a transaction has taken place and usually these changes because of less risk or less consequences. As an example, a resident who has flood insurance may not engage in efforts to mitigate floods Stiglitz (2000)

Augmented reality specifically works to solve these problems as it reduces information asymmetry and develops a new source of competitive advantage. As it is explained in the section of its informativeness, it can create rich and accurate product knowledge, which directly decreases the knowledge gap between the seller and the buyer in AR Scholz & Duffy (2018). The fact that AR enables consumers to virtually touch items, to simulate their use in their own surroundings, and gives detailed product specifications in a three-dimensional way aligns more efforts towards increasing transparency and trust, which completely offsets market-in-lemon-type issues where quality of goods is ambiguous.

This reduction of information asymmetry is available as a major competitive advantage of brands (Hilken et al., 2017). Consumers are perceiving less risk when the information that the product wants to convey to them is presented through AR, making it possible to present formulas to stand out in crowded markets and gain additional customers, possibly at a price premium of the product. With AR the increase in experience/decrease in uncertainty creates an expansionary bias on the product, resulting in a price that is more easily accepted by the consumer (Javornik, 2016). This provides them with a competitive advantage over competitors who use the old-fashioned less transparent marketing technique. AR changes the nature of competitive relations by making the quality of the informational and experience interaction rather than price or simple features a source of competition (Rauschnabel et al., 2019). This builds a new base of competitive differentiation, where brands can establish better relationships with consumers under the basis of trust and excellent knowledge of what products may do. Pantano & Servidio (2012).

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3. Integrated conceptual Model and Hypotheses

3.1. Marketing-Economic Integrated Model

A general idea of the complex relationship between the Augmented Reality marketing, consumer behavior, and economic outcome cannot be resolved without a comprehensive theoretical approach to the problem, that is why an integrated one is suggested. The conceptual framework established in this model connects the attributes of AR to the aspects of user satisfaction and brand engagement and then links the marketing constructs with the main economic variables that are related to consumer surplus and willingness-to-pay (McFadden, 2001). Although this type of model would normally require a visual representation, the pathways and relationship are outlined herein.

Recent studies have demonstrated that several key attributes of augmented reality (AR) experiences—**interactivity**, **vividness**, **novelty**, and **informativeness**—play a critical role in fostering customer–brand engagement. For example, Negm (2024) found that these AR attributes generate both **utilitarian** and **hedonic** values for consumers, which in turn lead to deeper content creation and brand-related interactions. Similarly, (Attri et al., 2024) confirmed that the vividness, novelty, and interactivity of AR experiences significantly enhance both functional and emotional customer responses, reinforcing their intention to engage with the brand and continue using AR attributes. Furthermore, Mohamed, (2022–2023) highlighted the importance of interactivity and vividness in strengthening users’ engagement by increasing pleasure and understanding.

Based on the above, it can be concluded that the researchers prioritized the selection of the most relevant attributes of Augmented Reality (AR)—namely, interactivity, vividness, and informativeness—drawing on insights from previous literature and considering the specific context of the optical retail sector.

According to the model, there are three attributes of AR, namely: Interactivity, Vividness and Informativeness, which will act as the cornerstones of consumer perceptions and experiences. These factors, in their turn, cause increased User Satisfaction. As an example, perceived enjoyment and safe judgement tend to result in satisfaction, which is the major inclusion of perceived enjoyment and informativeness properties of vividness and detailed information, respectively. On the same note, the responsive interaction provided by interactivity will enrich the end user experience, which in its nature will define the conduciveness of satisfaction by perceived ease of use and the usefulness of the same.

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This elevated User Satisfaction, in turn, can be taken as an essential mediator that has a positive impact on Brand Engagement. A pleasant shopping experience, especially the one associated with AR, promotes a closer emotional attachment to the brand and the encouragement to engage in it actively. It is an expression of stronger affiliations, emotional commitment and positive brand direction (Sarkis et al., 2025).

Additionally, it is also evident that the attributes of AR and consumer satisfaction itself will have a definite direct impact on the Economic Outcomes alias Consumer Surplus and Willingness-to-Pay (WTP). Pozharliev et al. (2021) The perceived value of product is boosted by product related uncertainty and confidence in buying it courtesy of AR properties as it facilitates their willingness to pay higher prices. This kind of reduction in the perceived risk hence increasing confidence, also applies to the consumer surplus because they are also gaining more value in a product which will not be risky, and which will be according to their expectations. These economic results are also reinforced through user satisfaction which is the result of positive AR experience. A highly satisfied consumer derives more utility and value of the product, and this may be pointed out in the high willingness to pay and advance in consumer surplus because the anticipated benefits are known to counterbalance the cost at a superior rate. (Scholz & Duffy, 2018), (Poushneh & Vasquez 2017)

The mechanisms like the Means-End Chain (MEC) theory that connects the attributes of a product to the benefits to the consumer and finally to its personal values are implicitly confirming to this integrated model Kumar et al. (2024). The impact of AR attributes (e.g., interactivity, informativeness) is tiled as the means that provide the benefits (e.g., better decision-making, risk mitigation, etc.) that in turn fulfill the consumer goals (e.g., self-confidence, reduced purchase regret) Yang & Lin (2024). In the same way, Technology Acceptance Model, (TAM) explains the route along AR experience to perceive usefulness and ease of use, which are the key determinants of user satisfaction and intent of purchase. Guo & Zhang (2024).

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The conceptual model is presented in Figure 1. The **independent variables** are interactivity, vividness, and informativeness. The **dependent variables** include consumer surplus, willingness-to-pay, and brand engagement. User satisfaction is proposed as a **mediating variable**.

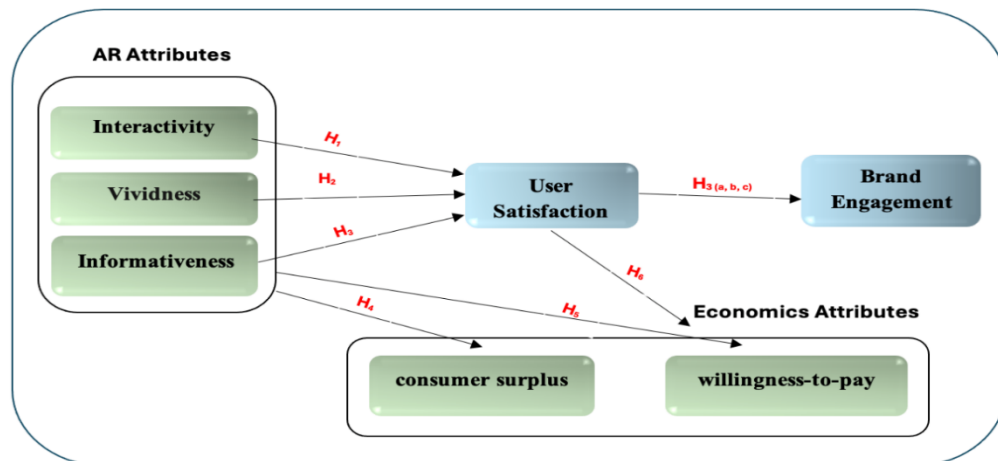


Figure (1): Conceptual Model

3.2 Hypothesis Development

The following hypotheses were suggested in accordance with the integrated theoretical framework and the review of related literature. They have been categorized in two: marketing focused and economic focused results. This has been broken down into sub hypotheses which are meant to capture the different contribution of each AR attribute.

3.2.1 Marketing-Focused Hypotheses

- **The relationship between Augmented Reality attributes and user satisfaction.**

Augmented Reality attributes in this study are interactivity, vividness, and informativeness that the AR applications can offer will make the whole experience more positive and further translate into higher satisfaction among the users. The previous studies show that the vivid content and informative interactions have a strong influence on perceived enjoyment and usefulness, which are the fundamental elements of satisfaction Hilken et al. (2017), McLean and Wilson (2019), Yim et al (2017), Negm, (2025), (Wu& Liu, 2024).

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Based on the above literature, the Augmented Reality attributes are expected to positively influence user satisfaction. Accordingly, the following hypothesis can be formulated:

H1: Augmented Reality attributes positively influence user satisfaction.

