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INVESTIGATING THE INFLUENCE OF VIRTUAL AND AUGMENTED REALITY ON ELEVATING CUSTOMER ENGAGEMENT WITH HEALTHCARE PRODUCT BRANDS AND SHAPING PURCHASE INTENTIONS

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***ABSTRACT*:**

The paper discusses how Virtual Reality (VR) and Augmented Reality (AR) can be used to interact with customers and influence purchase intentions of a health product in the healthcare sector. The research integrates both quantitative (n=500) and qualitative survey results and data of interviews, focus groups, and usability tests to examine the relevance of immersive technologies in consumer perception, trust, and consumer decision-making. The findings show that the implementation of VR/AR and the perceived quality of the experience lead to the significant improvement of customer involvement, which, in its turn, is a strong predictor of intentions to make a purchase ($2.4 = 0.68$, $p < 0.001$). The mediation analysis confirms that the mediation of the two variables is substantial engagement between immersive experience and behavioral intention. The qualitative results have also shown that real-time visualization, customization, and interactive simulation result in eliminating uncertainty and perceived authenticity, particularly within high-stakes healthcare. However, the adoption barriers remain, and they are the usability concerns with the older generation, the technological ignorance, the insufficiency of funding, and the confidentiality of information. The research article adds to the literature on the subject of engagement and technology acceptance research because it positions immersive technologies as a decision-supporting instrument in the healthcare marketing sphere. To put it in practice, the findings suggest that to make sure that VR/AR will be utilized to its full strategic advantage in healthcare branding, inclusive design, transparent data management, and scalable implementation strategies will be required.

***Keywords**: Augmented Reality, Customer Engagement, Healthcare Marketing, Purchase Intention, Technology Acceptance, Virtual Reality.*

INTRODUCTION

Virtual Reality (VR) and Augmented Reality (AR) have advanced significantly since their first conceptualisation in the late 1960s. VR allows a user to experience fully computer-generated environments, whereas AR superimposes digital objects onto the real world and does not replace real phenomena [1]. Since Ivan Sutherland created his pioneering head-mounted display, hardware and software have been enhanced to allow more interactive and multisensory digital experiences. These advancements have changed VR and AR as experimental technologies to commercially viable technologies that can revolutionize user interaction in industries[2].

Immersive technologies have proven to have high potential in transforming consumer-brand relationships in marketing settings. VR and AR enable customers to see products in real-life conditions, to act in virtual models,

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and to undergo individual presentations before buying. The global market of VR is estimated at USD 14 billion in 2020 and is expected to increase significantly in the years to come[3]. The immersive technologies are becoming perceived by consumers as a mainstream tool, and they will be as relevant in the future as smartphones. Empirical studies indicate that these technologies can positively affect the process of product assessment, brand recognition, and purchase intentions by lowering the level of uncertainty and increasing the experiential value[4]. Although VR and AR have been widely used in fashion, automotive, retail, and real estate industries, their use in marketing healthcare products is relatively under-researched. Within the medical field, the application of immersive technologies has been mainly in medical training, patient education, and clinical simulation[1, 5]. Nevertheless, few empirical studies explore the effect of these technologies on perceptions, engagement, trust and purchase behavior by consumers of healthcare product brands. The perceived risk, complexity, and informational imbalance in healthcare purchasing are more than in other consumer goods, and hence authenticity and transparency are vital factors in determining consumer trust. In that regard, the possibility of improving engagement and decreasing uncertainty with the help of immersive technologies is a considerable gap in research. Current research focuses on the ability of AR and VR to enhance product visualization and interactivity[6]. However, the role of each of them in shaping purchase intentions among healthcare product markets has not been fully studied. Further, the extent to which demographic factors, familiarity with technology, and ethical issues like data privacy moderate or mediate such relationships is also little known[7]. With projections of ongoing expansion in the use of immersive technologies, there is a need and timeliness to conduct a systematic study of their strategic application in healthcare marketing.

It is against this setting that the current paper seeks to conduct research looking into the effects of Virtual Reality and Augmented Reality on customer interaction with the brands of healthcare products and the subsequent intentions to purchase. The study attempts to fulfill a number of critical goals:

- “To examine the role of VR/AR in shaping customer perceptions of authenticity”;
- “To assess how immersive technologies enhance understanding of healthcare products”;
- “To determine how interactivity influences engagement levels”;
- “To evaluate trust in VR/AR marketing methods”;
- “To identify challenges associated with technology adoption”;
- “To explore ethical considerations surrounding implementation”; and
- “To analyze demographic factors affecting VR/AR effectiveness.”

To address these objectives, the study is guided by the following research questions:

1. “What role do Virtual Reality and Augmented Reality play in shaping customer perceptions of authenticity in healthcare product information?”
2. “What challenges do customers face in accepting VR/AR technologies within healthcare product marketing contexts?”
3. “To what extent do immersive VR/AR experiences enhance consumer understanding of healthcare product features and usage?”
4. “How do consumers compare VR/AR-based information methods with traditional healthcare information sources such as physician consultations or brochures?”
5. “What ethical considerations arise in the implementation of VR/AR technologies in healthcare marketing?”
6. “To what extent do consumers trust healthcare products promoted through immersive VR/AR methods?”
7. “How does the level of interactivity within VR/AR environments influence customer engagement?”
8. “How do demographic factors such as age, gender, and technological proficiency influence the effectiveness of VR/AR in driving engagement and purchase intentions?”
9. Theoretically, the paper extends the Technology Acceptance Model (TAM) and customer engagement theory by adopting the immersive technology constructs to a healthcare marketing system. This research is relevant to the current literature on the function of experiential technologies in high-involvement goods through engagement as a potential intermediate variable between VR/AR experience and purchase intentions [8]. In practice, the findings have practical implications for healthcare marketers who wish to develop immersive, transparent, and inclusive VR/AR strategies that will raise consumer trust and establish better brand relationships [9].

The analysis is carried out in Europe and the Middle East, which witness a proliferating digital technology and the trend of increased healthcare innovativeness. The mixed-method method, which involved a survey, interview,

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focus group, and the use of usability testing, was used to collect information between January and December 2024. Although the healthcare emphasis enhances contextual relevance, the results might not be generalizable to other industries. The difference in familiarity with technologies and access to hardware can also affect user reactions.

THEORETICAL BACKGROUND AND LITERATURE REVIEW

1.1. Virtual and Augmented Reality Technologies

Virtual Reality (VR) and Augmented Reality (AR) are immersive technologies that transform the interaction of the user with digital space. VR allows users to experience a fully simulated three-dimensional space, with the help of head-mounted devices, motion trackers, and controllers, to recreate the real-world environment or create fully artificial spaces[10]. VR originated in the 1960s and has since been developed to improve human-computer interaction by means of multisensory interaction. Its use cases are in gaming, simulation training, medicine, and industrial design, especially in situations in which there is a need to simulate complex situations in a safe and controlled environment[9, 11].

AR, on the other hand, is used to enhance the physical environments by giving the real world a digital overlay using smartphones, tablets, or wearables. AR is not a replacement for reality, as it adds value to it, unlike VR, and enables interaction with both physical and virtual items simultaneously[12]. AR has become used in the field of healthcare and industry, where real-time anatomical overlays and guidance are used to enhance accuracy and minimize error margins[13]. AR is used in retail and marketing to trial a virtual product and visualize space to increase consumer decision-making and minimize uncertainty[3].

