

Reconceptualizing AR/VR for Emerging Economies: Mobile-Based Solutions to Drive Accessibility and Adoption

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Abstract

Augmented Reality (AR) and Virtual Reality (VR) technologies hold immense potential for revolutionizing industries such as education, healthcare, workforce training, and entertainment. Despite their transformative efficacy, the proliferation of AR and VR products and services in emerging markets remains impeded by exorbitant costs, infrastructural deficiencies, and a dearth of localized content. Conventional VR and AR devices encounter significant barriers, including the requirement for powerful computing hardware inaccessible to wider population, poor user experiences due to internet connectivity issues, and limited smartphone compatibility, all of which impede scalability. This study employed a mixed-method approach, using surveys and expert interviews to capture user experiences and identify key factors limiting adoption. Key findings indicate lack of regional content and ecosystem support, rather than technical constraints, was the primary cause of the rise and fall of AR/VR products on the market today. Practical implications suggest developing regional content, making VR apps more accessible for low-end devices, and introducing sustainable business models like pay-per-use experiences and ad-supported content can all hasten the adoption of AR and VR in emerging countries. Collaboration between governments and private-sector stakeholders is pivotal in enhancing digital infrastructure and accessibility. Given AR and VR technologies immense potential to democratize immersive experiences across education, healthcare, and workforce training, this research underscores the viability of mobile-based VR as an accessible, affordable, and scalable solution. However existing barriers can be addressed through strategic investments in infrastructure fortification, affordability, and localization. The study concludes by providing a prescriptive roadmap to technology developers, investors, and legislators looking to close the adoption gap between AR and VR in cost-sensitive areas.

Introduction

Augmented Reality (AR) and Virtual Reality (VR) technology enhance user experiences by incorporating digital elements into real-world settings (Shankar et al., 2023; Moro et al., 2020). However, high device cost, inadequate infrastructure, and lack of pertinent material results in adoption barrier (Opeoluwa Akinradewo et al., 2025; Wish-Baratz et al., 2020). The research study uses a mixed-methods approach, incorporating surveys and expert interviews, to evaluate user difficulties. The findings further suggest that the invention is tripped not by technological issues, but by lack of localized and relevant content and ecosystem factors. The study highlighted that the key way around these adoption barriers as the necessity to deliver content tailored to geographical region, to optimize content for low end devices, and to develop viable business models, which include per-use charge and ad-funded models. In addition, the study reveals that, mobile based virtual reality is an affordable, scalable option, hence enhance access. It offers a real-life guideline for strategical advancement for both the developers of technology, investors and, legislators, for increasing affordability and effectiveness of AR/VR (Koumpouros 2024).

Literature Review

Augmented Reality (AR) and Virtual Reality (VR) are continuously evolving global technologies that can be used in various fields such as healthcare, education or tourism as well as in industrial production lines. These works were also examined to identify the number of advantages combined with disadvantages

that are high costs related to the hardware and software, low access to resources, and insufficient infrastructure. This paper gathers prior literature related to case studies and discussions about AR/VR technologies encompassing the quality attributes of implementations, cost analysis for cheaper solutions, and use of mobile-based solutions to increase the chances of implementation.

Incorporating UX in AR application is therefore very important for the successful implementation as highlighted by Gutiérrez, Samper, Jabba, Nieto, Guerrero, Betts, and López (2023). The given research offers a multicriteria decision-making approach for prioritizing UX aspects in AR applications. Their study found that usability, satisfaction, stimulation, engagement, and aesthetics are key factors influencing user experience. The integration of AR/VR with IoT and AI in smart city frameworks is gaining traction (Simon, & Jagatheesaperumal, 2023). The authors also discuss how AIoT (Artificial Intelligence of Things) and Extended Reality (XR) can enhance urban experiences by optimizing data-driven decision-making. Their study highlights the cost constraints of AR/VR adoption in IoT applications within emerging economies, emphasizing the need for low-cost mobile-based solutions to drive engagement.