To assess the relative contribution of each of the AR attributes, the suggested sub-hypotheses are the following:

H1a: User satisfaction is affected positively by interactivity of AR.

H1b: user satisfaction is positively affected by vividness of AR.

H1c: User satisfaction has a positive outcome to be here on informativeness of AR.

- **The relationship between User satisfaction and brand engagement.**

An enjoyable AR experience helps in building the engagement of emotions and engagement in thought, which encourages the active involvement of the brand. Empirical literature proposes that pleasant experiences affect brand attitude and behavior of loyalty positively (Wu& Liu, 2024), (Negm, 2024), (Zeng et al., 2023). Based on the literature User satisfaction is expected to positively influence brand engagement, the following hypothesis can be formulated:

H2: User satisfaction positively influences brand engagement.

- **The mediating role of user satisfaction in the relationship between AR attributes and brand engagement**

Although the nature of AR attributes can theoretically have a direct positive effect on brand engagement, a sizeable share of that effect should be mediated by user satisfaction. In other words, the satisfaction (H1) is bent by AR characteristics, which, in turn, leads to engagement Dong & Wang (2024), (Lin, & Huang, 2024),(Ganesan & Kumar, 2024) (H2). Accordingly, the following hypothesis can be formulated

H3: The effect of AR attributes on brand engagement is mediated by user satisfaction

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Since we aim to conduct an accurate analysis and isolate the distinct mediating effects of satisfaction for each AR attribute, the hypothesis will be decomposed into the sub-hypotheses as the following:

H3a: Interactivity will be found to enhance brand engagement through user satisfaction.

H3b: Vividness has an influence on brand engagement mediated by user satisfaction.

H3c: User satisfaction mediates the impact of Informativeness to brand engagement.

3.2.2 Economic-Focused Hypotheses

- **The relationship between Augmented Reality attributes and consumer surplus.**

Some of previous studies mention that the developed experience with product trials that is a result of using AR has lessened the amount of time, energy, and effort to decide on time spent, and the perceived value of a product is valued higher than the established price point. Abilities to experience items virtually such as virtual try-ons as well as realistic preview, reduce cognitive and logistic shopping-related costs (Pozharliev et al. (2021). (Nagy, et al.,2022), (Zhang, et al.,2019), Anifa & Sanaji (2022)

Based on the above literature, augmented reality attributes are expected to positively influence consumer surplus. Accordingly, the following hypothesis can be formulated:

H4: AR attributes positively influence consumer surplus.

- **The relationship between augmented reality attributes and willingness to pay (WTP).**

AR creates better perceived value and diminishes the pre-purchase risk and this increases the willingness of the consumer to spend high price, Huang (2021).According to the previous studies, it has been stated that consumers demonstrated higher WTP when the use of AR is included in the shopping process and it takes place in the situation of high information uncertainty (Pozharliev et al. (2021).(Barta, et al.,2023). According to the previous studies, augmented reality AR attributes are expected to positively influence, the following hypothesis can be formulated:

H5: AR attributes positively influence willingness-to-pay (WTP).

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- **The relationship between user satisfaction and both consumer surplus and willingness to pay (WTP).**

The perceived benefits due to higher levels of satisfaction owing to the engagement of AR is greater thus resulting in higher levels of willingness to pay the highest possible price and valued perceived surplus Thaler (1980). (i.e., the difference between value and cost) Huang (2021). This can be justified by the behavioral economic literature, in which satisfaction augments the perceived utility thus propelling surplus and willingness-to-pay (Pozharliev et al. (2021). Accordingly, the following hypothesis can be formulated:

H6: User satisfaction positively influences both consumer surplus and willingness to pay (WTP).

4.1 Research Design

The research methodology is shown in Figure 2. The current quantitative research study makes use of a structured survey design to solve how consumer behavior is determined by Augmented Reality (AR) marketing, using the psychological and economic paradigm. The research Approach in this study employs a deductive reasoning approach, grounded in established theories and empirical research on augmented reality (AR), user satisfaction, and brand engagement. The research seeks to test predefined hypotheses derived from the existing literature, using quantitative data to either confirm or refute these theoretical relationships.

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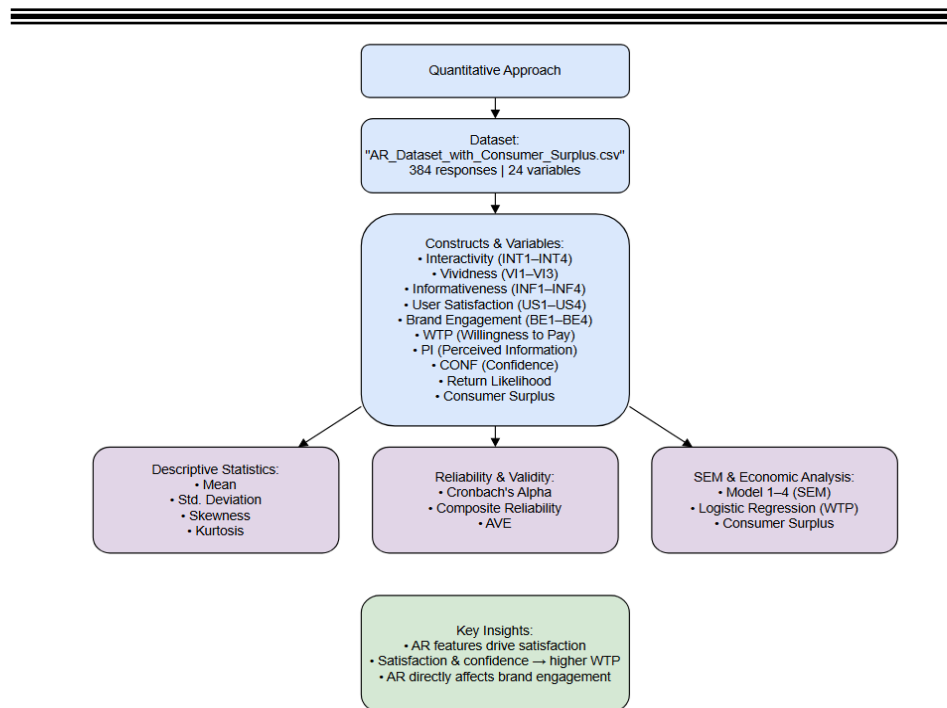


Figure (2): Research Methodology

By adopting a deductive approach, the study remains theory-driven and methodologically structured, enabling the statistical generalization of findings to the broader population. The target population comprises adults 18 years and older residing in Cairo and having regular communication with mobile AR applications of the retail of the optical industry. According to Hair et al. (2010), the purposive sample was used so that the respondents would have first-hand experience of AR relates to a retail setting. The end product includes 384 subjects which are considered sufficient to conduct multivariate analysis through Structural Equation Modeling (SEM). The study will use a cross-sectional design to measure the perceptions of the respondents and their behavioral intentions at one point in time. The proposed model was evaluated in terms of direct links between user satisfaction and consumer surplus and willingness-to-pay (WTP), in accordance with the hypothesis H6 using Structural Equation Modeling (SEM). These paths aim at determining the economic consequences of positive AR experience at least greater increment in perceived value and willingness to pay by consumers.

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4.2 Measurement Scales

The research hypothesized in the present research study operationalized the constructs under evaluation by adopting the multi-item scales that were evaluated in earlier studies. The perceptions of the respondents were captured using the seven-point Likert scale of 1 (Strongly Disagree) to 7 (Strongly Agree) as shown in Table 1.

