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HEALTHCARE PROFESSIONALS' PERCEPTIONS OF ADOPTING VIRTUAL REALITY FOR TRAINING AND DEVELOPMENT: ENHANCING SUSTAINABLE BUSINESS MODELS IN HOSPITALS

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ABSTRACT

Purpose
This paper explores healthcare professionals' perceptions of adopting Virtual Reality (VR) for training and development, focusing on how AI-driven VR technologies can improve healthcare training, patient outcomes, and hospital efficiency within the framework of Industry 5.0.

Design/methodology/approach
A descriptive research design assessed healthcare professionals' views on VR adoption for training. Primary data was collected from 285 professionals in hospitals across Kerala using a structured questionnaire and simple random sampling. The Technology Acceptance Model analysed perceptions of VR as a training tool, and statistical methods like Simple Percentage, reliability test, multiple regression, Correlation, Chi-square, and ANOVA were used for analysis.

Findings
The study found that healthcare professionals have a positive perception of VR as a training tool, acknowledging its potential to improve efficiency, reduce errors, and enhance skill development. Key determinants for successful adoption include organizational readiness and technological infrastructure, while challenges such as high implementation costs and resistance to change were noted

Discussion
The study highlights that integrating VR and AI in healthcare training can create sustainable business models by enhancing efficiency, reducing costs, and promoting continuous learning. VR helps healthcare institutions develop dynamic training environments that address Industry 5.0 demands and implementation challenges.

Research limitations
This research is limited to Kerala and may not represent the views of healthcare professionals in other regions. The rapid evolution of AI and VR technology may also impact future adoption patterns, necessitating on-going assessment of perceptions.

Practical implications
Hospitals adopting VR for training can improve operational efficiency, reduce errors, and enhance patient care quality, providing a roadmap for integrating AI-driven VR technologies effectively.

Originality
This study is one of the first to explore AI-driven VR technology and sustainable business models in healthcare training within the industry 5.0 framework.

Keywords: Virtual Reality, Artificial Intelligence, Healthcare Training, Hospital Efficiency, Sustainable Business Models

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1. INTRODUCTION

In an era marked by rapid technological advancements, the healthcare industry is increasingly exploring innovative solutions to meet the evolving demands of medical training and development. Virtual Reality (VR), a tool once limited to the entertainment sector, has emerged as a promising resource in healthcare for training professionals by creating immersive, risk-free environments for procedural learning and skill development. The application of VR in healthcare training addresses crucial needs, such as reducing medical errors, enhancing precision, and improving patient outcomes, while simultaneously supporting sustainable business models by optimizing resource allocation and minimizing training costs.

The evolution of industrial revolutions has paved the way for this kind of technological integration in healthcare. Beginning with Industry 1.0 in the 18th century, mechanized production using steam and waterpower replaced manual labor in industries such as textiles and iron. Industry 2.0 brought electrical energy and mass production through assembly lines, leading to standardized, efficient goods production. Industry 3.0 saw automation through electronics, computers, and robotics, which enabled flexible and automated manufacturing systems. The digital transformation of Industry 4.0 introduced interconnected devices, big data, and AI, creating "smart" factories where IoT and cyber-physical systems allow for real-time monitoring and optimization.

Figure 1

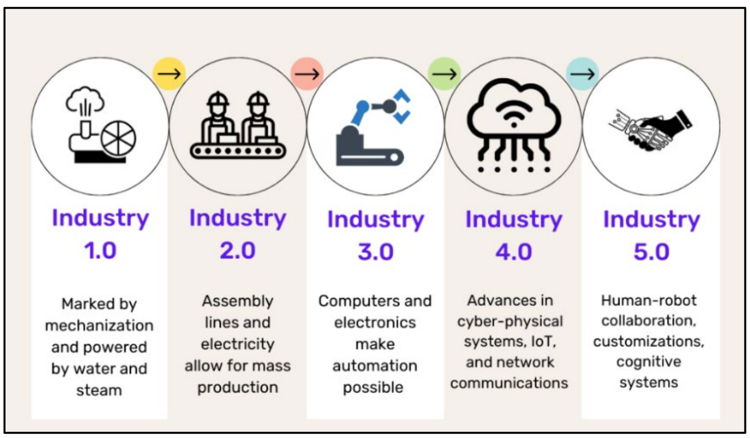

Figure 1 Evolution of Industry

By integrating VR within the Industry 5.0 framework, hospitals can enhance training efficiency, support a workforce that combines technology and empathy, and promote sustainable practices that benefit all stakeholders. Understanding healthcare professionals' perceptions of VR adoption is essential, as their acceptance and engagement are key to successful integration into training protocols, fostering a more adaptable and responsive healthcare sector. This study aims to explore these perceptions, providing insights into how VR can enhance sustainable business models in hospitals within the industry 5.0 framework.