Another recent study provides an in-depth review of tracking technologies for AR, categorizing them into sensor-based, marker-based, and hybrid systems. Mobile-based AR applications rely heavily on vision-based tracking, which utilizes smartphone cameras and sensors for real-time interaction (Toqeer, Muhammad, Abdullah, Salman, Namoun, Alzahrani, Nadeem, & Alkhodre, 2023). Their findings indicate that mobile AR solutions can be optimized using lightweight development tools such as ARToolKit and Unity plug-ins, which lower barriers to entry for developers in resource-constrained environments. The high cost of AR/VR hardware remains a major barrier to widespread adoption. Studies suggest that mobile-based AR/VR solutions can significantly reduce costs by leveraging existing smartphone infrastructure. The authors advocate for cost-effective XR solutions through the integration of AI-driven content generation and cloud-based rendering, which can reduce reliance on expensive standalone AR/VR devices. Additionally, smartphone-based AR applications offer greater accessibility by eliminating the need for specialized headsets, making them more suitable for users in emerging economies.

With the rise of collaborative AR applications, security and trust management have become crucial concerns. The studies discuss vulnerabilities in collaborative AR (CAR) systems, particularly in distributed environments where multiple users interact in real time. The proposal of blockchain-based security models to enhance trust, data integrity, and privacy in AR-based communication platforms is also a key takeaway from the study. Such security frameworks are essential for ensuring the reliable deployment of AR applications in education, healthcare, and business collaboration in emerging economies (Toqeer, Muhammad, Abdullah, Salman, Namoun, Alzahrani, Nadeem, & Alkhodre, 2023).

Research Methods

The study employs a mixed-methods approach to investigate the adoption barriers and opportunities for AR/VR in emerging economies, with a particular emphasis on mobile-based solutions. By integrating both quantitative and qualitative methodologies, the research provides a comprehensive analysis of technological, economic, and user experience factors influencing AR/VR adoption. Secondary data from industry reports, technology white papers, and market research publications are analyzed to understand current adoption trends, cost structures, and technological advancements in mobile AR/VR solutions. Selected case studies from emerging economies provide real-world insights into successful and failed AR/VR implementations. These cases highlight key challenges, success factors, and lessons learned from previous initiatives. A combination of surveys and expert interviews captures insights from AR/VR users, developers, business stakeholder and policymakers.

Key Concepts

Mobile-First AR/VR Accessibility

Given the high cost of dedicated AR and VR hardware, leveraging mobile devices as primary platforms for immersive experiences is a critical strategy for emerging economies. Mobile-based AR/VR solutions utilize existing smartphone infrastructure, reducing barriers to entry and increasing accessibility. By optimizing applications for lower-end smartphones and developing lightweight AR tracking and rendering techniques, developers can create inclusive experiences without requiring expensive headsets or high-performance computing power (Lampropoulos, 2025). This approach ensures broader adoption across

regions with limited purchasing power while aligning with the increasing penetration of smartphones worldwide.

Localized Content and Cultural Relevance

The success of AR/VR adoption in emerging markets is heavily dependent on the availability of culturally and contextually relevant content. Many existing AR/VR applications cater primarily to Western audiences, making it difficult for users in different regions to connect with the experiences (Gutiérrez, Samper, Jabba, Nieto, Guerrero, Betts, & López, 2023). By developing region-specific applications such as local language educational tools, healthcare simulations based on prevalent medical conditions, and tourism applications showcasing historical sites, stakeholders can enhance engagement and usability. Encouraging local content creators to contribute to AR/VR ecosystems can bridge the content gap and improve user adoption rates.

Sustainable Business Models for AR/VR Growth

Traditional AR/VR monetization strategies, such as direct hardware sales and high-cost software licenses, are not viable in cost-sensitive markets. Instead, alternative business models can drive sustainable adoption. Pay-per-use services, ad-supported content, and microtransaction-based experiences allow users to access immersive applications without significant upfront investment (Lampropoulos, 2025).

However, the governments and private sectors can employ collaboration with non-profit organizations in order to sustainably support of AR/VR in such industries as education and healthcare. Some of these business models can make the AR/VR solutions to have a cost advantage and thus increase the market penetration.