The use of technology in industries has increased at a faster rate. VR and AR developed quickly in the 1990s and early 2000s, respectively, with immersive simulations and mobile computing and wearables. Recent tendencies show interdisciplinary growth in a considerable way. Virtual Reality is also used extensively in medical training and rehabilitation, such as Virtual Reality Exposure Therapy[11], whereas AR is used to improve the visualization of surgery and diagnostic accuracy[13]. There is also an augmented usage by consumers; the application of augmented reality in shopping settings increased significantly in 2017-2023, which testifies to the further penetration of immersive tools into business settings[14].

1.2. VR and AR in Marketing

The addition of VR and AR to the marketing practice has revolutionized the idea of customer interaction since the marketing strategies have become interactive and informative in terms of brand engagement. AR applications can enable consumers to test the products virtually or see them in their own space, which boosts confidence and perceived lower risk of purchase. There is empirical evidence that such interactivity increases customer satisfaction and conversion rates [14].

VR also prolongs the experiential marketing by developing the brand environments. As an example, virtual showrooms and 3D simulations enable consumers to personalize products and to experience what they can do in simulated environments [15]. Even though the accessibility of headsets has posed a challenge to mass adoption, the use of immersive brand environments has good prospects to build on emotional connection and brand loyalty. This influence is represented by cross-industry case studies. Virtual try-ons, which are enabled by AR, have enhanced customer satisfaction and purchase intentions in fashion and beauty[13]. The car brands are using VR showrooms to provide customers with immersive customization, which does not require physical infrastructure. Virtual tours of property are offered by real estate companies, which increases spatial knowledge and convenience[11]. All these applications point to the revolutionary nature of immersive technologies in increasing the value of experience.

1.3. VR and AR in Healthcare and Healthcare Product Marketing

In the health sector, VR and AR have mostly been applied in clinical training, surgical simulation, rehabilitation, and diagnostic imaging. Surgical simulators (MIST-VR and LapMentor) are VR-based systems designed to enhance procedural competence and decrease clinical risk[16]. AR systems can be used to visualize anatomy in real-time and improve the precision of surgery and decision-making [9]. Gamified AR settings are also used in rehabilitation programs to help patients recover [12].

Though the clinical uses of immersive technologies in healthcare products are strong, the marketing potential of immersive technologies is under-researched. AR will be able to support 3D visualization of pharmaceutical mechanisms and medical devices, and contribute to a better understanding and clarity of the products [13]. In a

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similar manner, VR virtual reality simulations can enable consumers to have an experience of a medical procedure or device performance in a simulated environment before making a purchase [3]. These abilities indicate that there is potentially much to do to improve trust, engagement, and purchase intentions, especially in high-involvement healthcare markets where perceived risk is high.

1.3.1.Customer Engagement Theory

Customer engagement (CE) is a description of the relationships among consumers and brands that are based on emotional, cognitive, and behavioral engagement beyond transactional relationships. It has been linked to loyalty, retention and customer lifetime value [17]. The engagement enhances the relational relationships in the competitive markets and heightens brand differentiation based on the experience [18].

Multidimensional models are models that visualize engagement based on three dimensions, namely cognitive (mental investment), emotional (affective attachment), and behavioral (active participation and advocacy)[19]. Service-Dominant Logic also places engagement in the category of co-creation, during which value is generated in the course of cooperation between companies and customers[5]. The immersive technologies are in line with these frameworks since they facilitate interactive engagement and experience.

Technology is a key factor in enhancing interaction. Relational marketing strategies are boosted by AI-driven individualization, interactivity of social media, and immersive digital platforms [20]. In this case, in particular, VR and AR provide a simulated experience of the product, making it seem more realistic and engaging to the emotions [21].

1.3.2. Purchase Intentions and Technology Acceptance

Purchase intention is influenced by attitudes, perceived behavioral control, and subjective norms. Attitudes that are positive towards technology-mediated shopping positively affect the buyer behaviour [22]. Social norms also affect consumer choice, particularly in digitally networked contexts [23]. The perceptions of behavioral control also serve as good predictors of purchase intention in cases where the consumers perceive that they can easily navigate technological platforms [9].

The Technology Acceptance Model (TAM) is a model that conceptualizes the uptake of technology as the perceived usefulness (PU) and perceived ease of use (PEOU) [24]. The two constructs have great significance in affecting trust and behavioral intention in online contexts [4]. There are other extensions, such as UTAUT, that incorporate social influence and facilitating conditions that provide a broader picture regarding the adoption of immersive technology. The VR retail environment increases purchase intention with perceived usefulness, ease of use, or social influence [25].

Empirical studies demonstrate that AR strengthens mental images and product consideration, which supports the purchase intention [26]. VR enhances brand attitude by developing the feeling of being present and experiencing gratification. The combined effects of these technologies on the decision-making processes involve cognitive and emotional levels of decision-making by the consumers [25].

1.3.3.Ethical Considerations in VR/AR Marketing

Immersive technologies usage also creates severe ethical concerns, primarily the privacy and security of data. The VR and AR technologies collect behavioral, biometric, and locational data, which causes apprehension about surveillance and data misuse [27]. VR worlds can record gaze and movement, which exposes the possibility of a data breach. Such measures as clear systems of consent, encryption, and a minimum amount of data collection are therefore required [24].

Ethical marketing also includes responsible design, which eliminates the manipulation through persuasive immersive techniques. Psychological richness of VR experiences demands the concepts of ethical equivalency adherence, i.e., virtual communication must be equivalent to activities in real life. Transparency in skewing the consumer and user control are the greatest in maintaining consumer trust [24].

1.3.4. Demographic Influences on Immersive Technology Adoption

Demographic factors play a rather important role in VR and AR adoption. People of a younger age tend to be more technologically affined, but when the usability barrier is reduced, the older generation expresses positive attitudes [28]. Older populations in question will be more concerned with interface simplicity and intuitiveness[29].

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Adoption patterns are also influenced by gender and cultural factors. It has been shown that women can have more emotional involvement in immersion [30]. The perception of innovations is embedded in the culture; in developed economies, individual attitudes are the leading adoption factors, and in emerging ones, demographic elements are more influential [31]. These results reveal the need to customize the immersive marketing approach to different consumer groups.

1.3.5.Identified Gaps in the Literature

Despite the broad literature on VR and AR in retailing and entertainment, there is a lack of empirical studies in the context of healthcare product marketing. The literature is highly concentrated on short-term involvement and short-term purchase intentions, and little has been done in the long-term relational results. Moreover, the ethnic moderators and ethical implications need to be examined more closely in healthcare settings. Combining TAM, customer engagement theory, and immersive technology constructs in healthcare branding has not been thoroughly tested. This research, therefore, fills these gaps by exploring the role played by VR and AR on customer engagement and buying intentions in healthcare product markets, including demographic variables and ethical issues, in a single empirical model.

METHODOLOGY

2.1. Research Design

The research is a mixed-methods investigation that explores the impact of Virtual Reality (VR) and Augmented Reality (AR) on customer engagement and intentions to purchase healthcare products during product marketing. It used a convergent parallel design, during which quantitative and qualitative data were obtained simultaneously, evaluated separately, and then combined to be interpreted [31].

The quantitative aspect is used to test relationships between VR/AR usage, experience quality, user familiarity, customer engagement, and purchase intentions statistically. The qualitative element, including interviews, focus group discussions, and usability testing, gives a more in-depth insight into the perceptions of the users, the experience aspects, the development of trust, and the ethical aspect. The combination of the two strands increases the level of analytical rigor and aids in triangulation, which is the power of internal validity and depth of interpretation. The empirical analysis is based on a theoretical model that is given in Fig. 1.