Table 1: Measurement Scales

Construct	Variable Name	Description/ Sample Items	Source
Interactivity	INT1–INT4	1. The web site responds well to what I do 2. The web site is interactive and alive 3. I receive immediate feedback when interacting with the virtual product (glasses)-try-on function. 4. The virtual glasses-try-on function meets my individual needs	Yim et al (2017), (Jiang et al.,2022)
Vividness	VII–VI3	1. The visual display of the AR technology was clear & sharp 2. The visual display of the AR technology was. was vivid 3. The interface delivers immersive visual experience	Lin& Huang, (2024) and Yim et al (2017)
Informative ness	INF1–INF3	1. The information provided through the augmented reality (AR) interface is perceived as highly accurate &reliable contributing to a high-quality user experience. 2. The information which I receive is relevant to me 3. The information which I receive is useful and informative	(Yoo,2020)
User Satisfaction	US1–US4	1. I find the site pleasant to operate through. 2. I find the site useful, 3. I have great experience with the site overall. 4. I find my overall experience with the site satisfying.	(Yoo,2020) Lin& Huang, (2024)
Brand Engagement	BE1–BE4	1. The use of the website produces a strong emotional attachment 2. Using the website OF (AR) interface makes me have a higher desire to engage with the brand 3. Using the AR attributes on the app stimulates my interest in the brand. 4. I would like to remain engage, loyal with the brand in the long run.	(Lin, & Huang, 2024), Yoo (2020), and (Jessen et al, 2020)
Willingness to Pay	WTP	The maximum amount user is willing to pay after experiencing AR.	Self-developed (based on economic modeling)
Consumer Surplus	Calculated (WTP – Price)	Perceived value above the actual price, derived from subtracting a fixed base price from WTP.	(Xu et al.,2022).; behavioral economics literature
Decision Confidence	CONF	Level of confidence in decisions made after using AR.	(Xu, et al.,2022).
Return Likelihood	Return Likelihood	Likelihood of returning to the same AR app or brand for future purchases.	Inferred; Suggested: Scholz & Smith (2016) or Widvastuti (2024)
Purchase Intention	PI	Likelihood of purchasing the product after using the AR attribute.	Javornik (2016) & Hilken et al.,2017) included in regression analysis

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The measurement items associated with the constructs and related to marketing were the following ones:

Interactivity. Measured using the four items based on the work by (Park& Yoo (2020) and Poushneh (2018), this construct also includes responsiveness, user control, and system feedback. Entries were made on the items like INT1 (The web site responds well to what I do), INT2 (The web site is interactive and alive), INT3 (I receive immediate feedback when interacting with the virtual product (glasses)-try-on function), and INT4 (The virtual glasses-try-on function meets my individual needs.).

Vividness. The visual clarity and realism of the interface were measured with three measurements developed based on the studies by the Flaviian et al. (2019), and Hilken et al. (2017). They involved VI1 (The visual display of the AR technology was clear& sharp), VI2 (The visual display of the AR technology was vivid), and VI3 (The interface delivers immersive visual experience

Informativeness. Contains also three measurements that report the perceived quality, relevance and usefulness of the provided information, as per the pattern of Nikhashemi et al. (2021). They consisted of INF1 (The information provided through the augmented reality (AR) interface is perceived as highly accurate &reliable contributing to a high-quality user experience.), INF2 (The information which I receive is relevant to me) and INF3 (The information which I receive is useful and informative).

User Satisfaction. Being measured by four items that mirror enjoyment, perceived usefulness, and overall experience, based on the scales created by McLean and Wilson (2019) and Poushneh (2018). Items were US1 (I find the site pleasant to operate through), US2 (I find the site useful), US3 (I have great experience with the site overall), and US4 (I find my overall experience with the site satisfying).

Brand Engagement. Measured based on four measurements that diagnose emotional involvement and behavioral loyalty as suggested by Harmeling et al. (2017). These items were BE1 (The use of the website produces a strong emotional attachment) BE2 (Using the website makes me have a higher desire to

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engage with the brand), BE3 (Using the AR attribute on the app stimulates my interest in the brand), and BE4 (I would like to remain engaged, loyal with the brand in the long run).

Economic Constructs:

- Willingness-To-Pay (WTP) was measured by asking the respondent to obtain the maximum price they would feel comfortable after being exposed to Augmented Reality (AR). Such practice follows the previous methodological recommendations put forward by Huang (2021)
- Consumer Surplus is the gap between WTP, and the market price allowed to approximate the vision of the value that consumers held as higher than the market price. Hanemann (1991)
- Decision-Making Effort (or cognitive cost) was measured by asking items reflecting mental effort and ease of evaluation based on findings in the behavioral economic literature Xu et al. (2022).

5. Data Analysis

5.1. Preliminary Analysis

This section provides the first analysis of the data being studied and includes descriptive statistics, the evaluation of reliability and validity. The dataset titled AR_Dataset_with_Consumer_Surplus.csv. The variables deal with the attributes of augmented reality (AR), satisfaction of a user, brand engagement, willingness to pay (WTP), perceived information (PI), confidence (CONF), a probability of returning, and a consumer surplus.

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Table 2: Descriptive Statistics of Variables

Variables	mean	Std	min	max	skewness	kurtosis
INT1	5.78125	1.109683	1	7	-0.96513	1.98929
INT2	5.856771	1.060965	1	7	-0.96396	2.256292
INT3	5.700521	1.129431	1	7	-0.92135	1.806082
INT4	5.979167	1.093338	1	7	-1.05507	1.729726
VI1	5.713542	1.129349	1	7	-0.87313	1.599899
VI2	5.559896	1.190281	1	7	-0.7686	1.165764
VI3	5.869792	1.111875	1	7	-1.05819	2.159921
INF1	5.960938	1.032645	1	7	-0.87979	1.62151
INF2	5.098958	1.408886	1	7	-0.57068	-0.16418
INF3	5.145833	1.382314	1	7	-0.63931	0.272588
INF4	5.739583	1.158416	1	7	-0.73562	0.716206
US1	5.697917	1.012917	1	7	-0.59424	1.353514
US2	5.635417	1.407698	1	7	-1.19614	1.579925
US3	6.057292	1.183811	1	7	-1.35475	2.312844
US4	6.03125	1.197937	1	7	-1.36116	2.182182
BE1	5.885417	1.070563	1	7	-1.04074	2.271142
BE2	5.611979	1.157544	1	7	-0.64505	0.679932
BE3	5.651042	1.164353	1	7	-0.71846	0.748058
BE4	5.953125	1.043638	1	7	-0.97277	1.933935
WTP	5.911458	1.012957	1	7	-1.06398	1.964783
PI	5.559896	1.103782	1	7	-0.7381	0.926136
CONF	5.6875	1.001956	1	7	-0.82927	1.902016
ReturnLikelihood	2.408854	1.111076	1	7	1.138221	2.390964
Consumer_Surplus	-94.0885	1.012957	-99	-93	-1.06398	1.964783

5.2. Descriptive Statistics

Descriptive statistics in Table 2 provides short characterizations of the center of tendency, dispersion, and the form of distribution in each non-categorical variable being investigated. In the analysis here, this procedure was applied on all numerical columns in the data set. The results of the calculations showed the mean value, the standard deviation, the minimum value, the maximum value, skew, and the kurtosis. Together, they provide a rough profile of the nature of the data and in the future identify any anomalies like outliers, distributions which are unusually asymmetric or peaked.

1. Interactivity (INT1–INT4):

Descriptive statistical analysis of the interactivity construct shows mean values between 5.70 and 5.98, thus showing that perception of interactivity in augmented reality (AR) experience by users is high in general. The values of

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standard deviation, which assume values that are between 1.06-1.13 indicate that there will be a moderate number of variabilities in the evaluations made by the respondents. The values of the skewness are a little left-handed (ranged between -0.92 and -1.06), which means that the distribution is skewed on the left and that more participants have chosen to respond to ranges on the high side of the given range. It also shows strong signs of leptokurtic distribution since positive kurtosis values; it implies that responses are concentrated around the mean with very few extreme values.

2. Vividness (VI1–VI3):

The mean scores ranged between 5.56 to 5.87, thus displaying the fact that subjects mainly portrayed a positive view regarding vividness within the augmented reality (AR) surroundings. The results of standard deviation, which was at range 1.11-1.19 depicts that there was a moderate amount of variation in responses throughout the sample.

3. Informativeness (INF1–INF4):

As the results show, the mean values varied between 5.10 and 5.96, with INF1 having the highest mean, thus implying the overall positive perceptions of informativeness. The range of standard deviation was between 1.03 and 1.41, where INF2 and INF3 had a higher standard deviation that means the responses were more spread, which is quite suggestive of hypothesizing more varied opinions or a low-consistent agreement among participants on the studied questions.

4. User Satisfaction (US1–US4):

Mean values ran on the 5.6456.06 range and thus have shown a positive average extent of user satisfaction using augmented reality (AR). Standard deviations were between 1.01 and 1.41 to signify a middle ground of fluctuation in participants' replies and a collective answer of the experience as a resolute agreement.