Infrastructure Development and Connectivity Enhancement

One of the main challenges impacting the future readiness of AR/VR in the emerging countries is the instability of the internet connection and the generally undeveloped digital environment. Since most AR/VR applications are demanding in terms of bandwidth requirements and rely on cloud-based computation, such solutions can hardly be implemented in rural or regions with limited Internet connection. These limitations can be addressed by factors such as implementing edge computing, offline functionalities as well as adaptive streaming solutions (Egbengwu, Garn & Turner, 2025). In addition, governments and technology solution providers should ensure that broadband connectivity is extended and that mobile networks for such applications are more reliable. Supporting digital environment does not only help to advance the acceptance of AR/VR but aids in improvement of technology in these areas as well.

Discussion

The study results vindicate findings made in other research on the compounding challenges and opportunities presented by AR/VR technologies in emerging economies. From the literature review we deduced that the deployment of AR/VR technologies is on the rise worldwide however there is a challenge in the resource scarce geographic areas whereby the technologies are expensive, the underlying structures are inadequate and there is little content in the geographic region. This approach of using case studies, structure survey and the interview of key experts provided a good ground to address a number of these challenges as seen from the user end and also from the industry perspective. However, the literature also indicates that there are barriers in adopting mobile based AR/VR solutions which include issues such as high costs of developing AR/VR applications from scratch and the need for infrastructure such as head mounted displays for mobile based AR/VR solutions; the literature even however reveals that mobile based AR/VR solutions that leverage on smartphone infrastructure can reduce these barriers. The position regarding pay-per-use and advertisement supported content reinforces other proposals based on future work done by the authors clarifying that, besides cost effectivity and accessibility, affordability for value-added services as well as prevalence should represent key criteria for a good pricing strategy.

Study and Data Collection

To achieve the research objectives of this study, the analytical tool that was used was mixed method approach to establish the adoption barriers for AR/VR technology and the possible suitability enhancement opportunity to be discovered. Using both quantitative and qualitative research, the paper offers analysis on the factors such as access, cost, and degree of expansion. Conducted data sources where case studies,

structured questionnaires and interviews with experts. The sample comprised both the AR/VR users and non-Users who have been selected from different employment categories and technological stages. To eliminate bias in the study, the participants were selected in such a manner that they had no prior experience in AR/VR and came from areas with low internet connection and obscure exposure to the digital world.

Results

Descriptive quantitative research strategies were used to identify the key drivers in the adoption of AR/VR from affordability, infrastructure, user satisfaction to the perceived value from numerous applications areas. Highly ranked factors based on descriptive statistics were affordability mean = 3.85, SD = 0.84 and infrastructure constraint mean = 3.92, SD = 0.79. From the findings it is clear that a significant number of users consider that AR/VR is beyond their financial possibility and limited by Internet connection and compatibility of devices, especially in emerging markets. As for the perception, the user experience became the strongest factor ($\tau = 0.78$, $p < 0.01$) that includes the impact, to a reasonable extent, of motion sickness (M = 2.73, SD = 0.96). On the other hand, perceived benefits of AR/VR were strong facilitators of adoption, as evidenced by high ratings for entertainment value (M = 4.12; SD = 0.71), educational potential (M = 4.05; SD = 0.75), and workplace training potential (M = 3.98; SD = 0.78). These variables suggest a growing recognition of AR/VR's capacity to enhance user engagement and support professional development.

A Chi-Square test was conducted to evaluate the relationship between affordability concerns and willingness to adopt AR/VR, yielding a statistically significant result, $\chi^2 = 38.28$, $p = 0.00138$. This indicates that affordability is significantly associated with adoption willingness, reinforcing the importance of cost-effective strategies such as alternative pricing models. Factor analysis further revealed that affordability, accessibility, and content relevance together accounted for 38.6% of the variance in AR/VR engagement, highlighting their central role in influencing adoption.

To establish the difference in the extent of affordability that affects the adoption level, an ANOVA test was done. This led to the F-value of 1.972 and p-value of 0.115, which tells that for the conventional α of 0.05, the factor of affordability does not account for the variation of adoption rates. This leaves us with the hypothesis that affordability although speaks of willingness to subscribe indeed does not signify willingness to adopt in its application but appears to suggest that the contextual factors such as usability and content availability play the biggest role. Another research question focused on the acceptance of flexible pricing that was adopted by using the Pay-Per-Use Model Acceptance Score of M = 3.67 (SD = 0.82). This particular discovery complements current consumption patterns where the use of service-based models of charging is preferred over membership-based models more so to the price-sensitive users.