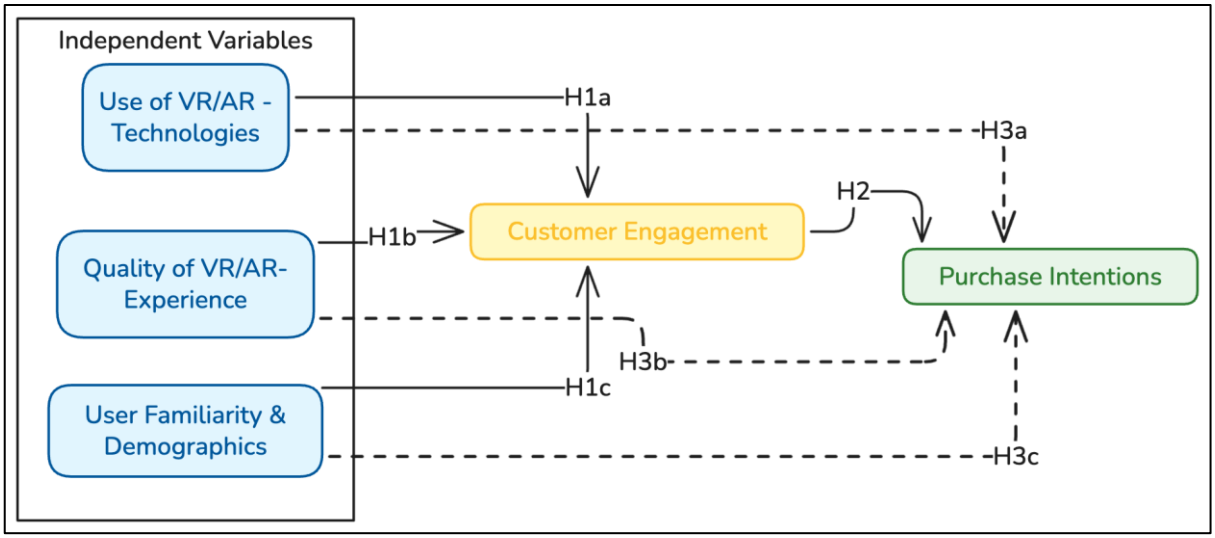

Figure 1:Theoretical Model of the Study Illustrating the Relationships Among VR/AR Usage, Experience Quality, Familiarity, Customer Engagement, and Purchase Intentions

2.2. Research Questions and Hypotheses

The study is guided by eight research questions addressing authenticity perceptions, technology acceptance barriers, product understanding, trust, ethical considerations, interactivity, and demographic influences in VR/AR healthcare marketing contexts.

DOI: 10.46121/pspc.53.4.26

Based on the literature and theoretical integration of the Technology Acceptance Model (TAM), Service-Dominant Logic, and Customer Engagement Theory, the following hypotheses were formulated:

- H1 (Drivers of Engagement).

H1a: "VR/AR usage positively influences customer engagement."
H1b: "Perceived VR/AR experience quality positively influences customer engagement."
H1c: "User familiarity and demographic factors significantly influence customer engagement."

- H2 (Engagement to Purchase Intention): "Customer engagement positively influences purchase intentions for healthcare products."
- H3 (Direct Effects).

H3a: "VR/AR usage directly and positively affects purchase intentions."
H3b: "VR/AR experience quality directly and positively affects purchase intentions."
H3c: "User familiarity and demographic factors directly influence purchase intentions."

- H4 (Mediation): Customer engagement mediates the relationship between VR/AR usage, experience quality, familiarity, and purchase intentions.

2.2.1. Measurement Instruments

All constructs were measured using established multi-item scales adapted from prior validated studies. Responses were captured using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree);

- VR/AR Usage and Experience Quality-Adapted from TAM [32] and immersive technology research[8]. Each construct was measured with three items assessing perceived usefulness, ease of use, and experiential realism.
- Customer Engagement-Measured using a multidimensional approach, capturing cognitive, emotional, and behavioral engagement through three items [33].
- Purchase Intentions-Adapted from [22], measured using three items assessing behavioral intention to purchase.
- User Familiarity and Demographics-Familiarity and technological proficiency were assessed through three items, while age and gender were captured through categorical variables. Reliability was reassessed using the study dataset. Cronbach's alpha values exceeded the recommended threshold of 0.70 for all constructs. Customer engagement ($\alpha = 0.862$) and purchase intention ($\alpha = 0.811$) demonstrated strong internal consistency.

2.2.2.Sampling and Participants

The target market included those consumers in Europe and the Middle East who already encountered VR/AR technology in healthcare marketing settings. The stratified random sampling strategy was used to provide representation in terms of age, gender, and the level of technological proficiency.
The sample size of the quantitative study was 500 respondents, which was enough to perform strong multivariate analysis and contrasts between subgroups. The qualitative part involved four semi-structured interviews, one focus group of three members, and a usability test on three subjects.

2.2.3. Data Collection Procedures

1) Quantitative Data Collection: Survey data were obtained through an online questionnaire distributed by means of Google Forms. Distribution had a reach to technology-conscious people in terms of healthcare communities, social networks, and digital. Prior to complete deployment, the instrument was pilot-tested in terms of clarity and alignment of the constructs.

2) Qualitative Data Collection: Semi-structured interviews were carried out through Zoom to examine the user perceptions and experiences of the interactivity, formation of trust, and ethical issues. The collective discussion of VR/AR applications and social influence dynamics was done in a focus group. The usability test was done on the interface navigation, design intuitiveness, and visual overlay accuracy of VR/AR healthcare applications.

2.2.4. Data Analysis

Quantitative Analysis: IBM SPSS Statistics (Version 26) was used in carrying out quantitative analysis. Sample characteristics were summarised by descriptive statistics. The t-tests, ANOVA, and multiple regression analysis were included as inferential analysis. An evaluation of construct validity was done through the exploratory factor analysis (principal component analysis). The one-factor test conducted by Harman was done to test the common method bias. The alpha of Cronbach was used in order to check internal consistency. The direct, indirect, and total

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effects have been estimated through Hayes PROCESS Macro (Model 4) to perform mediation analysis, and bootstrapped confidence to determine the significance of mediation.

Qualitative Analysis: Thematic analysis was employed to analyze qualitative information with NVivo software. The transcripts were coded in a systematic way, and themes were formed out of comparative thinking. Hegemonic themes were immersive engagement, formation of trust, usability issues and barriers to adoption. Methodological transparency, audit trail and data-based interpretation were used to maintain trustworthiness.

2.2.5.Ethical Considerations

Ethical approval protocols were observed under the normal research ethics principles. The participants were informed before they gave their consent. The anonymity of the data was ensured, and they were stored on password-protected systems and could be viewed only by authorized researchers. The sensitive information was reduced to a minimal and it was securely encrypted.

2.2.6.Reliability, Validity, and Rigor

Cronbach's alpha over 0.70 was found as a confirmation of quantitative reliability. Factor analysis supported construct validity. The integrity of qualitative rigour was maintained in terms of credibility (thick description), dependability (systematic coding procedures), confirmability (data-driven interpretation), and a clear description of analytical processes.

2.2.7.Methodological Limitations

There are some limitations to consider. The researchers used self-reported measurement partly, which subjects it to response bias. The focus on the geographic area of Europe and the Middle East can be a constraint to the generalization of other areas. The differences in technological familiarity can also affect the levels of engagement. Nevertheless, such limitations do not suppress the effectiveness of the triangulation of quantitative and qualitative data, which introduces the depth of knowledge in the area of VR/AR adoption in healthcare marketing. The next section gives the empirical results based on the statistical and thematic tests.

