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The adoption of virtual reality in e-commerce in South Africa

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Background: E-commerce in South Africa (SA) is growing, and virtual reality (VR) technology holds significant potential to transform the online buying experience. However, a deeper understanding of the barriers to VR adoption among e-commerce consumers in SA is crucial.

Objectives: This study aimed to understand how consumers perceive the usefulness and actual use of VR in e-commerce in SA.

Method: A qualitative method based on a case study using an explorative research design was adopted. Data were collected via semi-structured interviews among individuals aged 18 years and above who resided in Cape Town, SA. Through quota sampling, participants with varying degrees of familiarity with VR technology and e-commerce were included.

Results: Participants strongly believed VR would influence e-commerce in SA. They emphasised the importance of carefully selecting products suitable for VR experiences to maximise the benefits for online shoppers.

Conclusion: This research investigated barriers to VR adoption in e-commerce in SA. While participants were optimistic about VR's potential, concerns about cost, accessibility, and technical challenges were identified. The study highlights the need for a strategic approach to VR implementation, considering product categories and external factors.

Contribution: This study provides valuable insights for e-commerce businesses, policymakers, and technology developers in SA. Key contributions include the introduction and application of the VR Adoption Model (VRAM) in the South African context. The VRAM extends the Technology Acceptance Model (TAM) by incorporating dimensions such as perceived enjoyment, social influence, and immersion, offering a nuanced understanding of VR adoption dynamics.

Keywords: E-commerce; traditional shopping; virtual reality; virtual shopping; virtual reality adoption.

Introduction

The rapid expansion of Virtual Reality (VR) technology is not just a trend; it is a revolution that is reshaping various industries, such as gaming, education and healthcare (Abbott 2022). Notably, the retail industry, particularly e-commerce, is at the forefront of this transformative shift with the incorporation of VR technology, which offers consumers a more immersive and interactive shopping experience. As online shopping becomes increasingly popular in South Africa (SA) because of its convenience and time-saving benefits (Abbott 2022), it is essential to explore how VR could further enhance this experience. The potential for VR to revolutionise online shopping is significant, particularly in a market such as SA, where e-commerce is expected to generate substantial revenue growth, from $2.7 billion in 2020 to an estimated $4.8 billion by 2025 (Oladunjoye & Tshidzumba 2022). However, despite the promising outlook, the growth of e-commerce in SA is hindered by challenges such as limited internet access, distrust in online payment systems and a general lack of awareness about the benefits of online shopping (Mmakhuthe 2022). While VR technology has been extensively studied and applied in various sectors, its adoption in e-commerce, particularly in the South African context, remains underexplored (Oladunjoye & Tshidzumba 2022).

Existing research highlights the potential benefits of VR in enhancing the online shopping experience, including increased purchase intention, perceived utility and overall customer satisfaction (Lee 2009; Kim 2022). However, studies also indicate a significant gap in consumer awareness and adoption of VR in SA, with only a small percentage of consumers familiar with

the technology (Maziriri et al. 2023; Peukert et al. 2019). Moreover, only 1% of South African retailers reported adopting VR to enhance their online shopping platforms by 2019 (Peukert et al. 2019). This study aims to fill this knowledge gap by investigating the factors influencing the adoption of VR in e-commerce among South African consumers. Doing so, contributes to the scientific understanding of the barriers to VR adoption in developing markets and offers insights into how these barriers might be overcome.

In a comprehensive review of literature on augmented and VR within the context of e-commerce, several key studies have been examined, each contributing unique insights into the adoption and impact of these technologies. However, each study introduces a specific research gap, ranging from the need for more focussed investigations in South African e-commerce to a deeper exploration of the impact and effectiveness of VR in enhancing online retail, especially post-coronavirus disease 2019 (COVID-19).

Fan et al. (2020) delve into the adoption of augmented reality in online retailing, specifically examining its influence on consumers' product attitudes from a cognitive perspective. The findings of their study provide valuable insights into the relationship between augmented reality adoption and consumer perceptions. However, a notable research gap emerges as their study's relevance is limited to the broader scope of technology adoption in online retail, lacking a specific focus on the nuances of technology adoption within the context of South African e-commerce. The study performed by Glazer et al. (2010) explores the intriguing concept of a VR shopping experience. While the authors introduce this captivating idea, the specifics of their findings remain elusive. The research gap here lies in the absence of detailed insights into the impact of a VR shopping experience on consumer behaviour or the factors influencing its adoption, leaving an area for further exploration and understanding.

Kim (2022) shifts the focus to the post-COVID-19 retail landscape, suggesting the use of VR to enhance e-commerce. While this forward-looking perspective provides a potentially innovative solution, the research gap emerges in the form of the effectiveness of VR in enhancing e-commerce, particularly within the unique challenges posed by the post-COVID-19 era. In a study by Lee, Kim and Choi (2019), the adoption of VR devices is explored, emphasising the integration of enjoyment, social interaction and the strength of social ties within the Technology Acceptance Model (TAM). The research gap identified here pertains to the applicability of the TAM in explaining the adoption of VR devices, specifically within the context of e-commerce in SA.