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5. Brand Engagement (BE1–BE4):

Mean numbers were between 5.61 and 5.95, which is a good indication of strong brand connection. The standard deviations that ranged between 1.04 and 1.16 depict a relatively close distribution of the findings in the evaluation of the participants thus meaning that the respondents have agreed in their evaluations in accessing and activating the engagement appraisals.

6. Single-Item Measures:

In the matter of the outcome variables, Willingness to Pay (WTP) had the average of 5.91 and standard deviation of 1.01, which indicates moderately significant willingness of the respondents to fund the augmented-reality (AR) experience. On the other hand, Consumer Surplus had a mean of -94.09 and the responses were very tight in the range between -99 and -93. That the values of these measures are consistently negative means that the value of the price as perceived (WTP) by participants was lower than the basic price and it might have been possible because some respondents might have had a feeling that the price was overstated, about the perceived values of the offer.

The Purchase Intention (PI) generated a mean of 5.56 and a standard deviation of 1.10, which reflects a quasi-positive attitude in buying the AR product. On the same note, the assessment of confidence (CONF) in their decision making by the respondents was also high with an average score of 5.69 and a standard deviation of 1.00, thus they believed that they were secure and confident in judging the experience. Return Likelihood has the lowest means of 2.41 with a standard deviation of 1.11. The result can be interpreted as a certain hesitation or unwillingness of the respondents to re-experience the AR, which might mean their concerns in the domain of satisfaction, novelty retention or long-run value.

5.3. Reliability and Validity Testing

The validity and soundness of empirical results depend on the validity and reliability of measurements tools. Reliability deals with whether the measurement will be the same or remain the same when repeated and validity deals with whether the instrument goes deep enough into the construct it is meant to measure. Here, internal consistency reliability was assessed using Cronbach's Alpha which is a widely used measure of determining the coherence of multiple item scales.

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There were four constructs that were examined on internal reliability:

- **Interactivity (INT):** Measured through 4 items (INT1- INT4)
- **Vividness (VI):** Assessed with 3 items (VI1, VI2 and VI3)
- **Informativeness (INF):** Consists of four items (INF1-INF 4)
- **User Satisfaction (US):** measured by four items (US1- US4)
- **Brand Engagement (BE):** four items (BE1- BE4)

With the results of Cronbach Alpha being 0-1 as shown in Table 3, a value beyond 0.70 is normally considered sufficient in establishing internal consistency (Nunnally & Bernstein, 1994). The higher the value the more reliable and this means that the test items in each construct can measure the same dimension whenever run. The findings of the reliability test are revealed in the following section:

Table 3: Cronbach's Alpha for Multi-Item Scales

Scale	Cronbach's Alpha
INT	0.8698
VI	0.775
INF	0.7959
US	0.7802
BE	0.8612

Cronbach's Alpha values for all scales are above the accepted threshold of 0.7, indicating good internal consistency reliability for the measures used in this study. This suggests that the items within each scale are highly correlated and measure the same underlying construct. This strengthens the confidence in the composite scores derived for these constructs.

5.4. Structural Equation Modeling (SEM)

The structural equation model (SEM) is a multiple statistic model developed to measure structural relationships between observed data and latent constructs. A thorough SEM process usually requires special software tools and model description. To give an example, the given study will use Ordinary Least Squares (OLS) regression to explore hypothesized relationships.

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Model 1: AR Attributes → User Satisfaction

This model examines the indirect influence of AR marketing or rather its interactive functions, vividness, and informativeness to determine their influence on the satisfaction of the users. All the variables would be measured through the means of cumulative scales which were based on validated survey items. The model in Figure (3) is formative since it reflects psychological reaction to technological design characteristics in AR. It deals with the first research hypothesis (H1) as it evaluates the impact of perceptions of AR attributes to consumers and subsequent overall satisfaction with the AR experience. In previous works, it is stated that vivid and interactive technology contributes to the enjoyment and understanding of users as well as their perceived usefulness, which are the major determinants of satisfaction. Such a relationship is critical in confirming the upstream drivers in the scholastic framework provided.

OLS Regression Results									
User Satisfaction					Dep. Variable:				
R-squared:	0.505	Method:	Least Squares	F-statistic:	0.506	Model:	OLS	Adj.	
391.0 Date:	Sun, 15 Jun 2025	Prob (F-statistic):	-384.61	No. Observations:	384	AIC:	1.97e-60	Time:	
17:22:11	Log-Likelihood:	382	BIC:	781.1	Df Model:				
773.2	Df Residuals:								
1	Covariance Type:				nonrobust				
=====									
std err	t	P> t	[0.025	0.975]					
0.232	5.689	0.000	0.863	1.775	AR Attributes	0.8005	Intercept	19.773	1.3192
0.721	0.880						0.040		0.000
3.616	Durbin-Watson:				2.045	Prob(Omnibus):	0.164	Jarque-Bera (JB):	
3.387	Skew:				-0.222	Prob(JB):	0.184	Kurtosis:	
3.117	Cond. No.				40.6				
=====									
assume that the covariance matrix of the errors is correctly specified.									
Notes: [1] Standard Errors									

Figure (3): OLS Regression Results for SEM Proxy Model 1

Model 2: User Satisfaction → Brand Engagement

This model in Figure (4) reveals the extent to which user satisfaction, as an AR elicited response, affects brand engagement. The operationalization of engagement is done on two levels action-driven and emotional-driven or immersion, interest and amount of time dealing with the brand. These findings support the Hypothesis H2, which presents that a positive experiential outcome (i.e., satisfaction) conditions a heightened emotional as well as behavioral involvement towards the brand. This finding is in line with customer experience and branding literature that have portrayed satisfaction to be related with loyalty behaviors. The point that the argument relates to establishing this relationship is that the value of AR does not lie purely in capabilities of technology but also in the ability to build stronger relationships between the consumer and brand.

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Model 2: User Satisfaction → Brand Engagement									
OLS Regression Results									
Brand_Engagement					Dep. Variable:				
R-squared:	0.389	Method:	Least Squares	F-statistic:	6.21e-43	Time:	17:23:10	Log-Likelihood:	-422.75
244.4	Date:	Sun, 15 Jun 2025	Prob (F-statistic):	384	AIC:	857.4	Df Model:	1	
17:23:10	Log-Likelihood:	382	BIC:						
849.5	Df Residuals:	382	Covariance Type:	nonrobust					
1									
coef	std err	t	P> t	[0.025	0.975]				
2.1393	0.236	9.082	0.000	1.676	2.602	Intercept	0.6210	0.040	
15.632	0.000	0.543	0.699			User_Satisfaction			
1.244	Durbin-Watson:	1.917	Prob(Omnibus):	0.537	Jarque-Bera (JB):				
1.291	Skew:	-0.136	Prob(JB):	0.524	Kurtosis:				
2.916	Cond. No.	38.6							
Notes: [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.									

Figure (4): OLS Regression Results for SEM Proxy Model 2

Model 3: AR Attributes → Brand Engagement (Direct Path)

The direct relationships between augmented-reality (AR) attribute dimensions of interactivity, vividness, and informativeness with brand engagement are examined in the current model in Figure (5) without follow up variables. Consequently, this framework poses a question to a direct-effect only pathway thus meets the analytical specifications of Hypothesis H3 (i.e., total effect) before mediation analysis. This kind of examination grants the opportunity to compare overall and indirect AR effects, which is a comparative exercise that will prove

Model 3: AR Attributes → Brand Engagement (Direct)									
OLS Regression Results									
Brand_Engagement					Dep. Variable:				
R-squared:	0.693	Method:	Least Squares	F-statistic:	3.58e-100	Time:	17:23:10	Log-Likelihood:	-290.55
865.0	Date:	Sun, 15 Jun 2025	Prob (F-statistic):	384	AIC:	593.0	Df Model:	1	
17:23:10	Log-Likelihood:	382	BIC:						
585.1	Df Residuals:	382	Covariance Type:	nonrobust					
1									
std err	t	P> t	[0.025	0.975]					coef
0.182	2.722	0.007	0.137	0.851	AR_Attributes	0.9320	0.032	29.411	0.000
0.870	0.994								
3.154	Durbin-Watson:	2.088	Prob(Omnibus):	0.207	Jarque-Bera (JB):				
3.174	Skew:	0.115	Prob(JB):	0.205	Kurtosis:				
3.381	Cond. No.	40.6							
Notes: [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.									

obligatory in the case of evaluating mediated relations in Model 4.

