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Impact of Demographic Factors on Adoption of Virtual Reality and Augumented Reality Technologies in Nigerian Construction Industry

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ABSTRACT

This study investigates the impact of demographic factors on the adoption of Virtual Reality (VR) and Augmented Reality (AR) technologies in Nigeria Construction Industry. Despite the global growth of immersive technologies, their adoption in Nigeria remains uneven, influenced by age, gender, income, education, and geographical location. Using a descriptive survey design, the research collected data from 539 built-environment professionals and 278 members of the general public. Findings reveal significant disparities: urban youth, higher-income earners, and educated individuals exhibit greater adoption rates, while rural populations, low-income groups, and older adults face barriers such as high device costs, limited internet access, and low awareness. Gender differences were also noted, with males favoring VR for gaming and females preferring AR for social media applications. The study highlights the urgent need for inclusive policies, subsidized devices, and targeted awareness campaigns to bridge the digital divide and ensure equitable access to the socio-economic benefits of VR and AR technologies.

Keywords: Virtual Reality (VR), Augmented Reality (AR), Demographic Adoption, Technology usage, Demographic Factors.

INTRODUCTION

In recent years, Virtual Reality (VR) and Augmented Reality (AR) technologies have become transformative forces across multiple industries, including education, healthcare, entertainment, and the built environment. VR enables users to immerse themselves in fully computer-generated environments using devices like headsets and motion controllers. AR, by contrast, superimposes virtual information onto real-world settings via smartphones, tablets, or smart glasses (PwC, 2022; Shin, 2018). These technologies are redefining how people interact with digital content and how professionals visualize, plan, and execute complex projects.

The **construction industry**, particularly in Nigeria, is increasingly exploring the integration of immersive technologies like VR and AR to enhance accuracy, collaboration, and communication (Adewumi et al., 2025). In the context of **architectural specifications** and **working drawings**, these technologies enable professionals to visualize spaces and components in real time, reducing ambiguities and minimizing on-site errors. Rather than relying solely on 2D technical drawings, architects and engineers can use **VR simulations** and **AR overlays** to communicate design intent clearly to clients, contractors, and site workers (Alugbue et al., 2024). For instance, BIM (Building Information Modeling) integrated with VR allows stakeholders to virtually walk through a building before construction begins, thereby identifying potential clashes or design inefficiencies early (Eze & Aluko, 2022).

In Nigeria, where challenges like misinterpretation of drawings, poor adherence to standards, and communication gaps often affect project quality, VR/AR offers an opportunity to bridge those limitations (Techpoint Africa, 2023). A growing number of architectural and construction firms are using **AR-enhanced specifications** to highlight product selections and performance standards. Meanwhile, some firms are adopting **VR walkthroughs** to support client engagement and improve design coordination (Imisi 3D, 2022).

However, the adoption of these tools is still uneven. Factors such as income level, digital literacy, geographic location, and access to infrastructure play a significant role in determining who benefits from immersive tech.

Urban-based professionals and firms with higher digital capacity are more likely to use VR/AR tools, while rural practitioners or small firms may struggle with access and cost. A study by Stears Data (2023) revealed that while 39% of architecture professionals in Lagos have interacted with VR tools, only 11% of their counterparts in regional towns have done so.

These disparities point to the urgent need for localized research on the demographic dynamics influencing adoption.

According to Judith Okonkwo(Founder Imisi 3D Lab),In Nigeria, we're seeing excitement about VR, but mostly among urban youth and forward-thinking firms. The next challenge is making it practical and scalable across the industry.

These realities reflect a broader issue of digital inequality. AR and VR have the potential to democratize knowledge, improve learning outcomes, transform healthcare, and boost creativity but without intentional inclusion strategies, they may instead deepen existing societal gaps (Rauschnabel et al., 2022; PwC, 2022).

In recent years, local innovation hubs such as **CcHub**, **Imisi 3D**, and **AR/VR Africa** have started bridging these gaps by hosting hackathons, training sessions, and bootcamps focused on immersive storytelling, design, and app development (TechCabal, 2022). Yet, these efforts remain localized and are often dependent on foreign partnerships or grants. National policy frameworks for immersive tech inclusion remain weak or nonexistent (Eze & Aluko, 2022).

Furthermore, the gender divide also persists. A study by **Eze and Aluko (2022)** on Nigerian students revealed that while male students were more likely to experiment with VR devices, female students leaned toward AR experiences via mobile apps like Snapchat, Instagram, or retail-based AR. This difference in engagement styles underscores the importance of understanding not just access, but also usage behavior within demographic groups.

Thus, a deeper understanding of the demographic determinants of immersive technology adoption is crucial to guide more inclusive innovation. VR and AR technologies are not just tools as they represent a future of interaction. If access remains exclusive, entire communities risk being excluded from the socio-economic and educational benefits these platforms offer (Rauschnabel et al., 2022; PwC, 2022).

However, despite the promise of immersive technologies in enhancing design communication and construction accuracy, access and usage in Nigeria remain unequal across demographic and professional lines. If left unaddressed, this gap could deepen the digital divide and hinder innovation within the local construction sector (Olowu & Adeoye, 2021).