RESULTS

3.1. Quantitative Results

Respondent Profile and Technical Proficiency: The research examined the data on 500 participants in Europe and the Middle East. Table I shows the distribution of VR/AR technical proficiency between gender and age groups.

TABLE I. DISTRIBUTION OF VR/AR TECHNICAL PROFICIENCY BY GENDER AND AGE GROUP

		Technical Proficiency					
		High		Low		Moderate	
		Count	Percentage %	Count	Percentage %	Count	Percentage %
Gender	Female	50	30.9%	39	27.1%	67	34.5%
	Male	61	37.7%	52	36.1%	67	34.5%
	Prefer not to say	51	31.5%	53	36.8%	60	30.9%
Age Group	18-25	21	13.0%	20	13.9%	33	17.0%
	26-35	33	20.4%	22	15.3%	43	22.2%
	36-45	24	14.8%	26	18.1%	28	14.4%
	46-55	26	16.0%	24	16.7%	37	19.1%
	56+	58	35.8%	52	36.1%	53	27.3%

Table I demonstrates that the degree of proficiency in technical aspects (High, Moderate, Low) was fairly balanced between gender groups. The female respondents had 30.9% high proficiency, 34.5% moderate proficiency, and 31.5% low proficiency. The same was reported by the male respondents, with 31.7% reporting high, 36.1% moderate, and 32.1% low proficiency. Those who did not want to reveal their gender had similar trends. These results point to the fact that gender is not a significant distinguishing factor of VR/AR-technical capability in the sample.

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Differences on the basis of age were more significant, though. The high category proficiency was more represented among younger respondents with ages ranging between 18 and 35. Conversely, those respondents who were aged 46 and above showed concentration in moderate and low proficiency. Table II shows the cross-tabulation of age group and level of proficiency.

TABLE 2. CROSSTABULATION OF VR/AR PROFICIENCY BY AGE GROUP

Proficiency with VR/AR Technology * Age Group Crosstabulation

Count

		Whatisyouragegroup					
		18-25	26-35	36-45	46-55	56+	Total
HowwouldyourateyourproficiencywithusingVRARtechnology	High	21	33	24	26	58	162
	Low	20	22	26	24	52	144
	Moderate	33	43	28	37	53	194
Total		74	98	78	87	163	500

The pattern of distribution shows that the familiarity with and exposure to immersive technologies reduce as age advances. Fig. 1 visually demonstrates this tendency, representing the bar chart of the levels of proficiency in the age groups.

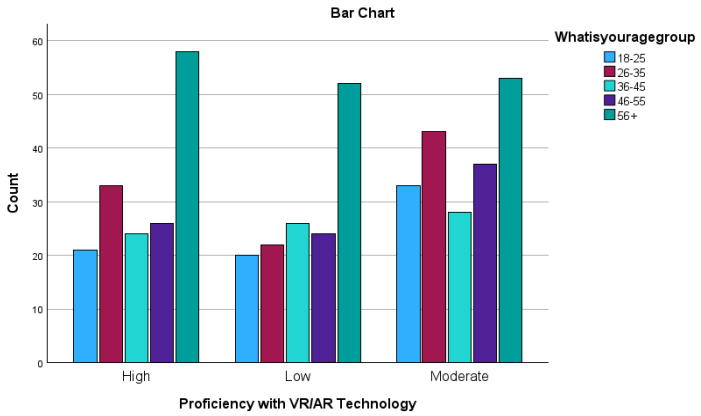

Figure 2: Distribution of VR/AR Technical Proficiency Across Age Groups

The graphical illustration affirms that younger generations exhibit large shares of high levels of technical familiarity, and the respondents are older and are relatively less competent. This observation upholds the hypothesis that exposure to digital technologies across generations affects the use of immersive technologies. On the other hand, there is limited diversity in the gender-based distribution presented in Fig. 2, both for males and females.

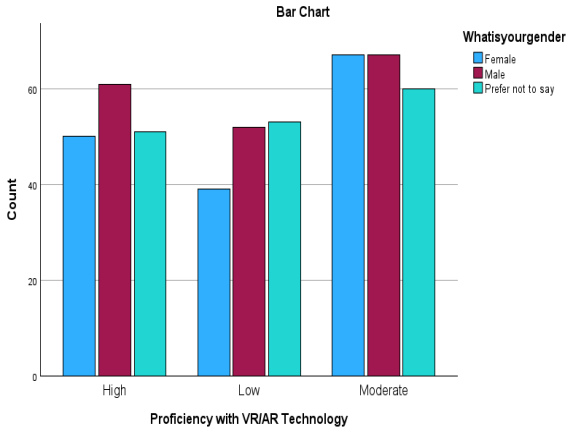

Figure 3: Distribution of VR/AR Technical Proficiency Across Gender

DOI: 10.46121/pspc.53.4.26

Overall, demographic analysis suggests that age exerts greater influence than gender in determining VR/AR proficiency levels among healthcare consumers.

3.1.1. Descriptive Statistics

Descriptive statistics for the primary study variables are presented in Table 3.

TABLE 3. DESCRIPTIVE STATISTICS OF STUDY VARIABLES

Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Use of VR/AR Technologies	1.00	5.00	3.0930	.96161
Quality of VR/AR Experience	1.00	5.00	2.9500	1.04484
User Familiarity with VR/AR	1.00	3.00	2.0360	.78226
Customer Engagement	1.00	5.00	3.0660	1.47036
Purchase Intentions	1.00	5.00	2.9960	.97050

Each construct was measured on a five-point Likert scale with 1 (Strongly Disagree) to 5 (Strongly Agree). Use of VR/AR Technologies had a mean of 3.09 (SD = 0.96), which is moderate use of immersive platforms by the sample. This is an indication that although, the respondents are partially familiar with VR/AR in healthcare, they are not yet very widespread or routine.

The Quality of VR / AR Experience has an average of 2.95 (SD = 1.04), which indicates the moderate level of perception of realness, responsiveness, and visual accuracy. The respondents did not rate the quality of the experience negatively, but the results suggest that there is a possibility of technological detailing and better system functioning. User familiarity with VR/AR showed a low mean of 2.03 (SD=0.78), which means that quite a number of the participants are quite new to immersive technologies. This low level of familiarity is in line with the demographic results that depict a variation in the technological exposure.

Customer Engagement produced an average of 3.06 (SD = 1.47), indicating a moderate degree of psychological and behavioral engagement with the healthcare products demonstrated using VR/AR interfaces. Purchase Intentions had a mean of 2.99 (SD = 0.97), which indicated the reserved yet positive intentions to buy healthcare products as encountered in immersive settings. Altogether, the descriptive results lead to moderate adoption, moderate engagement, and moderate purchase inclination, which means that immersive healthcare marketing is still at a preliminary stage of development.

3.1.2.Reliability and Validity Assessment

Internal consistency reliability was assessed using Cronbach's alpha coefficients. The results are summarized in Table 4.

TABLE 4. CRONBACH'S ALPHA RELIABILITY COEFFICIENTS

Variable	Cronbach's Alpha
Use of VR/AR Technologies	0.738
Quality of VR/AR Experience	0.721
User Familiarity with VR/AR	0.752
Customer Engagement	0.862
Purchase Intentions	0.811

All constructs were above the recommended value of 0.70 (Hair et al., 2017) which validated the presence of acceptable to strong reliability. Customer Engagement proved to be the most reliable (0.862) then Purchase Intentions (0.811). Internal consistency of the scales used to measure VR/AR usage, quality, and familiarity was also satisfactory, and it means that the measurement tools are capable of capturing the desired constructs.