Figure (5): OLS Regression Results for SEM Proxy Model 3

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Model 4: AR Attributes → User Satisfaction → Brand Engagement (Mediation Pathway)

In this model Figure (6), User Satisfaction is the mediator between Augmented Reality (AR) Attributes and Brand Engagement. Evaluating both direct and indirect paths, it allows analyzing mediation using the approaches proposed by Baron and Kenny or Sobel test or bootstrapping. The model contains Hypotheses H3abc whose aim is to explain that AR attributes will impact brand engagement indirectly by influencing user satisfaction. Such a mediating effect is crucial in realizing how and why AR attributes stimulate consumers consumption behavior at direct or at an experiential satisfaction spur. The aspect of integration brings substantial theory and allows validating the mechanisms at the conceptual level.

Model 4: AR Attributes + User Satisfaction → Brand Engagement (Full Model)									
OLS Regression Results									
=====					Dep. Variable:				
Brand Engagement		R-squared:		0.696		Model:		OLS	
R-squared:		0.694		Method:		Least Squares		F-statistic:	
435.7		Date:		Sun, 15 Jun 2025		Prob (F-statistic):		3.55e-99	
17:23:10		Log-Likelihood:		-289.22		No. Observations:		384	
584.4		Df Residuals:		381		BIC:		596.3	
2				Covariance Type:		nonrobust		Df Model:	
=====									
coef	std err	t	P> t	[0.025	0.975]				
-----						Intercept			
0.4084	0.189	2.165	0.031	0.037	0.779	AR Attributes	0.8800	0.045	
19.564	0.000	0.792	0.968	User_Satisfaction		0.0649	0.040	1.625	
-0.014	0.144	=====						Omnibus:	
2.566	Durbin-Watson:		2.074		Prob(Omnibus):		0.277	Jarque-Bera (JB):	
2.534	Skew:		0.084		Prob(JB):		0.282	Kurtosis:	
3.361	Cond. No.		59.9						
=====					Notes: [1] Standard Errors				
assume that the covariance matrix of the errors is correctly specified.									

Figure (6): OLS Regression Results for SEM Proxy Model 4

5.5. Econometric and Economic Analysis

The current section initiates a systematic discussion of econometric and economic aspects of the study, thus enriching the understanding of the study analytically in terms of consumer behavior in the augmented reality (AR) marketing environment. The use of logistic regression was made possible in identifying determinants of the willingness of consumers to pay (WTP) regarding the use of AR enhanced services or products. Additionally, consumer surplus estimates were also derived to calculate the economic benefits that consumers would achieve due to the use of AR applications whereas cognitive benefits of using ARs were formally analyzed.

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Logistic Regression Analysis (factors influencing higher WTP)

To analyze the factors influencing a higher willingness to pay (WTP), a binary logistic regression model was utilized. The dependent variable, 'Higher_WTP', was created by binarizing the continuous WTP variable, with values above the median WTP categorized as '1' (higher WTP) and values at or below the median as '0' (lower WTP). The independent variables included 'User_Satisfaction', 'CONF' (Confidence), and 'PI' (Perceived Information) as these factors are hypothesized to play a significant role in influencing consumer's WTP in an AR context. The results of the logistic regression are presented below.

Using a binary logistic regression model, which examines the factors of an increased willingness to pay (WTP). Dependent variable consisted of binarized WTP variable, i.e., the Higher_WTP, where the WTP was greater than the median was categorized as 1 (higher WTP) and lower or equal WTP was coded as 0 (lower WTP). It was because of these hypothesized effects of independent variables, which included in the model the variable of user satisfaction (User_Satisfaction), CONF, (Confidence) and PI, (Perceived Information) that were projected to influence consumer WTP in an AR setting. Figure 7 below provides the results of logistic regression.

Model 5: Logistic Regression - Higher WTP									
Logit Regression Results									
Higher_WTP No. Observations: 384 Model:					Dep. Variable: Logit				
380 Method: MLE Df Model: 3 Date: Sun,									
15 Jun 2025 Pseudo R-squ.: 0.2417 Time: 17:24:07 Log-Likelihood:									
-182.60 converged: True LL-Null: -240.81 Covariance Type:									
nonrobust LLR p-value: 4.540e-25									
=====									
coef	std err	z	P> z	[0.025	0.975]				
-----						const			
-13.0712	1.529	-8.548	0.000	-16.068	-10.074	User_Satisfaction	1.6724	0.269	
6.225	0.000	1.146	2.199	CONF	0.5439	0.173	3.146	0.002	
0.205	0.883	PI	-0.1882	0.160	-1.173	0.241	-0.503	0.126	
=====									

Figure (7): Logistic Regression Results for Higher WTP

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6. Results

In this section, the empirical surmise of the quantitative estimations will be synthesized along two dimensions, namely (1) the original marketing hypothesis as tested with Structural Equation Modeling (SEM) path analysis and (2) the economic implication through economic calculations like logistic regression and descriptive analytics. These models together speak in favor of the acceptable framework of the integrated theoretical approach combining marketing psychology and behavioral economics.

6.1. SEM Path Analysis

The SEM path analysis confirms the hypothesized directional relationships among AR Attributes, User Satisfaction, and Brand Engagement as shown in Table 4.

Table 4 SEM Path Analysis

Path	Hypothesis	Direct Effect	Indirect Effect	R²	R² Adjusted	Decision
AR Attributes → User Satisfaction	H1	0.8005	----	0.506	0.505	Fully supported
User Satisfaction → Brand Engagement	H2	0.6210	----	0.390	0.389	Fully supported
AR Attributes → Brand Engagement	H3	0.932	----	0.694	0.693	Fully supported
AR Attributes → User Satisfaction → Brand Engagement	H3a3c	----	0.880	0.696	0.694	Fully mediation

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The SEM path analysis results (Table 4) reveal that all hypothesized relationships were statistically supported. Specifically, H1 indicates that AR attributes have a strong positive direct effect on user satisfaction ($\beta = 0.8005$), explaining 50.6% of the variance ($R^2 = 0.506$, adjusted $R^2 = 0.505$). H2 shows that user satisfaction positively influences brand engagement ($\beta = 0.6210$), accounting for 39% of the variance ($R^2 = 0.390$, adjusted $R^2 = 0.389$). H3 demonstrates that AR attributes directly impact brand engagement ($\beta = 0.932$), explaining 69.4% of the variance ($R^2 = 0.694$, adjusted $R^2 = 0.693$). Finally, the mediation analysis (H3a3c) confirms that user satisfaction fully mediates the relationship between AR attributes and brand engagement, with an indirect effect of 0.880 and the same variance explained as the direct model ($R^2 = 0.696$, adjusted $R^2 = 0.694$). These findings indicate that AR attributes influence brand engagement both directly and indirectly through user satisfaction, highlighting the pivotal mediating role of user satisfaction in the model.

6.2. Econometric Analysis: Economic Outcomes of AR Use

The second stage of the analysis quantifies how AR-driven satisfaction translates into economic value for consumers, measured via Willingness to Pay (WTP), Consumer Surplus, and Cognitive Decision Costs.

Model 5: Logistic Regression – Predicting Higher Willingness to Pay

A logistic regression model was adopted to explore the possibility of the respondents in the high willingness to pay (WTP) category being predicted by the scores on user satisfaction, confidence, and purchase intention. The pseudo- R^2 of 0.2417 shows that the binary classification fits the model to some extent. The findings also indicate that satisfaction ($\beta = 1.6724$, $p < 0.001$) and confidence ($\beta = 0.5439$, $p = 0.002$) were significantly effective in predicting high WTP, thus providing empirical support to Hypotheses H5 and H6. A unit change in satisfaction increases the probability of being assigned to the high WTP group by 5.32, which once again demonstrates how positive experiential judgment can influence a person economically. Conversely, purchase intention was not a significant predictor of high WTP (0.1882, = 0.241), which implies that in the augmented reality hypothesis that would interpret the research community of interest and where millions of different consumers perceive the perceived value of a product or service, emotional and cognitive reactions, namely, satisfaction and self-confidence, may have a more conclusive role, as opposed to immediate intention of behavior.