2. OVERVIEW OF HEALTHCARE 5.0

The evolution from healthcare 1.0 to healthcare 5.0 marks a series of transformations in medical practice, technology integration, and patient care.

- **Healthcare 1.0** refers to traditional, manual, and predominantly reactive medical care, characterized by face-to-face consultations and paper-based records. The focus here was on diagnosing and treating diseases after they occurred, with limited technological intervention.

- **Healthcare 2.0** saw the digitization of medical records, the introduction of electronic health records (EHRs), and increased use of the internet for health information. This stage enabled healthcare providers to share patient information more efficiently, fostering early steps toward integrated care.
- **Healthcare 3.0** introduced personalized medicine, integrating data analytics and patient-centered care to provide tailored treatments. Telemedicine and mobile health (mHealth) applications also gained popularity, enhancing accessibility and enabling patients to engage with their healthcare more actively.
- **Healthcare 4.0** represents the emergence of advanced technologies like artificial intelligence (AI), the Internet of Things (IoT), and big data. This stage focuses on predictive and preventive care, allowing healthcare systems to anticipate patient needs and deliver timely interventions. IoT-enabled devices and wearables enable real-time monitoring, significantly improving outcomes and patient engagement.
- **Healthcare 5.0** or "human-centered healthcare" integrates these advanced technologies within the Industry 5.0 framework, emphasizing collaboration between humans and machines for a more empathetic approach to healthcare. It aims to enhance the human experience, focusing on sustainability, ethics, and personalized care through AI, robotics, and virtual/augmented reality. This stage seeks to deliver not only efficient but also compassionate healthcare that addresses complex patient needs holistically.

Figure 2

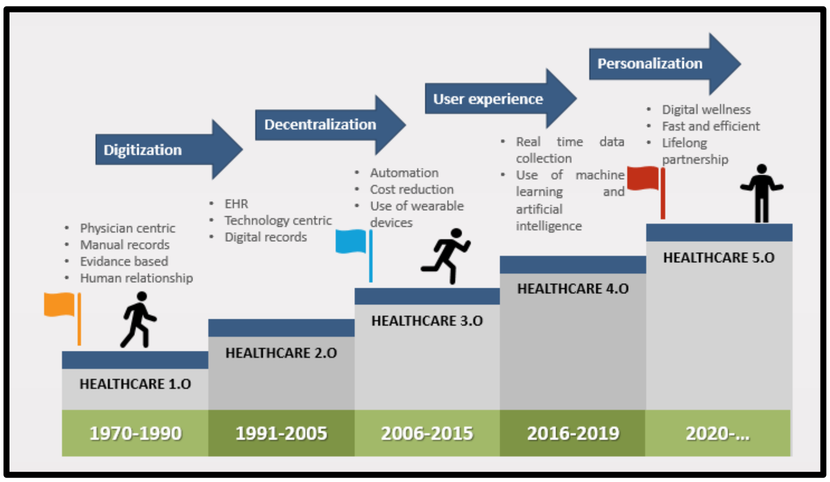

Figure 2 Evolution of Healthcare

The Fifth Industrial Revolution focuses on blending human intelligence with advanced technologies like AI and VR in healthcare, offering opportunities for personalized care and improved collaboration. However, challenges include ensuring equitable access, data security, and balancing efficiency with empathy. Industry 5.0 promotes human-centric, resilient, and sustainable approaches, aligning with healthcare values by enhancing skills through technology while maintaining compassionate care.

Virtual Reality (VR) within healthcare training is advancing with the integration of Industry 5.0 principles, which emphasize collaboration between humans and machines, personalization, and sustainability. Industry 5.0 in healthcare training takes VR to the next level by not only enhancing skills but also aligning with more personalized, human-centric approaches that foster better learning outcomes. Here’s how VR is transforming healthcare training under the Industry 5.0 framework:

1) **Human-Centric Customization**: Industry 5.0 highlights the need for personalized, tailored experiences, and VR in healthcare training is responding by offering simulations that adapt to the learner’s progress and needs. AI-driven algorithms can track individual performance and adjust scenarios to provide appropriate challenges, ensuring that each healthcare professional receives the most relevant and effective training based on their skill level, learning pace, and areas of improvement.

Figure 3

Figure 3 Human-Centric Customization

2) **Collaborative Training Environments**: While traditional VR training is often an individual experience, Industry 5.0 advocates for more collaboration between humans and machines. VR is increasingly being used to simulate team-based scenarios, where healthcare professionals can train together in a shared virtual space. For example, medical teams can practice coordinated responses to critical care situations, like emergency surgeries or patient resuscitation, improving their communication, teamwork, and decision-making skills.