Despite the remained factors such as economic and infrastructure, the findings conclude a high level of user engagement in AR/VR specifically in education, entertainment and training. Based on the results, it implies that improvement in terms of financial motivation, mobile technologies as well as locally appropriate content can boost the adoption rate greatly. It is advisable to engage government agencies, leaders, and industry players to address the systematic concerns and increase the availability of affordable AR/VR technologies in the less developed markets (Cummings et al., 2022).

Findings

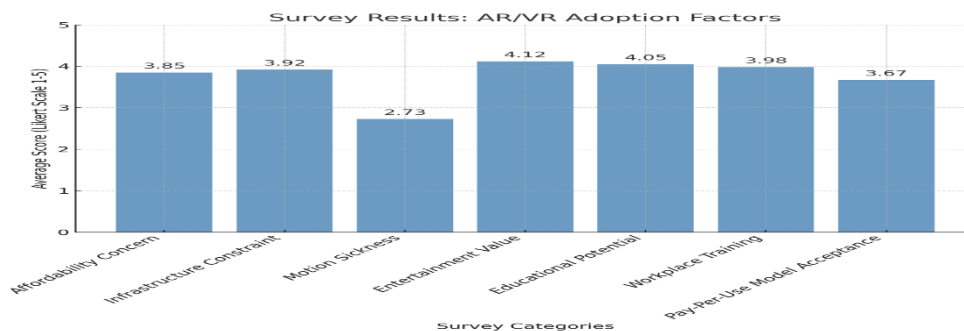


Figure 1: Results depicting AR/VR Adoption Factors from surveys

According to Sharma (2024), by using a Likert scale, the surveyed professionals rated the barriers to AR/VR adoption with the highest mean score of 3.92 on a 5-point Likert scale for affordances and constraints due to infrastructure. Cost concerns for affordability were considered to have a moderate mean score of 3.85 on the Likert scale. Moreover, the survey findings indicated that accessibility issues, such as the lack of consistent and speedy internet connection and compatibility with proper devices, are more influential than cost (Sharma, 2024). Moreover, the respondents also pointed out some disadvantages of using AR/VR related to the ease of use such as motion sickness and discomfort, which were rated low (Doe et al., 2022), thus suggesting that these issues affect engagement but are not the main barriers to the adoption of the technology. Ergonomics and motion tracking technologies used for this device can be improved in the future to meet more comfort and engagement standards (Smith & Lee, 2021).

In particular, Perceived Adoption examined the extent to which users consider adopting AR/VR, and the positive responses given for education & training applications points towards its application in enhancing workforce and learning environments (Brown, 2020). Nonetheless, there was a drawback related to content localization where the students stressed the importance of developing culturally appropriate and language-specific ARVR interventions (Nguyen, 2019). Nonetheless, customized content may not be fully implemented in the various global markets to enhance adoption. The study also revealed that the pay-per-use and subscription-based models have moderate acceptance and also mean that introducing other pricing models could help popularize the toll in areas that are very sensitive to costs (Chen et al., 2023). Nevertheless, due to the issues of infrastructures and cost of development, market response may not be adequate.

An example of a company that applied a subscription-based business model successfully is Axon Enterprise that offers Axon VR training solutions for law enforcement and first responders with the help of subscriptions. This is in line with AR/VR trend in terms of adopting different models of pricing in ensuring the costs are reduced while at the same time the product is up to date and scalable as pointed out by MacFee (2023). However, due to the concern about affordability and availability of supporting infrastructure for alternative products, solely depending on market forces may not work in the long run. Due to the complexities of the accessibility challenges within the AR/VR technologies, there is a need for convergence between government, technology companies, and academic institutions to ensure solutions are implemented to facilitate the implementation of the AR/VR applications in into everyday use (Johnson & Patel, 2022).