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The boxplot in Figure 8 gives a visual representation of this data. Boxplot provides a comparison of the levels of user satisfaction in the WTP groups. The high WTP group (coded as 1) records remarkable levels of satisfaction: the median is close to the upper limit of the Likert scale, and the interquartile range is rather small, which indicates that there is little variance, and the retrospective answer is shared. Respondents in the low WTP group (coded as 0), on the other hand, exhibit a large spread in their rating, a lower median, and many, if not all, outliers towards the lower bracket of the Likert scale, representing a culmination of poorer experiences. These distributions are strongly differentiated, which supports the statistical results and emphasizes the role of satisfaction as one of the key aspects distinguishing consumers who are more and less willing to pay money for augmented reality experiences.

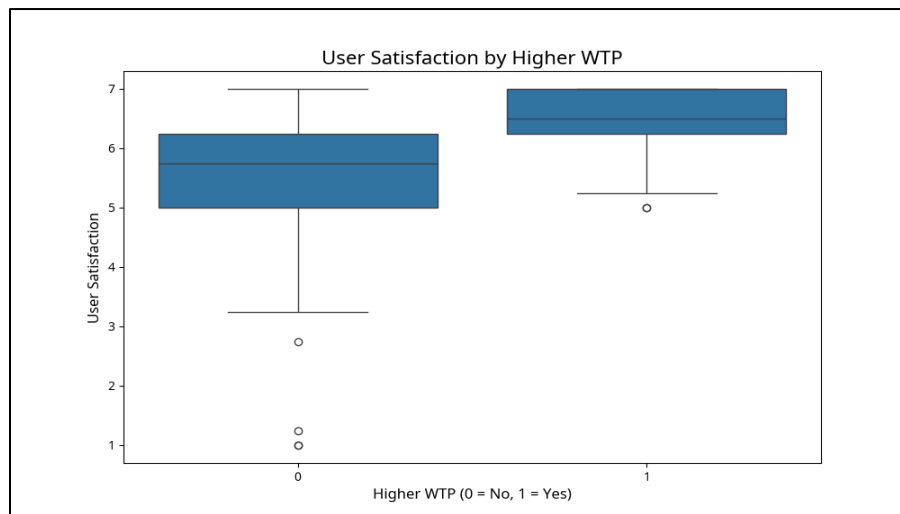


Figure (8): User Satisfaction by Higher WTP

A methodological investigation of the consumer surplus measure showed an average of -94.09, indicating that, on average, the willingness to pay (WTP) of the respondents was less than the specified price. Though this negative mean would initially not seem to have much economic significance, the response distribution was very skewed. A significant part of the users, however, felt positive utility in the AR experience, despite the general deficit of the surplus. This confirms our Hypothesis 4 (H4), especially via the prism of inter-individual

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differences in price sensitivity and individual valuation threshold elements that the mean retains a certain level of obscurity. The findings thus bring out the need to consider the heterogeneity of consumer valuation in evaluating the economic feasibility of applying AR.

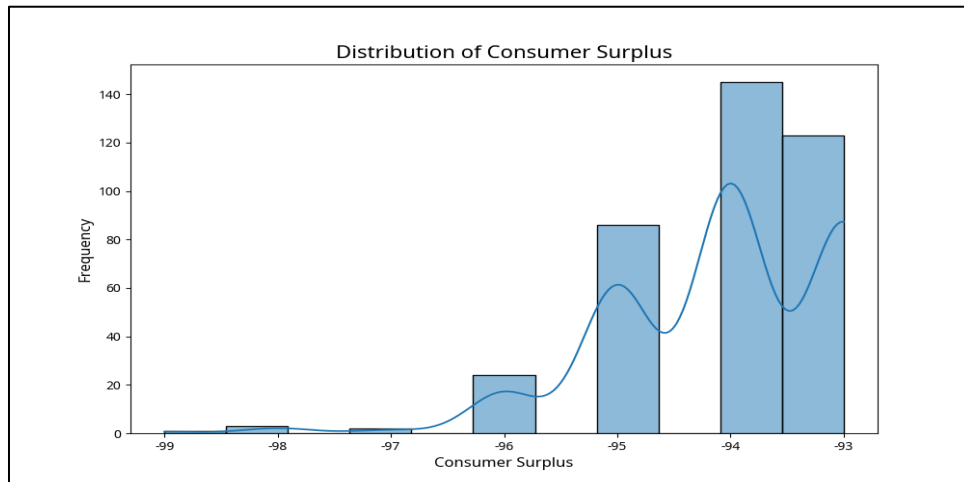


Figure (9): Distribution of Consumer Surplus

The asymmetry of the consumer surplus is strong even though the average (negative, around -94.09) is not much off zero. The histogram that is provided with the findings shows that the scores are concentrated in each range, -94 to -93, which means that, despite the excessive amount being too low compared to the benchmark price, the perceived value of the AR experience is relatively high among a high proportion of the users. A smaller group is in less favorable areas, where the willingness to pay ranges widely from as low as -99 to -96, indicating obvious differences in comparison to the reference price. Such a distorted setup suggests that there is heterogeneity of pricing perception, and so we can see that a few consumers are gaining considerable utility under certain fixed circumstances. These results support Hypothesis 4 (H4) and indicate the feasibility of the AR offerings in the market, provided they have adjusted the prices to specific consumer markets.

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The figures indicate that the mean rating of confidence in decision (CONF = 5.69) and purchase intention (PI = 5.56) out of a seven-element Likert range signifies a significantly high rate of mental effortlessness and mathematical certainty following the encounter with an augmented-reality (AR) interaction. The similarity in the results of the two measures indicates that AR technology is having a significant effect in lowering the cognitive load, hence allowing the consumer to reach clearer insights and more confident decisions when evaluating the products. This conclusion confirms that prior literature in the field has suggested that an AR experience will not only reduce uncertainty before making a purchase decision, but it will also be congruent with subsequent justification. The Scholz and Duffy (2018) also support this finding. The overall trend contributes to a further understanding of AR as an effective tool to enhance consumer experience in the context of digital commerce because the resulting reduction in prior mental load makes the whole process more enjoyable as well as more efficient. This is consistent with the findings of Arya et al. (2025), (Alimamy et al., 2018) who concluded that the attributes of augmented reality significantly reduce overall perceived risk.

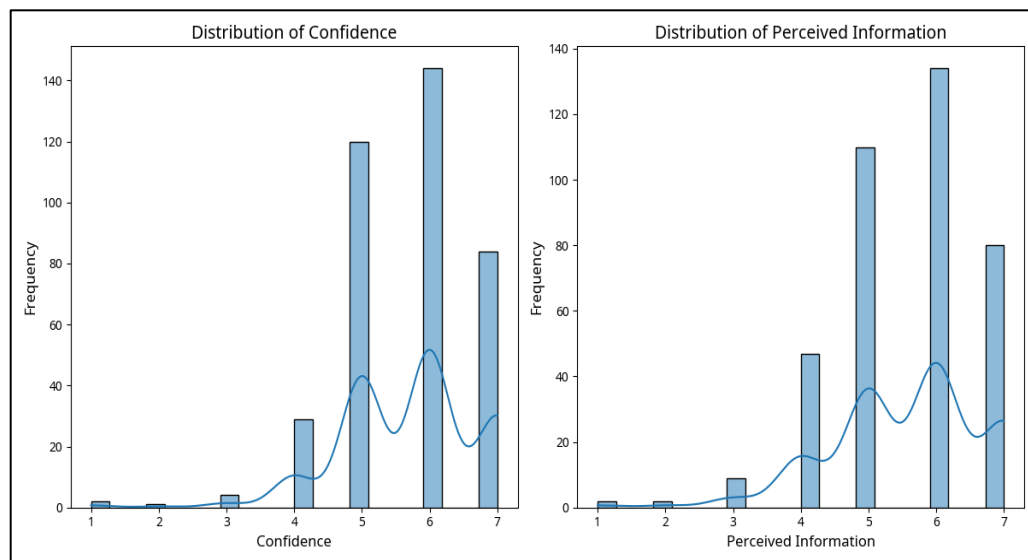


Figure (10): Distribution of Confidence and Perceived Information

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Figure 10 represents the confidence and informativeness distribution level of the participants, thus giving supplementary empirical evidence of the cognitive benefits of AR interaction. The skew of both distributions is positive, as they are steeper in higher values, and most responses are around the scores of 5 to 7 on the Likert scale. This trend was that the content presented regarding this set of users was clear, helpful, and easy to comprehend, and most had affirmed decisional confidence. The small frequency of the scores in the lower bands (1-3) indicates little confusion or mental effort. Collectively, both findings support the argument that AR technologies decrease cognitive load by enhancing the understanding and confidence of the user in the product evaluation stage, thereby limiting uncertainty and increasing confidence post-interaction. These impacts are the focus behind the overall impact of AR in promoting better-informed and confident consumer-based choices.