This study is socially valuable as it seeks to address these challenges by investigating the potential of VR to improve the quality of online shopping experiences in SA, ultimately leading to higher consumer satisfaction, trust and loyalty. Furthermore, the study addresses specific gaps in the body of

literature by focussing specifically on South African consumers and retailers to understand their perceptions and barriers related to VR in e-commerce. Finally, the study aims to develop a tailored theoretical framework (Virtual Reality Adoption Model – VRAM) that extends TAM to include factors such as perceived enjoyment, social influence and immersion, making it more applicable to the South African context.

The fast advancement of VR technology offers a considerable potential for innovation in e-commerce. Nonetheless, its implementation in SA is obstructed by socio-economic obstacles, such as restricted internet connection, elevated equipment costs and insufficient consumer understanding of VR advantages. Although research has examined VR's transformational potential in improving online purchasing worldwide, studies addressing its adoption in the distinct socio-economic and infrastructural environment of SA are few. This research investigates South African customers' impressions of VR, the obstacles to its acceptance and the consequences of e-commerce expansion.

Literature review

Virtual Reality is recognised as a technological innovation that can revolutionise various industries, including e-commerce (Maziriri et al., 2023). However, consumer perception of the ease of using VR in e-commerce is vital for its successful adoption, particularly in SA (Grewe 2023). By examining factors influencing technology adoption, insights can be gained into the acceptance and challenges of VR in the South African e-commerce context. The e-commerce industry in SA, including models such as business-to-consumer (B2C), business-to-business (B2B), and customer-to-customer (C2C), has become a key driver of economic growth and technological advancement, fuelled by Internet and mobile technology integration (Moriset 2018).

The following thematic sections shall be reviewed in support of the literature review for this study:

- Growth of e-commerce in SA
- Challenges in South African e-commerce
- Government initiatives and market expansion
- Future prospects and VR integration.

Growth of e-commerce in South Africa

The e-commerce sector in SA has evolved gradually, with a notable increase in internet connectivity, from 54.0% in 2014 to 61.8% in 2019, as reported by Statista (2023). This growth in internet access has coincided with the expansion of the e-commerce market, driven by rising internet penetration rates, mobile device adoption and changing consumer behaviour (Donga & Kadyamatimba 2020). These advancements have significantly impacted business operations and consumer purchasing behaviours, positioning e-commerce as a crucial element for economic growth and technological progress in the country (Mon 2020; Ndayizigamiye & Khoase 2018). The increase in mobile commerce, supported by the proliferation

of smartphones and tablets, further underscores the importance of mobile-friendly platforms for businesses in SA (Baxter & Hainey 2019).

Challenges in South African e-commerce

Despite the progress in internet accessibility, SA still faces a significant digital divide, particularly in rural areas, where internet penetration was only 22.3% in 2019 (Martínez-Navarro, Bigné, Guixeres, Alcañiz & Torrecilla, 2019). This digital divide limits access to e-commerce opportunities for a substantial portion of the population, highlighting the need for targeted initiatives to bridge this gap (Ferguson et al. 2020). Moreover, consumer concerns about online transaction security, fraud and data privacy pose challenges for e-commerce businesses, necessitating the implementation of robust security measures and transparent practices to build consumer trust (Malapane & Ndlovu 2024). The complexity of SA's payment ecosystem and logistical challenges in delivery also impact customer satisfaction and require strategic planning and innovation by e-commerce companies (Moodley & Buthelezi 2023). Despite these challenges, the South African e-commerce sector continues to show significant growth potential, driven by government initiatives and evolving consumer behaviour.

The South African government's commitment to advancing digital infrastructure and e-commerce is evident through initiatives such as the National Integrated Information Communication Technology (ICT) Policy White Paper (Li, Pogodin & Vasilyeva 2022). These policies, along with investments in broadband connectivity and related technologies, are expected to contribute to the growth of the e-commerce industry by providing businesses with opportunities to access untapped markets and promote inclusivity in e-commerce adoption (Glazer et al. 2010). The significant growth in online sales, highlighted by a 66% expansion in SA's e-commerce sector in 2020, reflects the shift in consumer preferences towards online shopping platforms and the increasing role of mobile commerce in the e-commerce landscape (Sibindi 2022).

Future prospects and virtual reality integration

The integration of VR into South African e-commerce presents opportunities for enhancing customer engagement and improving decision-making processes. Research suggests that VR can lead to higher customer satisfaction, emotional attachment to products and reduced return rates (Lima, Irigaray & Lourenco 2019; Rolls et al. 2016). While global trends in VR adoption highlight its potential to enhance product perceptions and customer experiences, the successful integration of VR into South African e-commerce requires careful consideration of the unique challenges and opportunities presented by the South African market.