Figure 4

Figure 4 Collaborative Training Environments

3) **Enhanced Sustainability**: In line with Industry 5.0's focus on sustainability, VR training can help reduce resource consumption and waste in healthcare training. By replacing the need for physical models, cadavers, and real-life clinical practice, VR reduces the environmental footprint of training programs. It also ensures that the same high-quality training resources can be reused indefinitely, contributing to long-term sustainability in medical education.

Figure 5

Figure 5 Enhanced Sustainability

4) **Integration of Advanced Technologies**: Industry 5.0 promotes the synergy between human intelligence and advanced technologies. VR training in healthcare is incorporating cutting-edge technologies such as AI, machine learning, and real-time data analytics. These technologies can analyze a trainee's performance in real-time and offer feedback to improve outcomes. Furthermore, VR can incorporate haptic feedback and biometric sensors, enhancing the realism and effectiveness of training scenarios.

Figure 6

Figure 6 Integration of Advanced Technologies

5) **Inclusive and Global Access**: One of the key benefits of VR under Industry 5.0 is its ability to democratize access to healthcare education. VR training platforms can be deployed globally, allowing healthcare professionals in remote or underserved regions to access state-of-the-art simulations. By overcoming geographic and economic barriers, VR can contribute to a more equitable distribution of healthcare knowledge, ensuring that all professionals, regardless of location, can benefit from high-quality, immersive training experiences.

Figure 7

Figure 7 Inclusive and Global Access

Industry 5.0 is reshaping healthcare training through VR by creating more personalized, collaborative, sustainable, and technologically advanced training environments. This evolution not only improves the effectiveness of training programs but also enhances patient care by better preparing healthcare professionals to navigate the complexities of modern healthcare challenges.

3. REVIEW OF LITERATURE AND THEORETICAL BACKGROUND

This section reviews literature on VR adoption in healthcare training, highlighting key challenges and theoretical frameworks. Hemant Patel (2007) critiques technology adoption models, identifying social and personal factors as key to VR adoption. Afkhami (2012) highlighted simulation-based education as an effective method for medical training, with VR providing a safe environment for students to practice medical procedures. Sok Ying Liaw (2014) explores how interprofessional VR simulations help healthcare students understand diverse roles in patient care. Tun et al. (2015) noted that VR adoption in South African medical training is hindered by cost, lack of evidence, and resistance to change. Schmid (2016) explored physiotherapists' experiences with VR training for stroke rehabilitation, identifying key barriers and facilitators. Aziz (2018) discusses the challenges of VR in healthcare, including high costs and the need for regular updates, while emphasizing its potential in improving clinical services. Samadbeik (2018) found that VR significantly enhances medical training, particularly in laparoscopic surgery, and should be adapted to specific medical needs. Wong (2018) examined CPR instructors' perceptions of VR, finding that VR could enhance CPR training. Fagan (2019) used the technology acceptance model to assess nursing students' perceptions of VR simulation, confirming its potential for future adoption. Farra (2019) provided a cost analysis of VR adoption in neonatal ICU training, suggesting VR may offer long-term benefits despite initial costs. Truong et al. (2020) examine VR's effectiveness across medical domains, noting its potential in diagnosis and rehabilitation. Adele Pei Ning Woon (2021) emphasizes the importance of innovative teaching strategies, using VR to improve nursing students' knowledge and skills. Chen (2021) finds VR beneficial for patient engagement, suggesting its personalization capabilities. Elliot Mbunge (2021) proposes healthcare 5.0, integrating VR to enhance healthcare delivery during crises. Lastly, Manar Algahtani (2021) studies VR's adoption in healthcare, finding factors like satisfaction and infrastructure crucial for VR's acceptance. These studies collectively underscore VR's transformative potential and its current limitations in education and healthcare. While existing research highlights virtual reality's transformative potential in healthcare and education, a gap remains in understanding healthcare professionals' perceptions of VR adoption specifically for sustainable training and development models within hospital business frameworks.

The Technology Acceptance Model (TAM) explains how users accept and utilize new technologies, focusing on actual system use as the endpoint. Behavioral intentions (BI), influenced by attitudes (A), drive this engagement. In this study, Industry 5.0 is described as a framework enhancing interaction and information delivery to healthcare professionals through digital interfaces, examining the relationships between perceived usefulness, ease of use, and system utilization in the context of Virtual Reality for training. Perceived usefulness reflects the belief that technology enhances performance, while perceived ease of use indicates how effortless it is to engage with the technology. Both factors significantly influence attitudes toward adoption, with perceived ease of use also impacting perceived usefulness.