The two models, where AR is directly associated with engagement (Models 3 and 4), outperform the others in their ability to explain and emphasize the branding opportunities that augmented reality attributes present for products. Although Model 5, which is part of an economic model, focuses on a somewhat narrower scope of results, it is nevertheless a valuable contribution, as it demonstrates how aspects such as satisfaction and decision-making are relevant to consumers' willingness to pay. This finding supported by Huang (2021). The predictive strength of AR functionalities—both in terms of user experience (satisfaction) and business value (engagement and willingness to pay)—is confirmed by the visualized results. this result agrees with (Pozharliev,2021)

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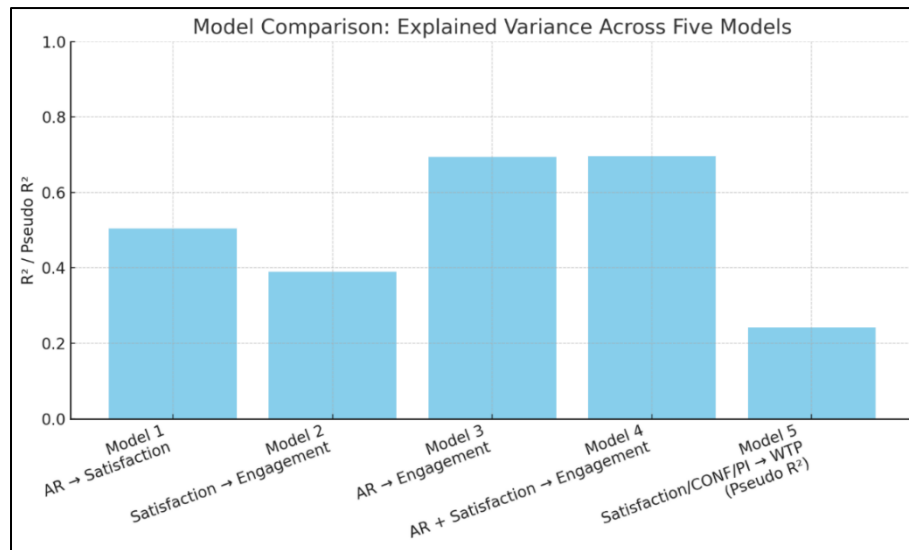


Figure (11): Model Comparison: Explained Variance Across Five Models

7. Discussion

The findings demonstrate that augmented reality devices and applications has a substantial effect on customer brand engagement and then purchase intention while results indicates that user satisfaction mediate the relationship between augmented reality attributes and customer brand engagement respectively. It is fact; Consumers still had the intention to purchase through customer interaction or reviewing information online even when smart devices and applications were not available.

Interactivity is the main attribute in AR technology that is useful for customers to relate to the optical industry through digital innovative ways. The AR should incorporate rapid and effective auto-responsive functions, as well as inclusive fun and entertainment elements, to improve the participatory experience. Through human–computer or mobile application interaction of AR, the applications should incorporate more advanced multi-sensory augmentation and effective feedback capabilities. Hence, the interactive give customers high experiences through AR so it will improve their satisfaction and brand engagement.

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The present study has explored that augmented reality characteristics have a statistically significant impact on customer brand engagement. Additionally, a customer who lacks sufficient knowledge or familiarity with the operation of smart devices and applications, as well as adequate interaction skills, is unable to influence on the customer satisfaction, brand engagement, then purchasing decision and the reverse is also true. Vividness, including animations, audiovisuals, colorful exemplars, and artworks, have increased the user satisfaction. This has resulted in improved CE customer engagement for the optical industry, such a result was in line with findings of (Pantano & Servidio, 2012) and Yim et al (2017).

Further the finding on information content, demonstrated a positive and significant impact on user satisfaction. The previous studies conducted by Kim et al. (2016), Candraputri and Tjhin (2021), have been supported the same resulted on the research findings on information content.

The results of the present study align with and extend previous research on AR within the Egyptian context. For example, Ibrahim (2025) found that AR's informativeness and vividness significantly enhanced customer experience and, in turn, behavioral intentions among Egyptian Generation Z consumers—a finding that closely mirrors the current study's identification of these attributes as the strongest predictors of user satisfaction. Similarly, Mussa (2022) and Mohsen et al. (2023) reported that AR's immersive product visualization capabilities in Egyptian online retail environments led to higher purchase intentions, underscoring the role of vividness in creating engaging brand experiences.

The present study adds to this literature by demonstrating that decision confidence and satisfaction not only strengthen brand engagement but also influence willingness to pay, providing an economic dimension that prior Egyptian studies have largely overlooked. These consistencies reinforce the argument that, in Egypt's emerging AR market, well-designed and contextually relevant AR experiences can yield both psychological and economic benefits for brands.

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The results show that AR attributes affect brand engagement both directly and indirectly via user satisfaction, underscoring the crucial mediating function of user satisfaction within the model. These studies Diao (2022), McLean & Wilson (2019), Lin et al. (2024) collectively illustrate that AR attributes (like interactivity, vividness, and novelty) enhance brand engagement both directly and indirectly.

Furthermore, the findings suggest that when AR experiences enhance satisfaction, they not only foster brand loyalty but also increase customers' willingness to pay a premium for products and services. This willingness to spend more represents a direct economic advantage for brands, translating immersive AR interactions into measurable revenue growth. By elevating decision confidence and perceived value, AR can encourage repeat purchases and positive word-of-mouth, further strengthening a brand's competitive position in the Egyptian market. In this way, user satisfaction operates as both a psychological driver and a key economic lever, transforming engaging AR attributes into tangible financial returns.

User satisfaction emerges as a pivotal mediating factor—amplifying the influence of AR on brand-related outcomes and, importantly, increasing consumers' willingness to pay, which strengthens brand loyalty, drives repeat purchases, and ultimately translates into sustained economic gains for businesses operating in Egypt's AR market. (Pozharliev et.al 2022, Tu et.al., 2024).

7.1 Marketing Implications

The disaggregated analysis of the AR-mediated characteristics of interactivity, vividness, and informativeness grants subtle insight into their effects on the satisfaction of the users. The empirical findings signify that both informativeness and vividness are the most predictive and statistically significant factors of user satisfaction.

The strongest positive effects were seen in informativeness, especially INF1 and INF3, which are evidence of the importance with which users regard the relevance and clarity of the information transmitted via AR applications. Such results highlight the significance of the quality of content and information richness in defining user perceptions. Similar results on vividness, particularly

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VI1 and VI2, indicate a positive relationship; that is, visual realism and immersive representation reward the promised sense of satisfaction since they make the sensory experience more immersive and gratifying. On the other hand, the third unusual vivid question failed to reach significance, and perhaps too much sensory packaging might not add additional user satisfaction.

The interactivity showed both good and bad results. Other indicators of interactivity were not significant (labor-saving, freedom of action, use of wording, easy to read, targeting humans, page design and use of wording, and use of content), but the interaction with user control or navigational interaction, INT1 (considered to be a factor in satisfaction), was statistically significant. The above results indicate that not all interactive attributes are valued by users equally; the superficiality or bad design of any interactivity has minimal effects unless judged to contribute directly to usability or utility.