Challenges in virtual reality adoption in South Africa

Obstacles such as elevated equipment expenses, restricted internet connectivity and scepticism towards online payment methods are substantial impediments to VR adoption in SA. Peukert et al. (2019) disclosed that hardly 1% of South African merchants had embraced VR by 2019. According to Dlamini and Botha (2024), consumer awareness of VR remains low in SA, with many perceiving it as a luxury rather than a necessity. The limited internet connectivity in rural areas, as emphasised by Martínez-Navarro et al. (2019), further hinders VR adoption, highlighting the need for tailored initiatives to address these challenges. Kim (2022) illustrated the significance of perceived utility and pleasure in facilitating VR adoption. Nonetheless, these studies often neglect to include the distinct cultural and economic elements affecting South African consumers, including digital literacy and confidence in emerging technology.

Conceptual framework

This research enhances the TAM by integrating socio-economic and infrastructural variables (Figure 1). Although Davis (1989) highlights perceived utility and simplicity of use, these characteristics are nonetheless inadequate in circumstances such as SA. Incorporating other factors such as subjective pleasure, social impact and external variables yields a more comprehensive picture of VR adoption. The study will be grounded in the TAM, which provides a valuable framework for examining users' acceptance and use of new technology (Ajibade 2018; Davis 1989). Technology acceptance model posits that perceived usefulness (PU) and ease of use are key determinants of technology adoption (Lewis 2019). In this study, TAM will be applied to understand how South African consumers perceive the usefulness of VR in e-commerce, their attitudes towards its adoption and their actual usage of the technology. This theoretical framework will guide the investigation into the factors that influence consumer behaviour in the context of VR adoption in e-commerce.

Perceived ease of use

The concept of perceived ease of use (PEOU) pertains to the degree to which prospective users believe a specific technology is straightforward to operate (Davis 1989; Rahman et al. 2017). In the context of e-commerce, PEOU pertains to the extent to which consumers can effortlessly navigate the VR interface and successfully engage in activities such as product browsing, item selection and purchase transactions. According to Abbott (2022), an elevated
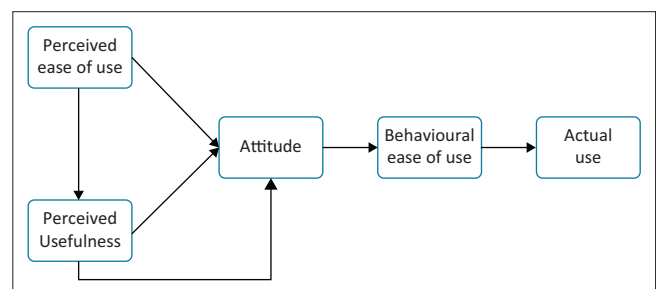
Source: Davis, F.D., 1989, 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly* 13(3), 319–340. https://doi.org/10.2307/249008

FIGURE 1: Technology acceptance model.

perception of ease of use would enhance the probability of adoption.

Perceived usefulness

The concept of PU pertains to the extent to which individuals hold the belief that a particular technology will augment their level of performance or productivity (Hsiao & Yang 2011; Rahman et al. 2017). In the area of e-commerce, within the framework of VR, the concept of PU pertains to the degree to which individuals perceive that VR technology has the potential to enhance their shopping encounters. This may encompass functionalities such as the capacity to virtually simulate the experience of wearing garments or visually represent products in three-dimensional form (Marasco et al. 2018; Tussyadiah et al. 2018).

Attitude

Attitude pertains to an individual's comprehensive assessment of a particular technology (Davis 1989; Rahman et al. 2017). Within the domain of e-commerce, the concept of attitude pertains to the overall perception regarding the utility and efficacy of VR technology in augmenting online shopping encounters. A favourable disposition towards VR would enhance the likelihood of adoption in e-commerce.

Behavioural ease of use

Behavioural intention pertains to an individual's inclination or willingness to utilise a specific technology, as defined by Chau and Hu (2001). In e-commerce, the concept of behavioural intention pertains to the probability that a consumer will engage in online shopping through the utilisation of VR technology. An elevated level of behavioural intention is positively associated with an increased probability of adoption (Tussyadiah et al. 2018).

Actual use

Actual use refers to the degree to which individuals engage in the use of a particular technology (Davis 1989; Rahman et al. 2017). In the context of VR in e-commerce, actual use would pertain to the number of consumers who have actively used VR for online shopping. Higher actual use would indicate greater adoption of the technology.

This study, therefore, leverages the TAM, which posits that PEOU and PU are critical determinants of technology adoption. By aligning the thematic findings with these constructs, the study explores how consumer perceptions influence VR adoption in the South African e-commerce context.

Research methodology

This study seeks to offer valuable insights into how VR can be leveraged to enhance the online shopping experience in SA, addressing both consumer needs and retailer strategies in a rapidly evolving digital landscape. In so doing, this study utilised a qualitative approach, employing a case study research strategy to investigate the barriers to the adoption of VR in e-commerce within the South African context. The case study approach was chosen because of the complex nature of VR integration in e-commerce, which is influenced by scientific advancements, societal dynamics and economic considerations. Kumar (2011) argues that qualitative research is better suited for examining complex issues because of its ability to delve into depth and uncover underlying meanings. This exploratory design allowed for an in-depth examination of the factors influencing VR adoption, focussing on the PU, ease of use and consumer attitudes towards VR technology.