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Exploratory factor analysis was used to assess construct validity. Table V presents the results of Kaiser-Meyer-Olkin (KMO) measure and Bartlett test of Sphericity.

TABLE 5. KMO AND BARTLETT'S TEST OF SPHERICITY

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.762
Bartlett's Test of Sphericity	Approx. Chi-Square	32.084
	df	28
	Sig.	<.001

The KMO of 0.762 is more than the suggested 0.70 which means that there was a sufficient sampling adequacy. The test of sphericity by Bartlett was found to be significant (χ^2= 32.084, p=0.001), thereby connecting the variables to be correlated to perform a factor analysis. The single factor test conducted by Harman did not identify one factor in particular explaining the largest percentage of variance indicating that common method bias is not a big issue in the validity of the findings.

3.1.3.Hypothesis Testing

Regression analysis was conducted to examine the direct relationships between VR/AR variables and customer engagement. The results are presented in Table 6.

TABLE 6. REGRESSION ANALYSIS RESULTS FOR CUSTOMER ENGAGEMENT

Hypothesis	Path	Beta Coefficient	T-value
H1	*"Use of VR/AR Technologies --> Customer Engagement"*	0.338	6.292
H2	*"Quality of VR/AR Experience --> Customer Engagement"*	0.250	4.679
H3	*"User Familiarity with VR/AR --> Customer Engagement"*	0.332	6.630
Note: *** p< 0.01* ** p <0.05* *n.s = not significant*			

Customer Engagement showed a strong positive correlation with the use of VR/AR Technologies (β= 0.338, t = 6.292, p < 0.01). Likewise, Quality of VR/AR Experience had a positive effect on engagement (β= 0.250, t = 4.679, p < 0.01). Engagement was also strongly positively correlated with User Familiarity with VR/AR (β=0.332, t = 6.630, p value = 0.01). These findings affirm that technological exposure, quality of experience and familiarity really add up to consumer involvement in healthcare marketing situations.

VR/AR usage and familiarity demonstrated a slightly higher standardized coefficient compared to perceived quality. This indicates that the number of interactions and the confidence of the user might be more significant factors in engagement development than experience refinement.

3.1.4. Mediation Analysis

The mediation analysis was performed with the help of Hayes PROCESS Macro (Model 4) to study whether Customer Engagement is the mediating factor of the connection between VR/AR variables and Purchase Intentions. These findings are described in Table 7.

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Power System Protection and Control
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Total effect of X on Y					
Effect	**se**	**T**	**p**	**LLCI**	**ULCI**
0.235	0.066	3.573	0.001	0.104	0.365
Direct effect of X on Y					
Effect	**se**	**T**	**P**	**LLCI**	**ULCI**
0.145	0.069	2.112	0.038	0.008	0.283
Indirect effect(s) of X on Y:					
MV	**Effect**	**BootSE**	**BootLLCI**	**BootULCI**	
	0.089	0.038	0.028	0.176	

TABLE 7. MEDIATION ANALYSIS RESULTS (HAYES PROCESS MODEL 4)

The overall impact of VR/AR-related variables on Purchase Intentions was important (Effect = 0.235, p = 0.001). The direct effect was also very large (Effect = 0.145, p = 0.038) and this was a partial mediation. The indirect effect of Customer Engagement through bootstrapping resulted in 0.089 with confidence limits (LLCI = 0.028; ULCI = 0.176) that are not equal to zero. This proves that the interaction plays a significant role in the relationship between immersive technology variables and buying behavior.

The results indicate that the application of immersive technologies cannot directly result in the purchase decision without the involvement of psychological engagement mechanisms. Customer engagement thus plays a pivotal role of providing a critical explanatory route between technological experience and behavioral intention.

3.1.5.Summary of Quantitative Findings

The quantitative findings indicate that the use of VR/AR, the quality of perceived experience, and user familiarity are significant to customer engagement. In its turn, engagement has a positive impact on purchase intentions, as well as mediates the relationship between immersive technologies and buying behavior to a partial extent. The differences in age in terms of technical proficiency also indicate that the adoption patterns are determined by the demographic factors (See Table 8).

TABLE 8. SUMMARY OF HYPOTHESIS

Hypotheses	Status
H1: "The use and quality of VR/AR technologies positively influence customer engagement with healthcare products."	**Supported**
H2: "The use and quality of VR/AR technologies positively influence customer engagement with healthcare products."	**Supported**
H3: "User familiarity with VR/AR technology and demographic factors influence the effectiveness of VR/AR in driving customer engagement and purchase intentions."	**Supported**
H4: "Customer engagement with healthcare products via VR/AR technologies significantly influences purchase intentions."	**Supported**

Overall, the findings support the theoretical framework and confirm that immersive healthcare marketing effectiveness depends on psychological engagement processes rather than technological presence alone.

3.2. Qualitative Results and Findings

3.2.1.Emerging Themes from Semi-Structured Interviews

The qualitative analysis of the interview data indicated three prevailing thematic categories, namely, improved engagement and perception of healthcare products, adoption and usability challenges, and ethical issues linked to data privacy and transparency. These themes add a contextual richness to the quantitative results and clarify the

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phenomenological processes by which VR and AR affect engagement and intentions to purchase in healthcare marketing situations.

The initial significant theme was that immersive technologies enhance engagement and perception of healthcare products. The respondents always mentioned VR and AR as much more interactive and engaging than the traditional means of communication, like brochures or verbal consultation. The visualization provided immersion, which allowed users to see and engage with simulated treatment and healthcare devices in real-time and improve understanding and perceived complexity. As an example, AR overlays with anatomical models or wearable medical devices enabled the participants to have a visualization of the product functionality in realistic settings. This immediate communication enhanced cognitive and emotional comfort.

The interviewees stressed that immersive simulations minimized doubts about untested medical technologies. The interactive nature of searching the device mechanisms or treatment processes provided relief to anxiety that usually involves making healthcare decisions. The respondents claimed that VR and AR increased the accessibility of complex medical information and reduced its abstractness. As a result, brands and providers of healthcare that applied immersive tools looked more open and trustworthy. This implies that immersive interactivity can help in the development of trust through the demystification of technical healthcare information. Engagement effects were also enhanced by personalization. Multiple respondents emphasized the fact that VR/AR demonstrations, depending on a particular situation, were more relevant and connected to emotions. To provide an example, a simulated use of a glucose monitor on a personal anatomical model was seen as more significant than generalized explanations. The individualized aspect raised the perceived value and enabled making a more informed decision. These results are consistent with the quantitative mediation evidence that engagement is an intervening psychological process between the experience of technology and purchase intention.
A structured overview of interview themes, sub-themes, and representative participant quotations is presented in Table 9.