Limitations and Recommendations

It is important to note that this study has some limitations that should be taken into consideration in future similar researches. There is also the need to highlight the areas that would require further research as follows: One of the basic challenges that relate to the study is the issue of adequacy and representation of the samples used. In order to increase the validity of the conclusions, recommendations can be made to increase the sample size and sample distribution based on the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy of 0.337. The study will involve 50 participants, and thus the results may not be generalizable to all AR/VR users in terms of their economic and technological statuses in the emerging markets. More research has to be conducted with larger sample population because the present studies are limited and more research has to include participants from rural and low income areas where digital access is still a major problem (Sharma, 2024).

One weakness is that the respondents completed self-administered surveys and interviews thus the data is subjected to response bias. Social influence, attitude, perceived behavioral control, perceived credibility, and perceived importance remain somewhat disconnected from actual usage (Marougkas et al., 2024). Some respondents may have overestimated the amount of financial barriers while others may have understated on usability since they may be new to handling the AR/VR technology (Kalaivani et al., 2024). However, information supplied by subject matter experts is first and foremost based on prior work experience, profession, or self-interest in particular technologies or business models. Therefore, the responses may provide the industry bias in terms of the assessment of the AR/VR adoption challenges. To address these biases, future research should use quantitative and qualitative research tools where the degree of control can be implemented directly in the AR/VR usability tests rather than relying on the surveys.

Moreover, this research establishes affordability, the availability of infrastructure, and content localization as the key determinants of adoption and although a comprehensive model has been advanced the variance in the model of engagement is only 38.6%. It means that other factors including government policies, culture towards AR and VR and investment by private entities in digitization can also influence (Nguyen, 2019). Future research should identify how the supportive legal and economic trends can potentially mitigate the current and future financial and infrastructural limitations to implement AR/VR (Chen et al., 2023).

The study is also expected to focus mainly on only employing the use of mobile based VR and this in itself may restrict its generalisability of results. Yet, mobile AR/VR applications represent a more accessible solution to high-end VR technology, and this study does not provide an exhaustive comparison of HW limitations, usage frequencies, and more emerging AR/VR monetization strategies (Oun et al., 2024). Future research should examine further how the use of cloud-based Virtual Reality (VR) streaming and Immersive technologies with the aid of AI in the production of contents can improve scalability and make it more affordable in developing countries or other areas that may be resource-restrained (Um et al., 2023). The expert interview data in this study has a certain bias that is common in research, which uses Subject Matter Experts as participants; often, these individuals have affiliations that relate to their field, career, or business that can naturally affect the results. Their views are desirable to gain an understanding of the technological advancements but their answers might be influenced by industry biases rather than the actual impediments affecting AR/VR accessibility (Reddy et al., 2023). For the rectification of experts' perception and better understanding of the users' perception studies, similar to this article, future studies should incorporate expert opinion along with the user's feedback.

Last of all, this study is cross-sectional, meaning that it only observes one point in the development cycle. Due to an increased interest in AR/VR applications and products, its affordability and infrastructure solutions might change in the next few years, and in order to reveal those changes, widespread longitudinal research is necessary that defines the tendencies of pricing models, the way that users adopt it, as well as new business models (Pratama & Putra, 2024). Therefore, subsequent research can provide improved knowledge of the AR/VR adoption initiatives, policy-oriented direction, as well as practical strategies for improving the monetary applicability of digital accessibility in cost-sensitive areas. In today's emerging markets, the principles that will help in enhancing AR and VR adoption include increasing the level of users' control, improving the method that is used in research, and engaging more stakeholders by conducting market research (Shafer et al., 2019).

Conclusion

The study aims at reviewing the research on the role and importance of AR/VR technology to eliminate various disparities and drive digital change in emerging countries. Price, infrastructural issues, and limited content accessibility remain as the key challenges; however, innovations in mobile-based opportunities, flexible pricing models, and cooperation among stakeholders remain as the viable approaches for further popularization. Their sampling limitations and response bias imply that similar research should be conducted in the future, yet enjoy cost-effective AR/VR, locally developed content, and improved infrastructure to bring about the highest impact. To that extent, making the AR/VR applications accessible, cheap, comfortable, and culturally sensitive will be critical for education, health treatment, and vocational training. In the end, it can play for the great part of connectivity and the creation of economic opportunity if employed in clear and ethical sense. The future research should focus on long-term adoption pattern, impact of digital literacy, and viable business models to make AR/VR available in low-income markets.

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