4. PROBLEM STATEMENT

In the healthcare sector, continuous skill enhancement and efficient training methods are crucial for adapting to a rapidly changing environment and ensuring organizational sustainability. Traditional training methods often fall short in addressing complex challenges, leading to medical errors and poor patient outcomes. Virtual reality (VR) has emerged as a transformative tool, providing immersive learning experiences that can enhance healthcare professionals' skills, improve hospital efficiency, and support sustainable growth. However, there is limited understanding of healthcare professionals' perceptions regarding VR adoption, particularly its impact on skill development and organizational efficiency. This research aims to explore these perceptions, focusing on the challenges, benefits, and applications of VR in healthcare training. This project aim is knowing the perception of healthcare professionals during fifth industrial revolution

1) How do healthcare professionals perceive the effectiveness of VR training in enhancing their skills?
2) What challenges do healthcare professionals face in adopting VR technology for training purposes?
3) How does the use of VR training contribute to organizational efficiency and sustainable growth in hospitals?

5. OBJECTIVES

This study aims to identify key factors that influence healthcare workers' adoption of Virtual Reality (VR) for training purposes. It gathers insights from healthcare professionals such as occupational, physical, and rehabilitation therapists regarding specific perceived barriers and facilitators to VR usage. The study also examines how VR training impacts participants' knowledge (their understanding of relevant themes), skills (ability to perform procedures or techniques), satisfaction (perception of the VR learning experience), confidence (self-assurance in mastering the content and process), and performance time (duration spent on test tasks). Such factors should be carefully considered when implementing VR in healthcare settings. The research aims to deepen understanding of VR's effectiveness in the healthcare sector, its solutions to various industry challenges, and to assess different VR methodologies to promote practical applications in healthcare training.

The primary objectives of this study are:

- To understand healthcare professionals' perceptions on VR's potential role in training.
- To identify factors that drive VR technology adoption.
- To analyze the readiness of healthcare professionals and benefits for VR technology adoption.
- To assess healthcare professionals' attitudes and behavioral intention toward adopting VR technology.
- To identify challenges in adopting VR for training and development among healthcare professionals in the study area.

6. METHOD AND SAMPLE

This study uses a quantitative questionnaire to collect data, analyzed with tools like SPSS. The Technology Acceptance Model (TAM) helps understand healthcare professionals' views on VR training within healthcare 5.0. A descriptive research design examines factors influencing VR adoption, with data gathered through a structured survey. Simple random sampling was used to select 285 healthcare professionals from hospitals in Kerala, ensuring a representative sample and minimizing bias. This approach provides insights into the barriers, facilitators, and readiness for VR adoption in healthcare training.

7. DATA COLLECTION PROCESS

Data for this study were collected through both primary and secondary sources. Primary data were obtained via observations and interviews with healthcare professionals, including doctors and training department heads in hospitals, providing first-hand insights into VR adoption in training and development. Secondary data were sourced from journals, newspapers, and online databases, offering contextual information to support the study. An initial pilot study with select respondents led to a refined questionnaire, improved based on feedback for clarity. Various statistical tools were applied, including percentage analysis, Reliability analysis, multiple regression, correlation, ANOVA, and Chi-Square tests, to analyze relationships between variables and explore factors affecting VR adoption. This approach offers a comprehensive view of healthcare professionals' perceptions of VR as a tool for skill enhancement and organizational growth in hospitals.

8. HYPOTHESIS DEVELOPMENT

Based on the research objectives, the following hypotheses have been formulated:

- **H1:** Technology acceptance factors (perceived usefulness, perceived ease of use, attitude, and Behaviour intention to use) significantly influence the actual usage of virtual reality in training among healthcare professionals.
- **H2:** There is a significant association between demographic variables (educational qualification, type of occupation, and work experience) and the actual usage of virtual reality in training among healthcare professionals.

- **H3:** There are significant differences in perceived usefulness of virtual reality (VR) technology among healthcare professionals based on their educational qualifications.
- **H4:** There are significant differences in perceived ease of use of virtual reality (VR) technology among healthcare professionals based on their educational qualifications.
- **H5:** There are significant differences in attitudes toward virtual reality (VR) technology among healthcare professionals based on their types of occupation.
- **H6:** There are significant differences in behavioral intention to use virtual reality (VR) technology among healthcare professionals based on their work experience.