Setting

The study was conducted in Cape Town, South Africa, a city known for its diverse population and growing digital economy (Arnardu & Francke 2021). Cape Town was selected as the study location because it serves as a hub for digital commerce in SA, characterised by high internet penetration rates, a thriving e-commerce industry and a diverse consumer demographic (Mmakhuthe 2022). This makes it an ideal setting to explore the adoption of innovative technologies such as VR in e-commerce. Furthermore, the city's mix of tech-savvy and traditional consumers provides valuable insights into varying attitudes towards VR adoption in different market segments.

Study population and sampling strategy

The study population consisted of individuals aged 18 years and above, residing in Cape Town, with knowledge or experience in information technology (IT) and e-commerce. The inclusion criteria focussed on participants with varying degrees of familiarity with VR technology, ensuring a diverse representation of perspectives on its adoption in e-commerce. Quota sampling was employed to ensure a diverse representation of participants across varying levels of familiarity with VR technology and e-commerce. Quotas were established based on predefined characteristics, including participants' level of exposure to VR (e.g. regular users, occasional users and non-users) and their engagement with e-commerce platforms (e.g. frequent online shoppers, occasional online shoppers and those with minimal online shopping experience). This approach allowed the inclusion of a wide range of perspectives, thereby capturing nuanced insights into the barriers and facilitators of VR adoption. By categorising participants into these subgroups and allocating quotas to each category, the study ensured balanced representation, which is particularly important given the exploratory nature of this research. In addition, this method facilitated data collection until data saturation was reached, where no new themes emerged from participant responses.

Data collection

The primary data collection method was semi-structured interviews, which allowed for flexibility in exploring the

participants' attitudes, beliefs and perceptions regarding VR and e-commerce. Semi-structured interviews, as noticed by Low (2019), are a valuable tool for gathering rich and detailed data. This research employed this method to comprehensively explore the factors influencing VR adoption in e-commerce within the South African context. The open-ended nature of the questions enabled participants to provide comprehensive and nuanced responses, offering valuable insights into the complexities of VR adoption in the South African e-commerce sector. The interviews were conducted in English, and the interview guide was developed based on the constructs of the TAM, focussing on PU, PEOU and attitudes towards technology. The interviews were conducted virtually and in person in Cape Town, South Africa, to accommodate participants' preferences and accessibility. Each interview lasted between 30 min and 45 min, a duration deemed appropriate to explore the topic in-depth while maintaining participant engagement. A structured interview protocol was used to maintain consistency across sessions, ensuring that all relevant themes were covered while allowing for spontaneous, participant-driven discussions.

Addressing potential biases

Several measures were implemented to mitigate potential biases:

- **Interviewer bias:** To maintain neutrality, interviewers adhered to the structured guide and avoided leading questions.
- **Selection bias:** Quota sampling ensured diverse representation across demographics, including age, gender and familiarity with VR and e-commerce.

Data analysis

The data collected from the interviews were transcribed, checked for accuracy and cleaned before analysis (Braun, Clarke & Weate 2016). The study employed thematic analysis as the primary method for analysing the data. This qualitative research technique involved identifying patterns or themes within the data, which were then categorised according to the constructs of the TAM. Thematic analysis was chosen for its ability to identify and categorise patterns in qualitative data, aligning with the exploratory nature of this study (Kumar 2011). The study employed NVivo software to facilitate the thematic analysis of the interview data. The software was selected for its ability to handle qualitative data efficiently, particularly in coding and organising themes across large datasets. The software enabled systematic coding of participants' responses, making it easier to identify recurring patterns and unique insights. By leveraging NVivo's advanced search and visualisation tools, the analysis achieved a high level of accuracy and reliability, ensuring that all data points were considered when developing the study's findings.

The choice of NVivo was also informed by its compatibility with qualitative research methodologies, particularly its ability to streamline the coding process and provide visual representations of themes. As the participants articulated, this facilitated a deeper exploration of the barriers and opportunities for VR adoption in e-commerce.

Ethical considerations

Ethical approval for the study was obtained from the relevant ethics committee at the Cape Peninsula University of Technology, with permit number 208150240/2023/29. All participants provided informed consent before participating in the study, and their confidentiality and anonymity were maintained throughout the research process. The study adhered to ethical guidelines, ensuring that the participant's rights and well-being were protected at all stages of the research.

The following measures were implemented:

Informed consent: Before participating, all individuals were provided with an informed consent form detailing the study's objectives, methodology, potential risks and benefits. The form also outlined participants' rights, including the freedom to withdraw from the study at any point without repercussions. Participants were required to sign this document to confirm their voluntary participation.

Anonymity and confidentiality: Participants' identities were anonymised to ensure confidentiality. Pseudonyms (e.g. P1, P2) were used throughout data analysis and reporting to prevent identification. In addition, no personally identifiable information was recorded or included in the final manuscript. Any specific details that could indirectly identify participants (e.g. job titles, unique characteristics) were excluded or generalised to safeguard their privacy.