TABLE 9. SUMMARY OF INTERVIEW FINDINGS, CORE THEMES, SUB-THEMES, AND REPRESENTATIVE QUOTATIONS

Core Theme	Sub-Themes & Codes	Key Participant Quotations (Evidence)
1. Enhanced Engagement & Perception	Immersive Interactivity *(Codes: Engagement, Real-time, Tangibility)*	"VR and AR have definitely provided a more engaging and interactive way of understanding healthcare products... it's immersive, you can actually explore the product's features in a more hands-on manner." - Person A "It's not just abstract concepts anymore, they can see, in real-time, what I'm talking about, which helps reduce their anxiety." - Person A
	Clarity & Understanding *(Codes: Visual learning, Demystification)*	"It takes the guesswork out of what you're buying or recommending. Traditional brochures feel so one-dimensional now." - Person X (Focus Group corroboration)
	Personalization *(Codes: Tailored experience, Relevance)*	"Using the AR app to demonstrate a glucose monitor in real-time on a patient's arm provided a much clearer and more interactive understanding... tailored demonstrations... made the explanation more tailored and relevant." - Person H (Usability Test corroboration)
2. Challenges in Adoption & Usability	Cost & Resource Constraints *(Codes: High investment, ROI uncertainty)*	"The high costs of VR headsets and AR/VR content development are one of the reasons why small healthcare practices are not implementing it." - Person S (referenced in thesis text as Interviewee)

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	Usability Issues *(Codes: Discomfort, Tech-savviness)*	"Older patients might be intimidated by AR interfaces...they struggled with the learning curve." - Person H (Usability Test) "VR was outside the comfort zone for some, who reported feeling disoriented, motion sick, or uncomfortable." - Synthesis of Interview Feedback
	Technical Accuracy *(Codes: Glitches, Precision)*	"If the technology glitches,like if the AR doesn't align correctly. It can do the opposite and diminish trust. It has to work flawlessly." - Person X
3. Ethical Concerns & Data Privacy	Data Security & Privacy *(Codes: Sensitive data, Protection)*	"When you're dealing with products like glucose monitors or fitness trackers, these devices are collecting sensitive health data... If I can't trust the brand to safeguard their data, it makes it hard for me to promote the product." - Person D
	Transparency & Consent *(Codes: Clear policies, User knowledge)*	"Users need to know exactly what data is being collected and how it is going to be used... If there's any uncertainty, I won't recommend it." - Person Z "I make a point of checking the company's data policy before endorsing a product." - Person D

The second theme was identified as the problem of the adoption and use of VR/AR technologies in healthcare marketing contexts. Participants identified financial and infrastructural barriers as the key constraints to the implementation at large scale. The other weakness identified was the price of VR headsets, accessories that can work with AR, and the creation of immersive content, particularly among smaller health practitioners. The question that was raised by the respondents was whether a measurable ROI would be worth the huge implementation, especially when the outcomes of engagement may be difficult to quantify in the long run.

The usability barriers were also generated during the interview accounts. The respondents also indicated that older users who are not well-versed in technology may feel insecure or lost when using the VR systems. Motion sickness, the complexity of the interface, and cognitive overload were potential deterrents. Nevertheless, despite the introduction of smartphones, AR remained considered more accessible, and its use still required minimal digital literacy. These results complement the quantitative results that the usage of immersive technology is influenced by familiarity and age.

Technical accuracy was particularly relevant in medical-related applications. Any minor anomaly in AR superimpositions or delay in VR changes seemed to be a weakness factor. Respondents pointed out that precision is paramount in maintaining trust as far as medicine is concerned. Technological glitches were viewed as not only inconveniences in functionality, but also factors that can lower the credibility of the product and the brand. This highlights the need for perfection in the application of immersive healthcare marketing strategies.

The third theme was most dominant, and it was the ethical considerations and privacy of data. The interviewees were also very sensitive to the collection and processing of health-related information using immersive technologies. The respondents admitted that VR and AR applications can capture biometric, behavioral, and usage data, which is an issue in the security and storage of this kind of data. Unsafe actions like the violation of confidential clinical information were perceived to be a big threat to consumer confidence.

One of the primary expectations became the data practice transparency. The participants emphasized that the healthcare brands should be transparent on the information they collect and the way and manner in which they are handled. Informed consent was described as the process that guaranteed the implementation of ethics. Some of the respondents admitted that they would be terrified in a state of uncertainty about data management and would not suggest or use VR/AR-enabled healthcare devices. The results provide evidence that ethical visibility is a natural element of long-term involvement and purchase intention in immersive healthcare environments.

3.2.2.Emerging Themes from Focus Group Discussion

The focus group discussion helped intensify and extend the interview findings, particularly in terms of how trust can be built and decisions made. The group attention of the participants was on the fact that the perceived

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transparency is high because of the possibility to feel the product directly. VR and AR were described as the mode of transformation of an abstract description of products into an experiential form. It was believed that this aspect of the experience contributed to enhancing trust by reducing uncertainty and enhancing a more informed evaluation.

According to the participants, the real-time image of the anatomy on the AR and the VR simulator of medical equipment use had an enormous effect on their confidence in recommending the product. Immersive exposure was a decision support system that aids in comprehending the aspects of operations as well as potential outcomes. This is consistent with the results of other researchers who have revealed that the immersivity of interactivity improves the experience of mental images and by appraisal [26]. However, the group members also understood that one can lose trust so easily because of technical mistakes or failure to deliver.

The next focus group situation entailed adoption barriers. The cost aspect, inconvenience due to the lasting use of the headset, and fear of using an overly sophisticated interface were cited. The other participants did not believe in the frivolous or gimmicky nature of AR that was not informational. The implications of these implications are that digital experiences using immersive technologies must offer believable experiential utility rather than novelty to retain interest and behavioral impacts.

3.2.3.Insights from Usability Testing

The usability test provided as the practical evidence on the dynamics of interaction in VR/AR healthcare applications. The respondents asserted that immersion-based demonstrations enhanced learning and participation. The application of a real-time interaction with the simulation of glucose data, wearable devices to track and model the type of patient situation, made people more convinced in work of the product. These findings are consistent with the quantitative outcomes that revealed the evidence of a high degree of positive customer engagement correlations with the use of VR/AR.

Despite these strengths, the participants also described the fact that the system occasionally took too much time, the interface was occasionally slightly recalibrated, and was visually misaligned. Even brief disruptions were reported to disrupt immersion and reduce reported professionalism. These technical discrepancies were viewed as potentially harmful to brand reputation in the healthcare environment, in which reliability and accuracy are the most significant aspects.

The data privacy concern was once again raised during the usability sessions. The respondents more strongly hoped that they would employ the immersive healthcare technologies if the companies provided certain assurances concerning the encryption processes and regulations on data control. There was increased understanding of security practices through open communication that enhanced a feeling of trust. The findings form the basis of the importance of introducing powerful moral safeguards in the systems of immersive healthcare marketing.

DISCUSSION

4.1. Discussion of Qualitative Results

4.1.1. Enhanced Engagement and Perception of Healthcare Products

On the basis of the qualitative findings, it is highly recommended that VR and AR technologies alter the flow of encountering, cognizing, and assessing healthcare products in a significant manner. During the interviews and focus groups, the participants constantly stated that the immersive technologies were superior to the traditional communication methods. In usability testing, Person H mentioned that when the AR app was used to show a glucose monitor in real-time on a patient's arm, the experience was much more interactive and clearer about the product than any paper-based explanation. The immersive nature of interaction in this quote is taken to a level where it is no longer about passive information provision, but about experiencing it.

Similarly, Person J noted that the ability to "*simulate glucose monitoring in real-time and switch between patient profiles enhanced my confidence in recommending the device*." This is not just centered on the visual stimulation, but on functional simulation. The application of immersion allowed the participants to observe cause and effect relationships and this reduced abstraction and increased applied comprehension. It is consistent with the immersive literature that suggests that perceived tangibility and cognitive elaboration increase with experiential interaction [26].