Figure 8

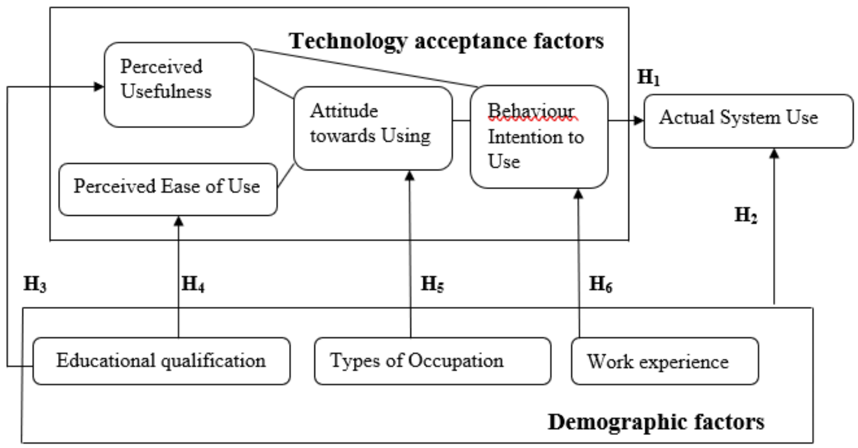

Figure 8 Conceptual framework (author's development)

9. ANALYSIS AND RESULTS

Table 1

Intersection of Demographic Variables			
Demographic profile		**Frequency**	**Percentage**
Education Qualification	Undergraduate	53	18.6
	Diploma Degree	5	1.8
	Postgraduate	174	61.1
	Doctoral degree	53	18.6
Type of Occupation	Doctor	41	14.4
	Nursing Staff	38	13.3
	Lab technician	36	12.6
	Therapist	170	59.6
Work experience	0-5 years	225	78.9
	5-10 years	20	7
	10-15 years	20	7
	Above 15 years	20	7

The demographic snapshot of participants in the study unveils the following observations:

1) **Educational Qualification**: The majority of respondents hold postgraduate qualifications (61.1%), followed by equal proportions of undergraduate and doctoral degree holders (18.6% each). A small segment holds a diploma degree (1.8%). This educational profile suggests a highly educated workforce, which may indicate a greater propensity for understanding and adapting to innovative training solutions like virtual reality.
2) **Type of Occupation**: Therapists constitute the largest occupational group (59.6%), followed by doctors (14.4%), nursing staff (13.3%), and lab technicians (12.6%). The diverse professional roles of the participants reflect a wide-ranging applicability of virtual reality training within various healthcare functions.

3) **Work Experience**: The majority of participants have between 0-5 years of experience (78.9%), with smaller proportions reporting 5-10 years, 10-15 years, and above 15 years of experience (7.0% each). This predominantly early-career demographic may be more adaptable to new training methodologies, like virtual reality, which could enhance skill development in their formative years in the healthcare sector.

Table 2

Cronbach's Alpha-Reliability Assessment of Internal Consistency of the Variables		
Variable	**Statements (Number of items)**	**Cronbach alpha**
Perceived Usefulness	1. Using VR in training improves my overall job performance	.852
	2. VR training helps me accomplish tasks more effectively	
	3. I find VR training to be useful in my professional development	
	4. VR training enhances the quality of my work	
	5. Using VR technology in training increases my productivity	
Perceived Ease of Use	1. I find it easy to learn how to use VR for training	.726
	2. Interacting with VR technology is clear and understandable	
	3. I find VR training tools user-friendly	
	4. It is easy for me to become skillful at using VR for training	
	5. I feel confident navigating VR technology during training sessions	
Attitude	1. I enjoy using VR technology for training.	.848
	2. VR training is a positive addition to my professional development.	
	3. I feel enthusiastic about using VR in healthcare training.	
	4. I believe VR training is a valuable experience.	
	5. I am open to incorporating more VR training in my daily routine.	
Behaviour intention to Use	1. I plan to use VR in future training sessions whenever possible.	.891
	2. I intend to recommend VR training to my colleagues.	
	3. I am likely to use VR for professional training within the next few months.	
	4. I expect to rely on VR as a primary training tool in the future.	
	5. I will consider VR as a preferred method for training and development.	
Actual usage	1. I regularly use VR technology in my training sessions.	.885
	2. I choose VR-based training over traditional methods when possible.	
	3. VR has become an integral part of my training routine.	
	4. I actively seek VR tools for continuous learning.	
	5. I frequently use VR technology in hands-on training activities.	