This study aim to inregistatue the impact of demographic factors on adoption of Virtual Reality and Augmented Reality technologies with the view to bridge the gaps between the rural and urban users in Nigeria. While the objectives are the following:

- Examine how demographic factors (age, gender, income, education, location) influence VR/AR adoption in Nigeria.
- Explore how immersive tools are used in the Nigerian construction industry for specifications and working drawings.
- Identify barriers and motivations for adoption among different user groups.
- Recommend strategies to improve access and integration of immersive technology across sectors.

In order to achieve this aim and objectives, the following research questions will be of help:

- Which demographic groups in Nigeria are early adopters of VR/AR?

- How are immersive tools being applied to specifications and drawings in the construction industry?
- What barriers limit access or discourage use among Nigerian professionals and the general public?
- What strategies can increase adoption among underserved groups?

This research will contribute to a growing body of literature on the digital transformation of emerging economies, with a specific focus on immersive technologies like VR and AR. Therefore by highlighting the demographic realities shaping usage in Nigeria, the study provides targeted insight into how digital inclusion can be strengthened across sectors, including the **Nigerian Construction Industry (NCI)**.

In the context of the NCI, the relevance of this research is particularly evident in how **specifications and working drawings** are created, communicated, and interpreted. Misinterpretation of 2D drawings and unclear specifications have long plagued the Nigerian construction landscape, often leading to errors, delays, and cost overruns. Immersive technologies offer a transformative shift by enabling **3D visualization of design specifications**, real-time site simulations, and **interactive walkthroughs of working drawings** tools that enhance clarity for both professionals and clients (Alugbue et al., 2024; Adewumi et al., 2025).

By providing data on **who has access to these tools**, how they're used, and what barriers exist, this study offers practical implications for:

1. **Policy-makers**, who must develop inclusive tech infrastructure to support AR/VR use in construction workflows;
2. **Educators**, designing curricula that train future architects and engineers in immersive platforms;
3. **Startups and software developers**, who can tailor immersive content and specification tools to local industry needs;
4. And **donors and NGOs**, who are working to close access gaps in marginalized or rural communities where digital literacy and infrastructure are low.

Ultimately, this research supports a more **equitable digital future** one where immersive technologies serve as bridges rather than barriers, empowering both high-tech urban firms and under-resourced rural practitioners to contribute meaningfully to Nigeria’s evolving construction landscape.

LITERATURE REVIEW

Global overview of VR/AR adoption

Virtual Reality (VR) and Augmented Reality (AR) have transitioned from niche technologies to mainstream tools influencing various sectors. Globally, industries such as gaming, education, military training, telemedicine, and architecture are integrating immersive technologies to improve engagement, learning outcomes, and decision-making. According to **IDC (2020)**, worldwide spending on AR/VR reached approximately $18.8 billion in 2020, with forecasts predicting a jump to over $72.8 billion by 2024.

The adoption curve, however, is uneven. Developed countries have led the way in consumer and enterprise-level integration of these tools. For instance, **South Korea and Japan** have implemented AR in public transportation systems, while the **U.S. military** uses VR for combat training (**PwC, 2022**). **Meta (2023)** announced that over 20 million VR headsets have been sold globally since 2019, with the majority of users concentrated in North America and parts of Europe.

The high adoption rates in these regions are driven by factors such as:

1. Robust digital infrastructure (5G, data centers)

2. Higher disposable income
3. Large-scale content ecosystems
4. Strong investment in digital education

Yet, even within these countries, adoption varies by demographic. Research by **Rauschnabel et al. (2022)** shows that younger individuals (aged 18–34) are far more likely to explore immersive tools, particularly through gaming and education, compared to those over 45. Similarly, **PwC (2022)** found that millennials account for over 60% of enterprise AR use cases, especially in marketing and design visualization.

Influence of age and generation

Age remains one of the most significant predictors of immersive tech usage. Studies show that:

1. Generation Z (born after 1997) tends to adopt AR for mobile-based entertainment, particularly on platforms like Snapchat, Instagram, and TikTok.
2. Millennials (1981–1996) are more likely to use VR for gaming, remote work, and skill-building.
3. Older adults (50+) often lag due to concerns about usability, motion sickness, and lack of perceived relevance.

A study by Shin (2018) reveals that most VR users fall between ages 18–35, citing entertainment, learning, and escapism as key drivers. Meanwhile, AR adoption is wider due to its accessibility via smartphones, but still skews toward younger demographics.

Gender and immersive technology use

Gender also influences how immersive tools are used. While adoption rates for VR among males are significantly higher, women are more engaged with AR applications, especially those related to social media and retail. Shin (2018) found that 74% of male respondents had experimented with VR compared to only 39% of females, yet AR usage among women was higher in domains like beauty apps, fashion try-ons, and mobile games.

In a Nigerian study by Eze and Aluko (2022), male students were more likely to own or try VR headsets, while female students preferred AR-based applications embedded in smartphone platforms. These patterns are also reinforced by gender roles, exposure levels, and cultural norms around technology.