Data storage and security: All collected data, including interview transcripts and audio recordings, were securely stored in encrypted files on password-protected devices. Access to the data was restricted to the principal researcher and supervisor, who signed confidentiality agreements. Backup data were stored in an encrypted cloud storage service to prevent data loss, with strict access controls in place.

Participants' rights and welfare: Measures were taken to protect participants' rights and well-being throughout the research. Participants were fully informed about the purpose of the study, how the data would be used and their right to ask questions or express concerns at any stage. To minimise psychological discomfort, the interview questions were designed to avoid sensitive or intrusive topics. Participants were provided with contact information so that the researcher and the ethics committee could address any follow-up concerns.

Adherence to ethical guidelines: This research followed the ethical guidelines of the Cape Peninsula University of

Technology, including respecting participants' autonomy, ensuring beneficence by minimising risks and maintaining justice by selecting participants equitably.

Results

Participants' demographical information

This section provides a clearer overview of the participants' demographic details, such as age, gender, expertise level and familiarity with VR.

The age range of participants in this research demonstrates diverse involvement with VR technology for online shopping. The majority of individuals in the sample, namely 45.5%, are between the ages of 26 years and 35 years, followed by ages 36–45 years, and those aged 46 years and over make up 18.2% of participants. Table 1 shows that the majority of participants are male, making up 72.7% of the sample, with females accounting for 27.3%. The majority of participants demonstrated high levels of IT expertise, followed by moderate and basic levels. Similarly, most participants exhibited high or moderate familiarity with VR, with a smaller proportion having low familiarity.

Thematic analysis

The thematic analysis revealed four key themes that emerged from the data, aligning closely with the study's objectives. These themes provide valuable insights into consumer perceptions of VR technology within the South African e-commerce landscape, particularly focussing on PEOU, PU, Attitudes (ATT) and External Variables.

Perceived ease of use

Two significant comments were made in this regard:

> 'Yes, I don't see difficulties in using virtual reality for online shopping, and it can make shopping very easy. If proper training can be provided, everyone will find it so easy to use virtual reality, including old people.' (P10, 26–35 years, Female)

> 'It will depend on the setup of that particular e-commerce platform. The young ones, those who are used to buying online, may not find it difficult, but someone not used to online shopping might find it challenging.' (P11, 46+ years, Male)

TABLE 1: Demographic information of participants.

Participant	Age range (Years)	Gender	Expertise level	Familiarity with VR
P1	26–35	Male	High	High
P2	26–35	Male	High	High
P3	26–35	Male	High	Moderate
P4	36–45	Female	Moderate	Moderate
P5	26–35	Male	High	High
P6	46+	Female	Basic	Low
P7	26–35	Male	High	High
P8	36–45	Male	Moderate	Moderate
P9	46+	Female	Basic	Low
P10	26–35	Female	Moderate	Moderate
P11	46+	Male	Basic	Low

VR, virtual reality.

The ease of use, especially when combined with proper training, is crucial for technology adoption. This is consistent with Bhutto, Jamal and Ullah (2023) and Hsiao and Yang (2011), who found that user training and the perceived simplicity of technology are important factors in technology acceptance. The initial challenges associated with VR, such as technological barriers and setup, are significant but manageable with appropriate support. These insights are valuable for e-commerce platforms considering VR integration, suggesting that investing in user training and support can enhance adoption rates.

Perceived usefulness

Two significant comments were made in this regard:

> 'VR shopping allows for a closer and more detailed examination of products, providing a level of scrutiny comparable to a traditional shopping experience.' (P6, 46+ years, Female)

> 'For customers in remote locations, traditional online shopping often lacks the opportunity to thoroughly examine products in a 3D environment.' (P10, 26–35 years, Female)

Participants' views on the usefulness of VR, particularly its ability to facilitate remote product examination, underscore its potential to address some of the limitations of traditional online shopping. The high costs of VR headsets and the slow adoption by e-commerce platforms are barriers that need to be addressed. The findings echo those of Kim (2022) and Mon (2020), that emphasise the importance of technological benefits in influencing consumer behaviour. E-commerce platforms could benefit from exploring ways to reduce costs and accelerate the adoption of VR to realise its potential benefits fully.

Attitudes

The positive attitudes expressed by participants reflect a growing acceptance and enthusiasm for emerging technologies in e-commerce. This aligns with the notion that consumers are increasingly open to innovative shopping experiences that VR can provide. Participant 9 stated:

> 'The level of effort a company invests in showcasing their product speaks volumes. I'm more likely to trust and purchase from a company that utilises immersive technology like VR to provide a comprehensive understanding of their product.' (P9, 46+ years, Female)

The anticipation and excitement about VR technology suggest that consumers are ready for more sophisticated shopping tools, which could drive future adoption and integration of VR into e-commerce platforms (Chuah 2018; Mon 2020).