The Cronbach alpha values for the variables in the study indicate strong internal consistency reliability. The constructs of perceived usefulness (.852) and attitude (.848) demonstrate particularly high reliability, surpassing the commonly accepted threshold of 0.7. The behaviour intention to use construct shows an even higher reliability at .891, indicating a robust measure of participants' intentions toward virtual reality training. The perceived ease of use construct, with a Cronbach alpha of .726, also exhibits acceptable levels of internal consistency, reflecting a reliable assessment of how easy healthcare professionals find it to use virtual reality for training. Finally, the actual usage construct demonstrates strong reliability at .885, suggesting that the measurement of actual engagement with virtual reality training technology is consistent and reliable. Overall, these findings underscore the reliability of the measures used in the study, affirming the validity of the constructions related to virtual reality training among healthcare professionals.

10. TEST OF HYPOTHESIS

Table 3

Employing Multiple Regression to Examine the Impact of Technology Acceptance Factors on Healthcare Professionals' Usage of Virtual Reality in Training			
Independent Variables (Technology Acceptance Factors)	**Dependent Variable (Actual usage)**		
	Standardized Coefficients (β)	**t-Value**	**Sig**
(Constant)	0.229	1.036	.301
Perceived Usefulness	0.137	2.125	.034

Perceived ease of use	0.28	4.565	.000
Attitude	0.214	3.164	.002
Behaviour Intention to Use	0.329	5.535	.000
R 0.708			
R^2 0.501			
F.Value		70.234	.000

The regression model has an R value of 0.708, indicating a strong correlation between the independent variables and actual usage. The R^2 value of 0.501 suggests that approximately 50.1% of the variance in actual usage can be explained by the technology acceptance factors included in the model. The overall model is statistically significant (F-value = 70.234, $p < 0.001$), indicating that the combination of these factors significantly predicts actual usage.

The regression coefficients reveal specific weights in the relationship, indicating that technology acceptance factors is influenced by Perceived Usefulness (X_1), Perceived ease of use (X_2), Attitude (X_3) and Behaviour Intention to Use(X_4) as expressed by the equation:

$AU = 0.229 + 0.137 \cdot PU + 0.280 \cdot PEU + 0.214 \cdot A + 0.329 \cdot IU$

The hypotheses examined in this study shed light on the intricate relationship between Technology acceptance factors and Actual usage. A direct relationship is established between the variables

1) **Perceived Usefulness** positively influences actual usage. The standardized coefficient (β=0.137) indicates that as consumers perceive the usefulness of the technology, their actual usage increases. This finding is statistically significant, with a t-value of 2.125 and a p-value of 0.034, suggesting that perceived usefulness is an important factor in determining how often users engage with the technology.
2) **Perceived Ease of Use** has a strong positive effect on actual usage. The standardized coefficient of 0.280 demonstrates that users are more likely to utilize the technology when they find it easy to use. This relationship is highly significant (t-value = 4.565, $p < 0.001$), highlighting the critical role that user-friendly design plays in driving actual technology usage.
3) **Attitude** also positively impacts actual usage. With a standardized coefficient of 0.214, this indicates that favorable attitudes towards technology enhance its usage. The result is statistically significant (t-value = 3.164, p = 0.002), reinforcing the idea that positive user attitudes contribute significantly to actual engagement with technology.
4) **Behaviour intention to Use** emerges as the strongest predictor of actual usage, with a standardized coefficient of 0.329. This suggests that the stronger the behaviour intention to use the technology, the more likely users are to engage with it. This finding is statistically significant (t-value = 5.535, $p < 0.001$), underscoring the importance of behaviour intention as a precursor to actual usage behavior.

The findings reveal that perceived usefulness, perceived ease of use, attitude, and behaviour intention to use significantly influence actual usage of virtual reality training technology among healthcare professionals, demonstrating positive relationships with user engagement. Specifically, healthcare professionals are more likely to engage with virtual reality training when they perceive it as useful, easy to use, and when they hold favorable attitudes toward it. Among these factors, behaviour intention to use emerged as the strongest predictor, indicating that healthcare professionals' intentions are critical for actual adoption of virtual reality training.

However, the constant term indicates that even when no other factors are considered, the baseline level of actual usage remains relatively low, though not statistically significant. This suggests that there may be additional factors influencing actual usage that were not captured in this model. Overall, these insights emphasize the importance of understanding the diverse elements that impact technology acceptance and usage among healthcare professionals and highlight opportunities for enhancing engagement with virtual reality training by focusing on perceived usefulness, ease of use, and positive attitudes toward the technology.