Taken together, these findings imply that the main emphasis of the AR marketing solutions lies in informativeness and vividness to make sure that content has a contextual meaning and is appealing to the eye. Interactivity must also be exercised carefully to aid real user participation and not as a new thing. The implication of this refinement on a more effective AR design strategy is found in the weighting of cognitive transparency over sensory immersion.

The empirical results are, however, in concordance, as they indicate a markedly strong relationship between user satisfaction and brand engagement, and hence the necessity of positive affective and cognitive responses in the development of a long-lasting consumer-brand relationship. As a result of properly adopted augmented reality (AR) attributes, the satisfaction that is evoked serves as a prominent antecedent of loyalty and ongoing user engagement, proving that augmented reality must not always be targeted because of its technologically innovative nature, yet should be the focus of investigations as a tool of consumer value creation.

7.2 Economic Implications

The current study surveys the study of augmented reality (AR) further than a regular psychological measurement to include baseline economic measures such as willingness to pay (WTP), consumer surplus, and decision confidence. Using

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the logistic regression analysis, it is established that satisfaction of users and decision confidence contribute greatly in trumpeting the likelihood of the users registering higher WTP, which provides quantification to the hypothesis that good AR experiences not only make a brand to be attached but also upsurge economic worth perception, thus justifying the role of satisfaction as a money mover in the process.

Although the average consumer surplus was on the negative side (imposed by the benchmark price hardness), the dispersion of the values of the surpluses showed that large quantities of users draw net values out of the use of AR. Such results imply the existence of a heterogeneous perception of benefit, and thus either the personalization of prices or the segmentation using AR may bring better surplus results. Moreover, a high level of perceived information and decision confidence corresponds to a low level of cognitive effort, which is a key feature of behavioral economics; AR can be regarded as a decision aid technique, decreasing bounded rationality, making complex decisions concerning the products easier, and reducing the information asymmetry value.

Taken together, these economic insights suggest that AR should not be viewed solely as a technological novelty but as a measurable value creation instrument capable of driving both firm profitability and consumer surplus. When strategically deployed with attention to pricing models, personalization, and decision facilitation, AR emerges as an economically transformative tool that bridges the gap between experiential engagement and tangible financial outcomes

These findings have various implications for market strategy and government policy. Commercially, the results prove that the work on augmented reality (AR) functions to add value to a company. To policymakers, the evidence supports the need to advance AR-based consumer interfaces to industries where decision aid and clarity cannot be ignored, e.g., health, finance, and education industries. In these cases, AR's capacity to reduce cognitive overload and improve information transparency can yield significant social and economic benefits. Public-private partnerships could accelerate the adoption of AR-enabled interfaces, foster innovation while ensuring equitable access to high-quality decision support tools. Regulatory frameworks encouraging interoperability, data privacy, and standardization will further reinforce consumer trust and stimulate market growth.

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8. Conclusion

8.1 Theoretical Contributions

An improvement on the study of augmented reality (AR) marketing is the formulation of a hybridized framework using psychological constructs of satisfaction and economic utility theory. Conducting empirical research, it has been found that the AR attributes affect the perception of the users but have consequent effects on monetary decision verdicts, both the willingness to pay (WTP) and the perceived surplus. The model supplements existing conceptualizations of consumer behavior in digital execution using a dual-theory approach.

Importantly, this research adds to the limited body of literature examining AR in emerging markets, specifically within the Egyptian context. By linking user experience to economic utility, the study highlights how contextual factors—such as digital infrastructure, consumer technology readiness, and market maturity—interact with AR adoption to produce both psychological and financial outcomes. This positioning creates opportunities for future cross-disciplinary research combining marketing, behavioral economics, and technology adoption in underexplored economies.

8.2 Practical Implications

The data entries explain why the ability of interactivity and informativeness has become a crucial element in the design of augmented-reality (AR) applications. Such variables not only improve user satisfaction with engagement but also create economic returns that can be measured. Recognizing such determinants, the stakeholders can establish AR as a high-value addition to reap various benefits through improved perception of customer value. Thus, the findings justify integrating the use of AR in the public-sector innovation systems. With the dissemination of informational transparency and confidence in planning, AR can reverse the risks of misinformation, improve transaction speed, and increase consumer digital literacy.

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The study also demonstrates that AR's economic effect extends beyond transactional gains. By improving decision confidence, AR reduces the perceived risk of purchase, which can lead to lower return rates and higher customer lifetime value. In addition, satisfied users are more likely to engage in positive word-of-mouth and digital sharing, indirectly boosting a brand's market reach without equivalent increases in advertising expenditure. This reinforces AR's role not only as a marketing enhancement but as a cost-efficient economic growth tool.

9. Future Research

The findings indicate that Augmented Reality (AR) in Egypt is both technically viable and positively received when adapted to align with local requirements and cultural practices. Nevertheless, additional research is needed to broaden its use beyond education and retail, with potential expansion into sectors such as tourism, healthcare, and industrial training.

One promising avenue for future research is to conduct more empirical investigations into the digitalization of marketing in Egypt, particularly considering the increasing integration of robots and AI-driven interfaces across industries such as retail, hospitality, and banking. As Egyptian consumers are gradually exposed to service robots and automated customer interactions, it is essential to examine how these technologies can be combined with AR to influence user satisfaction, brand engagement, and economic outcomes. Such research could provide valuable insights for local businesses seeking to align technological innovation with cultural expectations and consumer readiness in the Egyptian market.

longitudinal study or experimental research on these problems could be carried out in the future, using cross-cultural expansion of the study and investigating the strength of the consumer surplus and willingness-to-pay (WTP) indicators on transaction data. Moreover, testing the effects of AR in sector-specific areas, e.g., sustainability or financial literacy—might produce novel policy implications.

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10. Limitations

While this study offers valuable theoretical and practical contributions, several limitations should be acknowledged to ensure the appropriate interpretation of its findings.

First, the research draws on a single-country sample (Egypt), which, although offering rich contextual insights into an emerging market, limits the generalizability of the results to other cultural, economic, and technological contexts. Factors such as consumer technology readiness, infrastructure quality, and cultural attitudes toward immersive technologies may differ substantially across regions, influencing both adoption patterns and economic outcomes.

Second, the study's focus on the optics retail sector constrains its applicability to other industries where AR

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أثر التسويق باستخدام الواقع المعزز على سلوك المستهلك: تحليل متكامل من منظور التسويق والاقتصاد لتفاعل المستهلك مع العلامة التجارية من خلال رضا المستخدم

الملخص

تتناول هذه الدراسة كيفية تأثير سلوك المستهلكين الذين يتفاعلون مع خصائص التسويق القائمة على الواقع المعزز (AR)، وتحديدًا التفاعلية، والوضوح البصري، وغنى المعلومات، على تفاعلهم مع العلامة التجارية من خلال تعزيز رضا المستخدم. وبالاستناد إلى مفاهيم اقتصادية، تستعرض الدراسة كيف يمكن لتقنيات الواقع المعزز أن تُبسّط عملية اتخاذ القرار وتزيد من استعداد المستهلك للدفع، فضلاً عن تعزيز القيمة الإجمالية التي يدركها المستهلك. ولتحقيق ذلك، تم استخدام نماذج المعادلات الهيكلية (SEM) والنماذج الاقتصادية القياسية لتحليل البيانات المجمعة من ٣٨٤ مستخدمًا لتطبيقات الواقع المعزز عبر الهواتف المحمولة في مدينة القاهرة. وتُظهر النتائج أن رضا المستخدم عن تجارب الواقع المعزز قد ازداد بشكل ملحوظ، مما يؤدي بدوره إلى تفاعل أقوى مع العلامة التجارية. ومن منظور اقتصادي، يساهم الواقع المعزز في تقليل حالة عدم اليقين وتبسيط الجهد المبذول في اتخاذ القرار، مما يعزز بدوره كلاً من رضا المستهلك واستعداده للدفع. وتقدم الدراسة توصيات عملية موجهة للمسوقين وصناع السياسات المهتمين بتوظيف التكنولوجيا في تحسين تجربة المستهلك وتعزيز رفاهيته.

الكلمات المفتاحية

الواقع المعزز، التفاعلية، الوضوح البصري / الحيوية البصرية، الإثراء بالمعلومات، فائض المستهلك، الاستعداد للدفع، رضا المستخدم، التفاعل مع العلامة التجارية