External variables

Two significant comments were made in this regard:

> 'You may run into this type of issue where the VR experience is different from the real experience. Let's say you're selling a car, and the VR makes it look and feel good, but the actual product may differ.' (P9, 46+ years, Female)

'It is crucial to consider potential user experience barriers, like feeling disoriented during navigation in VR, which might need optimising for comfort and confidence.' (P10, 26–35 years, Female)

Concerns about product compatibility and return policies are significant external variables influencing VR adoption. These concerns are critical for ensuring a smooth user experience and building consumer trust. Martínez-Navarro (2019) highlights the impact of actual use on technology acceptance, which supports the need to address these external factors. E-commerce platforms should focus on improving product compatibility information and return policies to facilitate VR adoption and enhance consumer confidence.

The study provides a comprehensive view of the factors influencing the adoption of VR in e-commerce, highlighting both the potential benefits and challenges. The insights gained can inform strategies for improving VR technology integration and addressing consumer concerns, ultimately contributing to a more effective and engaging online shopping experience.

Strengths and limitations

A significant strength of this study lies in its use of qualitative methods to explore the nuanced perspectives of South African consumers regarding VR adoption. The use of semi-structured interviews allowed for in-depth exploration of participants' views, providing rich data on the factors influencing VR adoption in e-commerce.

The study also has limitations that need to be considered when interpreting the findings. One primary limitation is the small sample size of 11 participants. While the sample was sufficient to achieve data saturation and uncover key themes through a qualitative approach, it limits the generalisability of the findings to a broader population. The small sample size means that the insights are most applicable to the specific participants included in the study and may not fully capture the diversity of consumer experiences and perceptions across South Africa.

In addition, the study's geographical focus on Cape Town further constrains the generalisability of the findings. Cape Town is known for its relatively high levels of technological adoption and access compared to other regions in South Africa, which might not reflect the experiences of consumers in rural or less technologically advanced areas. This focus could mean that some unique challenges faced in other regions, such as greater connectivity issues or differences in purchasing power, may not have been adequately represented.

Despite these limitations, the findings provide valuable exploratory insights into the barriers to VR adoption in e-commerce in South Africa. Future research is encouraged to address these limitations by:

- Increasing the sample size to include a more diverse range of participants across different demographic and socio-economic groups

- Expanding the study to other regions in South Africa to understand regional variations in perceptions and barriers to VR adoption.
- Utilising mixed methods to combine qualitative depth with quantitative breadth for broader generalisability.

Implications or recommendations

The findings of this study have several implications for future research, policy and practice. E-commerce platforms should consider investing in user training and support to enhance the adoption of VR technology, as well as exploring ways to reduce the costs of VR headsets and accelerate their adoption. Addressing external factors such as product compatibility and return policies is also critical for building consumer trust and confidence in VR-enabled shopping experiences. Future research could focus on exploring VR adoption across different demographics and regions in South Africa, as well as conducting longitudinal studies to assess the long-term impact of VR on e-commerce. In addition, policymakers could consider supporting initiatives that promote the broader adoption of VR technology in the retail sector, potentially driving innovation and economic growth.

Specific recommendations for policymakers and practitioners include:

- **Subsidise virtual reality devices:** To make VR technology accessible to a wider audience, policymakers should consider implementing subsidy programmes or providing grants for VR devices. This approach can target underprivileged groups and small-to-medium enterprises (SMEs) to lower the financial barriers associated with adopting this technology.
- **Launch public education campaigns:** Governments and e-commerce stakeholders should collaborate to create public awareness campaigns highlighting VR's benefits for enhancing online shopping. These campaigns can include community workshops, online tutorials and VR demonstrations in public spaces to increase familiarity and trust in the technology.
- **Foster partnerships between e-commerce platforms and virtual reality providers:** Practitioners in the e-commerce sector are encouraged to partner with VR developers and technology providers to integrate VR capabilities into their platforms. These partnerships can enable cost-sharing, innovative use-case development and widespread adoption of VR technologies tailored to local market needs.
- **Encourage the development of local virtual reality ecosystems:** Governments can incentivise the growth of local VR development industries by offering tax breaks, research grants or incubation programmes for startups focussing on VR solutions in e-commerce. This fosters innovation and ensures solutions are tailored to the unique needs of the South African market.

A visual representation of the key findings is presented in Table 2. The results are structured around four primary

TABLE 2: Summary of thematic analysis from participant responses.

Themes	Sub-themes	Description
Perceived Ease of Use	Ease with training	Participants found that with adequate training, VR technology can be easy to use in online shopping contexts.
	Virtual versus physical shopping	The comparison between VR shopping and traditional physical shopping highlighted VR's potential to enhance the experience.
		Potential obstacles, such as technological barriers and initial setup issues, were identified.
Perceived Usefulness	Expense and availability of VR headsets	High costs and limited availability of VR headsets were seen as barriers to widespread adoption.
	Lack of adoption by e-commerce platforms	Participants expressed concern about the slow adoption of VR by e-commerce platforms.
	Remote product examinations	Virtual Reality was recognised for its ability to facilitate detailed product inspection remotely.
Attitudes	Inevitable impact	Participants believed that VR would inevitably shape the future of e-commerce.
	Positive impact of decision-making	Virtual Reality was perceived as having a strong positive influence on consumers' purchasing decisions.
	Anticipation to use	There was a high level of anticipation and excitement about the future use of VR in online shopping.
	Favourable intention	Participants showed a strong intention to adopt VR for future online purchases.
External Variables	Product categories and usability (behavioural ease of use)	Concerns were raised about the usability of VR for different product categories, affecting ease of use.
	Concerns about product fit and return policies (actual use)	Issues such as product fit and the clarity of return policies were significant concerns influencing VR adoption.
	Influence on willingness to us	External factors, including trust in the technology and return policies, were seen as critical to adoption.