Table 4

Pearson's Correlation Matrix					
	Perceived Usefulness	**Perceived Ease of Use**	**Attitude**	**Behaviour Intention to Use**	**Actual usage**
Perceived Usefulness	1				

Perceived Ease of Use	.444**	1			
Attitude	.597**	.501**	1		
Behaviour Intention to Use	.586**	.465**	.636**	1	
Actual usage	.527**	.531**	.585**	.625**	1

**Significance level of correlation is p < 0.01 (2-tailed).

The Pearson correlation analysis revealed significant associations among the variables related to virtual reality training. Notably, strong correlations were identified between the independent variables (Perceived Usefulness, Perceived Ease of Use, Attitude, and Behaviour Intention to Use) and the dependent variable (Actual Usage). The strongest statistically significant correlation coefficient ($r = 0.636$, $p < 0.01$) was found between Actual Usage and Attitude, indicating that a more favorable attitude towards virtual reality training is closely linked to higher usage levels.

Additionally, significant correlations were observed between Actual Usage and other independent variables, including Perceived Usefulness ($r = 0.527$, $p < 0.01$) and Behaviour Intention to Use ($r = 0.625$, $p < 0.01$), suggesting that perceiving VR as useful and intending to use it positively influence actual usage. The correlation between Actual Usage and Perceived Ease of Use ($r = 0.531$, $p < 0.01$) further indicates that ease of use plays an important role in the adoption of VR training technologies.

These findings underscore the interconnectedness of the factors influencing the usage of virtual reality training, highlighting the importance of enhancing perceived usefulness, ease of use, and positive attitudes to increase actual usage among healthcare professionals.

Table 5

Chi Square Test				
Demographic Variable	**Actual usage (Chi square)**	**Df**	**p**	**Sig.**
Educational Qualification	33.719	12	0.001	Highly significant
Type of Occupation	26.853	12	0.008	Highly significant
Work experience	26.374	12	0.009	Highly significant

The results of the Chi-square test reveal significant associations between demographic variables and actual usage of virtual reality training technology. Specifically, educational qualification ($\chi^2 = 33.719$, df = 12, p = .001) demonstrates a highly significant relationship, indicating that individuals with varying educational backgrounds differ notably in their engagement with virtual reality training. Similarly, the type of occupation ($\chi^2 = 26.853$, df = 12, p = .008) also shows a highly significant association, suggesting that different occupational roles exhibit differing levels of actual usage of VR training. Additionally, work experience ($\chi^2 = 26.374$, df = 12, p = .009) reveals a highly significant relationship, implying that the length of time professionals have worked in their field may influence their adoption and utilization of virtual reality training.

These findings underscore the importance of demographic factors in understanding how healthcare professionals engage with virtual reality training, suggesting that targeted strategies may be necessary to enhance usage across different educational qualifications, occupations, and levels of work experience.

Table 6

Comparative analysis using One-way ANOVA assessing the relationship between Educational qualification and Perceived Usefulness									
Demographic profile		**Mean**	**SD**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Educational qualification	Undergraduate	3.75	0.89						
	Diploma Degree	4.40	0.54	Between Groups	2.069	3	0.69		
	Postgraduate	3.86	0.74	Within Groups	178.443	281	0.635	1.086	.355
	Doctoral degree	3.84	0.87	Total	180.512	284			

The One-Way ANOVA analysis conducted in this study explored healthcare professionals' perceptions of adopting virtual reality (VR) for training and development, specifically examining how these perceptions varied across different educational qualifications. The results revealed no statistically significant differences among the groups, as indicated by an F-statistic of 1.086 and a p-value of 0.355.

Table 7

Comparative Analysis Using One-Way ANOVA Assessing the Relationship Between Educational Qualification and Perceived Ease of Use									
Demographic profile		**Mean**	**SD**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Educational qualification	Undergraduate	3.15	0.81						
	Diploma Degree	3.60	0.54	Between Groups	2.984	3	0.995		
	Postgraduate	3.40	0.72	Within Groups	156.511	281	0.557	1.786	.150
	Doctoral degree	3.39	0.74	Total	159.495	284			

The results indicated a total sum of squares of 159.495, with a between-group sum of squares of 2.984 and a within-group sum of squares of 156.511. The F-statistic was calculated to be 0.995, with a p-value of 0.150, suggesting that there are no statistically significant differences in perceptions of ease of use among the educational qualification groups.

Table 8

Comparative Analysis Using One-Way ANOVA Assessing the Relationship Between Types of Occupation and Attitude									
Demographic profile		**Mean**	**SD**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Types of occupation	Doctor	3.65	0.88						
	Nursing staff	3.52	0.76	Between Groups	3.095	3.095	1.032		
	Lab technician	3.61	0.72	Within Groups	184.449	281	0.656	1.572	.196
	Therapist	3.80	0.80	Total	187.544	284			

Results from the One-Way ANOVA indicated that there were no statistically significant differences in attitudes toward virtual reality (VR) technology among healthcare professionals based on their types of occupation. The total sum of squares was 187.544, with a between-group sum of squares of 3.095 and a within-group sum of squares of 184.449. The calculated F-statistic was 1.032, accompanied by a p-value of 0.196.