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Focus group participants reinforced this perception. Person X remarked that "*traditional brochures feel one-dimensional, but when AR accurately demonstrates how a device functions, it adds a layer of transparency that's hard to replicate.*" Transparency was one of the principal themes. The subjects who identified the immersive visualization as less uncertain did so on a repetitive basis. The ability to project the equipment under simulated real-time conditions appears to reduce the psychological ambiguity in the healthcare environment, where the products are very complicated and risk-sensitive.

Another dimension that kept recurring was trust-building. Person A said that he made use of AR overlays to show medical equipment to eliminate doubt and make patients more trusting, since they can see how the equipment will directly affect them. This points to the role of the immersive tools used not just as educational tools, but also as mediators of the relational trust. This trust, however, was conditional. Person Y warned that whenever AR is correct and presents accurate anatomical overlays, this instills confidence, whereas when it malfunctions, it may serve the reverse purpose. Therefore, the credibility is pegged on the technological reliability.

Personalization further amplified engagement. Person H emphasized that AR enabled "*tailored demonstrations… showing how a device would integrate with a patient's daily life*." This customization supported relevance and emotional attachment. Individualized immersion appears to increase interaction and usefulness in marketing of healthcare, a very personal decision-making domain. The qualitative data, therefore, suggest that immersion, clarity, and personalization are all drivers towards engagement and building trust.

4.1.2.VR/AR and Decision-Making Processes

In addition to engagement, VR and AR were viewed as decision-support mechanisms. The respondents defined immersive tools as tools that allow making more informed and confident decisions. According to Person A, VR and AR have offered a more interactive and engaging means of learning about healthcare products; they make things more evident and generate trust since patients feel more knowledgeable. It means that the immersive technologies help to process the information using cognition by converting complicated descriptions into experience.

Usability findings support this interpretation. Person, I reflected that "*being able to interact with the product in VR made me feel more confident about its features. I could see exactly how it works in different scenarios*." This real-time interaction minimizes the use of imagination and enables evaluation to be applied. Singh et al. (2022) state that immersive tools decrease the level of cognitive load in high-stakes healthcare decisions because they visualize the functional outcomes; the qualitative outcomes strongly support this theoretical statement [13].

The diminishing uncertainty was especially prominent. Healthcare acquisition tends to be perceived as risk. Person J complained that viewing equipment in simulated clinical settings minimized the level of ambiguity in decision-making. Similarly, participants of the focus group emphasized that AR simulations boosted product knowledge by offering a clear and unusual picture of the functioning of the device. Therefore, the immersive tools seem to convert the speculation into factual assurance.

Nonetheless, the participants also highlighted that the effectiveness of VR/AR is conditioned by the technical accuracy. Latencies, glitches, or misalignment affected immersion and reduced confidence in decisions. Person Y noted that technology, when it malfunctions, might kill trust rather than generate it. This observation underscores the instability of immersive trust: experience credibility has to be maintained technologically.

4.1.3.Barriers to Adoption

Despite strong engagement benefits, participants identified significant adoption barriers. Technological usability emerged as a major constraint. Person H observed that older patients "*might be intimidated by AR interfaces… (they) struggled with the learning curve*." This indicates a larger generational digital divide in the literature[28]. The use of immersive systems demands cognitive and motor familiarity, which not everyone in a demographic group has. Whistles and nausea were also mentioned. Some of the participants indicated that VR experiences were beyond the comfort zone of less technologically savvy users. Such obstacles to usability decrease accessibility and constrain scalability in healthcare settings.

Limitations of resources and cost were mentioned again and again. Person S noted that the expensive nature of VR headsets and the development of AR/VR content do not facilitate usage, particularly among smaller healthcare practices. Respondents raised concerns about the transparency of the return-on-investment, especially in cases of

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long-term involvement measures that cannot be measured. Such issues are in line with Kushnarevych and Kollárová (2023), who single out the barrier of finances as the most significant obstacle in the implementation of immersive [14].

Technological accuracy further influenced adoption. As Person X explained, "*If the AR doesn't align correctly, it can diminish trust. It has to work flawlessly*." Precision is a core aspect in healthcare, and therefore, even slight inaccuracy may compromise confidence. Therefore, the role of immersive marketing cannot be removed without two concepts: technological strength.

4.1.4.Ethical Considerations and Data Privacy

Issues about the privacy of data as an ethical issue proved to be a decisive factor in trust. The participants have been extremely conscious of the fact that immersive technologies capture sensitive health-related information. Person D pointed out that, "*in case I cannot believe the brand to protect their data, then it is difficult to advertise the product*". This assertion provides insights into the role that ethical reliability plays in determining whether people endorse it or not.

Openness was also of great significance. According to person Z, "*it is the duty of the user to be informed of what precisely is being gathered and what purposes it will serve... I will not recommend it in case of any uncertainty. The interviewees insisted on explicit consent and explicit data policies*". The quality of immersive experience was not enough to overcome the issue of privacy.

Person I echoed this in usability testing, noting that they would require "*reassurance from the company that they have solid privacy policies in place before fully committing.*" This indicates that trust in immersive healthcare technologies is contingent upon ethical governance structures. Ramirez et al. (2020) argue that immersive platforms require enhanced regulatory safeguards due to extensive data capture capabilities. The qualitative findings strongly support this argument [24].

Thus, ethical transparency appears to function as a foundational prerequisite for adoption. Without it, immersive engagement advantages may not translate into sustained behavioral intention.

4.2. Discussion of Quantitative Results

The qualitative findings are empirically supported by the quantitative findings. It was revealed that age had a statistically significant negative relationship with the perceived ease of use ($r = -0.45$, $p = 0.01$). The usability barriers were supported by the difficulty of the elderly subjects in interacting with the VR/AR technologies, as the qualitative evidence is concerned. Technical proficiency (0.53, $p < 0.001$) predicted the engagement to a large extent. Immersive satisfaction and confidence of the participants were related to higher technological competence. It aids in facilitating TAM suppositions regarding the perceived ease of use as a behavioral engagement predictor. Customer engagement (0.68, $p < 0.001$) was very strongly predicted to be a predictor of purchase intention. This supports the primary theoretical assumption according to which immersive technologies influence the purchasing behavior primarily through the engagement channels. The mediation analysis also affirmed that engagement had a partial significant relationship in the relation of VR/AR experience to purchase intent (indirect effect significant at $p < 0.01$). This is proving statistically the psychological process which was defined qualitatively by the participants, such as Person A and Person I.

Trust also mediated purchase intention, but the engagement was more predictive. This observation is in line with qualitative data that indicates that trust is required, but the level of immersion activity is a catalyst for the early involvement that, in turn, affects commitment to purchase decision-making. Finally, the quantitative barriers to adoption were obtained. The qualitative results of the generational differences in usability are also confirmed by the presence of a high-level negative relationship between age and perceived ease of use ($r = -0.49$, $p < 0.01$). Further, 45% of the responses mentioned cost as another significant barrier, which confirms that interview findings indicate financial problems.

CONCLUSION

According to the presented study, Virtual Reality (VR) and Augmented Reality (AR) are very significant in terms of customer interest and buying intentions in health care marketing. The findings confirm that immersion and interactivity help to increase cognitive attention, product awareness, and healthcare decision-making confidence.

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The quantitative results showed that there is a strong positive relationship between customer engagement and purchase intention (0.68, p= 0.001), and the mediation analysis, in its turn, revealed that engagement is a significant process that converts the immersive experience into purchase intention. The qualitative findings also stood in favour of the hypothesis that real-time simulation, tailored demonstration, and interactive representations reduce uncertainty and perceived authenticity, particularly in high-stakes healthcare environments where credibility and lucidity are crucial.