VR, virtual reality.

themes: PEOU, PU, ATT and External Variables. Each theme is further subdivided into specific sub-themes, providing a comprehensive overview of the findings.

Conclusion

The findings of this study have led to the development of a tailored and comprehensive modified TAM specifically designed for the adoption of VR technology in online shopping called the VRAM Model. Unlike the generic TAM model, which primarily focusses on PU and PEOU as the main determinants of technology adoption, this modified model incorporates additional dimensions that are particularly relevant to VR adoption. A more nuanced understanding of the intricate decision-making process involved in adopting VR technology for online shopping is provided by this modified TAM model, which incorporates perceived enjoyment, social influence, immersion and realism, and other crucial factors influencing users' attitudes and intentions towards VR adoption. This modification highlights the study's contribution to expanding theoretical frameworks customised to technical developments and their adoption patterns, as well as the unique problems and possibilities given by VR technology in the context of e-commerce. The findings emphasise the need for businesses and policymakers to address both technological and socio-economic barriers to VR adoption in South African e-commerce. Training programmes, cost subsidies and robust return policies are crucial for fostering trust and accessibility. By tailoring VR solutions to the unique needs of South African consumers, stakeholders can unlock its transformative potential, bridging digital divides and enhancing online shopping experiences.

The VRAM integrates constructs from the TAM with additional dimensions such as Perceived Enjoyment,

Immersion, and Social Influence to reflect the unique dynamics of VR adoption in e-commerce. Arrows indicate hypothesised relationships between constructs, informed by participant responses and prior literature.

Figure 2 presents the VRAM relating to this study. It includes the following items:

- **Perceived Ease of Use (PEOU):**
  - Participants acknowledge the importance of sufficient training and instruction for effectively using VR in online shopping.
  - Concerns about disorientation and technical difficulties highlight the need for continuous enhancement and advancement in VR technology.

Participants' emphasis on the usability of VR aligns closely with TAM's construct of PEOU. For instance, Participant 10 stated: 'Yes, I don't see difficulties in using VR for online shopping, and it can make shopping very easy if proper training is provided'. This insight underscores the necessity of intuitive design and adequate training to enhance PEOU, a key driver in TAM for increasing user acceptance.

- **Perceived Usefulness (PU):**
  - Virtual Reality technology is thought to be helpful for improving decision-making processes, enabling remote product exploration, and offering captivating and realistic shopping experiences.
  - Participants like how VR may enhance their entire shopping experience, confidence and product knowledge.

The participants' recognition of VR's ability to improve decision-making and enhance shopping experiences directly
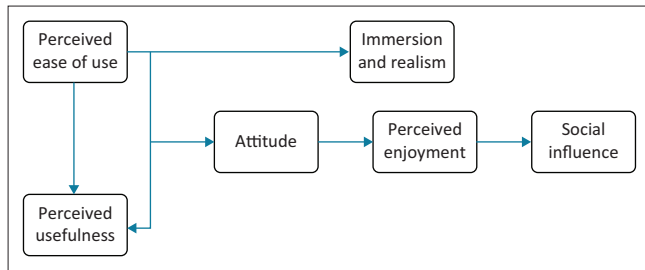
FIGURE 2: Virtual reality adoption model.

corresponds to the TAM construct of PU. For example, Participant 9 expressed: 'The level of effort a company invests in showcasing their product speaks volumes. I'm more likely to trust and purchase from a company that utilises immersive technology like VR'. This aligns with TAM's assertion that users adopt technologies they perceive as useful for achieving their goals, in this case, making informed and confident purchasing decisions.

- **Attitudes (ATT):**
  - Most participants believe VR will revolutionise online shopping, citing improved experiences and increased sales.
  - While some worry about user adoption, the overall sentiment is that VR is the future of e-commerce.
  - There is excitement for VR shopping because of its convenience, immersive experiences and ability to make informed decisions.
  - Participants expressed a positive outlook on VR's potential to improve online shopping experiences.

- **Immersion and Realism (IR):**
  - Participants value the immersive and realistic qualities of VR technology in providing a lifelike shopping experience.
  - Immersion and realism contribute to users' perceived engagement, enjoyment and overall satisfaction with VR-enabled buying experiences.