Table 9

Comparative Analysis Using One-Way ANOVA Assessing the Relationship Between Work Experience and Behavioural Intention To Use									
Demographic profile		**Mean**	**SD**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Work experience	0.5 Years	3.72	0.91						
	5-10 years	3.90	1.11	Between Groups	2.416	3	0.805		
	10-15 years	3.95	0.60	Within Groups	227.212	281	0.809	0.996	.395
	Above 15 Years	4.00	0.72	Total	229.628	284			

Results from the One-Way ANOVA analysis revealed no statistically significant differences in the behavioral intention to use virtual reality (VR) technology based on work experience among healthcare professionals.The total sum of squares was 229.628, with a between-group sum of squares of 2.416 and a within-group sum of squares of 227.212. The calculated F-statistic was 0.805, and the p-value was 0.395.

11. DISCUSSION

This study highlights the strong influence of perceived usefulness, ease of use, attitude, and behaviour intention to use on healthcare professionals' adoption of virtual reality (VR) for training. Behaviour Intention to use emerges as the strongest predictor, emphasizing the importance of fostering proactive engagement with the technology. Notably, healthcare professionals' attitudes toward VR are generally positive, suggesting an openness to embracing innovative training methods. The study also reveals that, despite varying educational qualifications and work experience, the overall perception of VR as a valuable tool for training is favorable across all groups. These findings suggest a strong foundation for the successful integration of VR in healthcare training, provided that the technology is tailored to meet the diverse needs of professionals across different roles and experience levels.

However, several challenges complicate VR adoption in healthcare training. High costs, both in terms of initial hardware and on-going software updates, can strain budgets, especially in resource-limited facilities. Infrastructure demands, such as dedicated space and reliable technical support, add logistical hurdles. Additionally, the steep learning curve for VR technology may discourage less tech-savvy professionals, requiring comprehensive training and on-going support to foster confidence and competence. Concerns about VR-induced discomfort or fatigue also affect adoption, highlighting the need for user-friendly, ergonomic designs. Addressing these barriers requires affordable, adaptable VR solutions, simplified user interfaces, and strong support systems to ensure effective integration across healthcare roles.

12. RECOMMENDATIONS

To promote sustainable VR training in hospitals, strategies must address cost, usability, and accessibility. The following recommendations aim to create practical VR solutions that support healthcare professionals' diverse needs and long-term adoption.

- Develop affordable VR training solutions tailored for healthcare settings to support sustainable integration.
- Invest in scalable infrastructure to flexibly accommodate VR training based on demand and resources.
- Provide targeted on boarding and technical support to ease VR adoption for healthcare professionals.
- Collaborate with developers to enhance VR user-friendliness, minimizing fatigue and discomfort.
- Gather regular feedback from users to continuously refine and align VR training with healthcare needs.

13. CONCLUSION

This study addresses the urgent need for effective VR training implementation in hospitals by assessing technology acceptance, feasibility, and infrastructure requirements. It provides hospitals with a standardized approach for adopting VR across various areas, streamlining the implementation process. The study also outlines the necessary tools and actions to ensure the sustainable development of VR technology. Looking ahead, hospitals plan to continue integrating VR training, with the findings serving as a reference for on-going management improvements. The study highlights VR's positive impact on skill enhancement, performance, and behavior, while fostering a collaborative, continuous improvement mind-set among healthcare professionals. This marks the beginning of an on-going journey toward perfecting VR training in healthcare.

14. LIMITATIONS AND FUTURE RESEARCH

The current study employs quantitative data to assess healthcare professionals' perceptions of adopting virtual reality (VR) for training and development in hospitals, though it has several limitations. Each interview took 15-20 minutes due to participants' busy schedules, which resulted in a reduced sample size of 285. Additionally, some respondents were uncooperative, further limiting the sample. The study assumes that the information provided was accurate, and the findings may not be generalizable to other industrial settings, as the data was collected exclusively from clinical staff, excluding non-clinical and 3-tier staff.

The adoption of VR for training in healthcare involves multiple independent factors. Future research could compare different VR models to identify the most suitable applications for various medical disciplines. Due to time constraints, not all determinants and challenges of VR adoption were explored, so more in-depth studies are needed. Additionally, further research should address infrastructure, financial, and policy implications for VR adoption, particularly in departments like oncology, surgery, and rehabilitation. Lastly, exploring the integration of technologies like IoMT, AI, and VR could enhance eHealth solutions and improve healthcare training outcomes.

CONFLICT OF INTERESTS

None.

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