Besides, the article also suggests that the success of VR/AR is influenced by demographic and situational factors. The level of interaction was influenced significantly by age and technological prowess because younger and technologically savvy users were more positive about immersive applications. Trust was another aspect that came into being as one of the complementary aspects, especially where the technologies operated as desired and openly. Still, usability problems, price constraints, and ethical concerns regarding data confidentiality remain major concerns for mass usage. Overall, the VR/AR technologies can alter the landscape of healthcare marketing but can only be effective in the long term when the technologies are designed inclusively, are made affordable, and their data governance models are properly developed.

LIMITATIONS

The study has several limitations. First, the paper has limited itself to healthcare products; therefore, it may not reflect on other industries with other types of risks, complexity, or consumer involvement. Second, the sample also comprised a much larger number of younger and techno-familiar members, and this may have influenced the overall engagement outcomes. Third, platform technical differences and device variability might have affected the consistency of the user experience. To prove the applicability and generalize the findings, additional research would require more diverse samples of participants, longitudinal research to examine the effects of long-term loyalty, and analysis of the VR/AR application in other industries.

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REFERENCES

1. Dalal, S.A., Virtual Reality (VR) and Augmented Reality (AR): A Thriving Technology. International Journal of Advanced Research in Science, Communication, and Technology, 2024.
2. Shanmugam, M., et al. Research opportunities on virtual reality and augmented reality: a survey. in 2019 IEEE International conference on system, computation, automation and networking (ICSCAN). 2019. IEEE.
3. Ekmeil, F., et al. Augmented reality and virtual reality revolutionize rusiness transformation in digital marketing tech industry analysts and visionaries during Coronavirus (COVID 19). in Journal of Physics: Conference Series. 2021. IOP Publishing.
4. Gupta, T. and S. Bansal, Immersive horizons: VR and AR in digital marketing. Journal of Marketing & Supply Chain Management, 2022. 1(2): p. 1-7.
5. Kitaria, D. and M. Mwadulo, Adoption of Augmented Reality (AR) and Virtual Reality (VR) in healthcare systems. African Journal of Science, Technology and Social Sciences, 2022. 1(1).
6. Nallasivam, A. and P. Kiran, Influence of augmented reality on purchase intention. Journal of Management and Science, 2022. 12(1): p. 52-60.

DOI: 10.46121/pspc.53.4.26

7. Abrar, K., Impact of augmented reality on consumer purchase intention with the mediating role of customer brand engagement: moderating role of interactivity in online shopping. Bahria University Journal of Management & Technology, 2018. 1(2): p. 64-80.
8. Manis, K.T. and D. Choi, The virtual reality hardware acceptance model (VR-HAM): Extending and individuating the technology acceptance model (TAM) for virtual reality hardware. Journal of Business Research, 2019. 100: p. 503-513.
9. Hsieh, M.-C. and J.-J. Lee, Preliminary study of VR and AR applications in medical and healthcare education. J Nurs Health Stud, 2018. 3(1): p. 1.
10. Cipresso, P., et al., The past, present, and future of virtual and augmented reality research: a network and cluster analysis of the literature. Frontiers in psychology, 2018. 9: p. 2086.
11. Kuehn, B.M., Virtual and augmented reality put a twist on medical education. Jama, 2018. 319(8): p. 756-758.
12. Muñoz-Saavedra, L., L. Miró-Amarante, and M. Domínguez-Morales, Augmented and virtual reality evolution and future tendency. Applied sciences, 2020. 10(1): p. 322.
13. Singh, S., et al., Augmented reality and virtual reality creating ripple in medical and pharmaceutical world, in Advances in Augmented Reality and Virtual Reality. 2022, Springer. p. 113-131.
14. Kushnarevych, A. and D. Kollárova. AR and VR as a Shaping Trend in Consumer Behaviour. in European Conference on Innovation and Entrepreneurship. 2023. Academic Conferences International Limited.
15. Devarasetty, P., A. Balasai, and B. Martin, The evolution of virtual and augmented reality and its various practical applications. J Stud Res, 2022. 11(3).
16. Pantelidis, P., et al., Virtual and augmented reality in medical education. Medical and surgical education-past, present and future, 2018. 26(1): p. 77-97.
17. Bibi, S., et al., Customer Engagement: Theoretical Framework, Reviewing, and Cataloguing, in Insights, Innovation, and Analytics for Optimal Customer Engagement. 2021, IGI Global. p. 49-65.
18. Bansal, R. and N. Pruthi, Role of customer engagement in building customer loyalty-A literature review. Samvakti Journal of Research in Business Management, 2021. 2(2): p. 1-7.
19. Pansari, A. and V. Kumar, Customer engagement: the construct, antecedents, and consequences. Journal of the academy of marketing science, 2017. 45(3): p. 294-311.
20. Kim, K.H., et al., Digital service innovation, customer engagement, and customer equity in AR marketing. Journal of Global Scholars of Marketing Science, 2021. 31(3): p. 453-466.
21. Soni, S., U. Yadav, and A. Soni. Virtual reality & augmented reality: A way to digital transformation of customer engagement. in 2022 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COM-IT-CON). 2022. IEEE.
22. Ma'ruf, J.J., O. Mohamad, and T. Ramayah, Intention to purchase via the internet: A comparison of two theoretical models. Asian Academy of Management Journal, 2005. 10(1): p. 79-95.
23. Akar, E. and T. Dalgic, Understanding online consumers' purchase intentions: A contribution from social network theory. Behaviour & Information Technology, 2018. 37(5): p. 473-487.

DOI: 10.46121/pspc.53.4.26

24. .Ramirez, E.J., et al. An ethical code for commercial VR/AR applications. in International Conference on Intelligent Technologies for Interactive Entertainment. 2020. Springer.
25. Mkedder, N., V. Jain, and P. Salunke, Determinants of virtual reality stores influencing purchase intention: An interpretive structural modeling approach. Journal of Retailing and Consumer Services, 2024. 78: p. 103757.
26. Hilken, T., et al., How to strategically choose or combine augmented and virtual reality for improved online experiential retailing. Psychology & Marketing, 2022. 39(3): p. 495-507.
27. Pase, S. Ethical considerations in augmented reality applications. in Proceedings of the International Conference on e-learning, e-Business, Enterprise Information Systems, and e-Government (EEE). 2012. The Steering Committee of the World Congress in Computer Science, Computer ….
28. Margrett, J., et al., GERONTECHNOLOGY PERCEPTIONS AND POTENTIAL ROLE OF VR/AR IN OPTIMAL AGING. Innovation in Aging, 2019. 3(Suppl 1): p. S239.
29. Kojić, T., et al., Effects of user factors on user experience in virtual reality: age, gender, and VR experience as influencing factors for VR exergames. Quality and User Experience, 2023. 8(1): p. 3.
30. Dirin, A., A. Alamäki, and J. Suomala, Gender differences in perceptions of conventional video, virtual reality and augmented reality. 2019.
31. Rojas-Mendez, J.I., A. Parasuraman, and N. Papadopoulos, Demographics, attitudes, and technology readiness: A cross-cultural analysis and model validation. Marketing Intelligence & Planning, 2017. 35(1): p. 18-39.
32. Davis, F.D., Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 1989: p. 319-340.
33. Hollebeek, L.D., M.S. Glynn, and R.J. Brodie, Consumer brand engagement in social media: Conceptualization, scale development and validation. Journal of interactive marketing, 2014. 28(2): p. 149-165.

DOI: 10.46121/pspc.53.4.26