- **Perceived Enjoyment (PE):**
  - Participants express enjoyment and excitement about the immersive and interactive nature of VR-enabled shopping experiences.
  - The enjoyment derived from using VR technology may positively influence users' attitudes and intentions towards its adoption in online shopping.

- **Social Influence (SI):**
  - The perceptions and opinions of peers, family and social networks may influence individuals' decisions to adopt VR technology in online shopping.
  - Positive social influence, such as recommendations from trusted sources or social validation, may enhance users' attitudes and intentions towards VR adoption.

Modified Technology Acceptance Model for virtual reality adoption in online shopping

PEOU → PU (Perceived Ease of Use to Perceived Usefulness): Perceived ease of use influences users' perceptions of the PU of VR technology in online shopping. If users find VR technology easy to use, they are more likely

to perceive it as useful for their shopping needs, as they can navigate and interact with the technology effortlessly. Higher ease of use may lead to a positive perception of usefulness, as users believe that VR technology can effectively facilitate their online shopping experience.

PEOU → ATT (Perceived Ease of Use to Attitude): Perceived Ease of Use influences users' ATT towards VR technology. If users find VR technology easy to use, they are more likely to develop a positive attitude towards its adoption, as they perceive it as accessible and user-friendly. Higher ease of use may lead to a more favourable attitude towards VR technology, as users feel more comfortable and confident in engaging with it.

PU → ATT (Perceived Usefulness to Attitude): Perceived Usefulness influences users' ATT towards VR technology. If users perceive VR technology as useful for their online shopping needs, they are more likely to develop a positive attitude towards its adoption, as they see value in incorporating it into their shopping routines. Higher PU may lead to a more favourable attitude towards VR technology, as users recognise its potential to enhance their shopping experience.

PEOU → IR (Perceived Ease of Use to Immersion and Realism): Perceived ease of use influences users' perceptions of IR in VR-enabled shopping experiences. When users perceive VR technology as user-friendly, they are more likely to interact with it comfortably and successfully, fully immersing themselves in the virtual world. User-friendliness means the system is intuitive and easy to navigate, with clear instructions and minimal technical jargon, accommodating users of all technical backgrounds. An appealing design, both visually and ergonomically, significantly enhances user comfort and engagement, contributing to a more enjoyable and immersive experience. Furthermore, simplicity in design – characterised by a streamlined interface and the elimination of unnecessary elements – ensures that users can focus on the content rather than struggling with the system's operation. Combining these elements, a user-friendly, visually appealing and simple VR system, fosters a more accessible, engaging and immersive experience, leading to higher user satisfaction and successful interaction. Increased usability might improve users' capacity to engage with VR interfaces and browse virtual storefronts, resulting in a higher level of immersion. Therefore, a positive perception of ease of use contributes to users' overall satisfaction with the IR of VR-enabled shopping experiences.

PU → ATT → PE → SI (Perceived Usefulness to Attitude to Perceived Enjoyment to Social Influence): Users' ATT towards VR technology is influenced by their PU, which is determined by how useful VR technology is to them for their online purchasing requirements. When consumers accept VR with passion and positivism, their Perceived Enjoyment (PE) of VR-enabled retail experiences is improved. Users' views of Social Influence (SI) are favourably impacted by higher reported pleasure from VR technology because they are more

likely to share their good experiences with friends and family, which promotes VR adoption on a positive social level.

IR → PE (Immersion and Realism to Perceived Enjoyment): Immersion and Realism in VR-enabled shopping experiences influence users' PE of the technology. If users perceive the VR environment as immersive and realistic, they are more likely to enjoy their shopping experiences as they feel more engaged and present in the virtual environment. Higher IR may lead to greater enjoyment of VR-enabled shopping experiences as users feel more connected to the virtual world and the products within it.

The original branches of PU and PEOU are still crucial in the updated TAM model for VR adoption in online commerce because they have a direct impact on consumers' attitudes and intentions towards VR technology adoption. These categories encapsulate the perceived value and simplicity of VR purchasing, which are key factors in determining consumers' adoption and inclination to interact with the technology.

The updated model could not specifically include the branches of Actual Use, Behavioural Intention and ATT. This is because PE, SI and IR serve as additional dimensions that complement and enrich users' attitudes and intentions towards VR adoption. These criteria comprise aspects of both attitude and behavioural intention because they influence consumers' overall judgements of the technology and their propensity to embrace it.

Furthermore, while real usage is a significant outcome variable in conventional TAM models, the modified model may not explicitly include it because it places more emphasis on the variables affecting users' initial adoption choices than on their behaviour after that. However, the effects of PE, SI and IR on actual use can still be inferred indirectly, as they contribute to shaping users' attitudes and intentions towards continued usage of VR technology in online shopping.

It follows that the modified TAM model offers a comprehensive framework for understanding the adoption of VR technology in online shopping. It captures both cognitive and affective dimensions of users' evaluations and intentions, emphasising PU, PEOU, PE, SI and IR.

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Authors' contributions

P.J. wrote the article under the supervision of E.R.F. and K.N.O. P.J., E.R.F. and K.N.O. read and approved the final manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author, P.J., upon reasonable request.

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