Education and digital literacy

Digital literacy and education level significantly impact how immersive technology is received. Globally, those with tertiary education or professional experience in STEM-related fields show higher adoption levels. In countries like Finland, AR is integrated into school curricula, while in Canada, universities are investing in VR for remote learning.

In Nigeria, educational institutions play a dual role: they are both facilitators and barriers. While some private universities like Covenant and Afe Babalola University have begun experimenting with AR/VR tools, most public universities and secondary schools still lack basic ICT infrastructure. A survey by (Olowu and Adeoye 2021) of 300 Nigerian students revealed:

1. 63% had heard of AR/VR
2. Only 21% had ever used an AR tool
3. Just 9% had experienced VR firsthand

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Students in architecture, anatomy, and engineering programs were more likely to engage with these technologies, particularly when digital labs were available. Okonkwo and Adebayo (2022) noted that students who had previous exposure to 3D modeling or computer-aided design found it easier to adapt to immersive interfaces.

Income and affordability

The cost of immersive hardware remains a key barrier. Even globally, VR remains a luxury, with most quality headsets (e.g., Oculus Quest 2, HTC Vive, Apple Vision Pro) priced at over $300. In Nigeria, these prices translate to ₦250,000–₦600,000, putting them beyond reach for the average income earner.

(Adelakun et al. 2020) found that only 8% of students from lower-income homes had access to AR/VR devices, compared to 41% from wealthier households. Moreover, lack of credit access, high data costs, and unreliable electricity further inhibit regular usage.

This situation reflects a larger digital inequality, where income level determines access to innovation. As of 2023, Nigeria's minimum wage remains ₦30,000 per month, making even second-hand immersive hardware unaffordable to most.

Urban vs. rural divide

The urban–rural gap is particularly stark in Nigeria. Infrastructure limitations especially in electricity, internet access, and ICT centers mean rural users often have no exposure to immersive tech. According to (Ibrahim and Usman 2021), VR/AR usage in Northern Nigeria is mostly confined to city centers like Kano and Kaduna.

A report by MTN Nigeria (2023) indicated:

1. Only 8% of rural schools have access to broadband internet
2. Urban areas are 4x more likely to host AR/VR workshops or demos
3. 77% of immersive tech startups are based in Lagos, Abuja, or Port Harcourt

Rural dwellers, even when interested, often lack access to devices, mentors, or educational content relevant to their context. This poses a risk of further marginalization in Nigeria’s digital transformation.

Motivators for adoption

Despite these barriers, several drivers are pushing adoption forward across Nigeria:

1. **Education**: Virtual labs, anatomy simulations, and language learning platforms;
2. **Entertainment**: Gaming, 360° videos, virtual concerts;
3. **Retail**: AR shopping experiences (e.g., Konga’s virtual showroom);
4. **Healthcare**: VR therapy for PTSD, AR in surgical planning;
5. **Design**: Architecture visualization, urban planning simulations.

Eze and Aluko (2022) found that medical students who used AR tools for anatomy retained 22% more information than those using traditional methods. Similarly, students using VR in virtual design studios scored higher in spatial comprehension tests. Startups like **Imisi 3D**, **AR/VR Africa**, and **AltSchool Africa** have also offered bootcamps training over 2,000 Nigerian youths in immersive storytelling and app development. These local efforts demonstrate how contextualized, affordable exposure can bridge gaps in access.

In the **Nigerian construction industry**, the motivations for adopting VR/AR are increasingly tied to the demand for **improved accuracy, client comprehension, and speed** in delivering specifications and working drawings.

Traditional 2D drawings are often misunderstood on-site, resulting in construction errors, material waste, and costly project delays. VR allows for **immersive walkthroughs** of architectural plans, enabling stakeholders to better understand space, materials, and functional flow before actual construction begins. AR, on the other hand, enables **on-site overlay of technical specifications**—helping craftsmen and contractors interpret drawings more effectively in real time. This not only boosts productivity but enhances safety and reduces rework (Alugbue et al., 2024; Adewumi et al., 2025). As the NCI continues to digitize, the use of immersive technology in working drawings and specifications is becoming a powerful tool for collaboration, precision, and innovation.

Developed vs developing country experiences

In developed countries, immersive tech benefits from government support, early integration in education, and private sector investment. For example:

1. In the US, over 6,000 public schools have access to VR labs.
2. In South Korea, AR is used for civic training and disaster preparedness.

By contrast, Nigeria and other developing nations face compounded challenges:

1. Limited public investment in tech education
2. High cost of digital devices
3. Lack of localized content
4. Cultural skepticism or unfamiliarity with immersive experiences

Nonetheless, grassroots innovation is on the rise. Imisi 3D's partnership with NGOs to roll out mobile VR classrooms is an example of how low-resource solutions can address structural barriers.

2.9 Gaps in existing research

While global studies offer valuable insight into general adoption trends of immersive technologies, there is a **notable lack of localized, context-specific research from sub-Saharan Africa**, particularly **Nigeria**. Much of the existing literature focuses heavily on Western contexts, leaving significant blind spots in understanding how **demographic variables influence VR and AR usage** within African societies.

Key gaps include:

1. **Gender-specific experiences** with immersive technology across diverse platforms
2. **Behavioral data** from artisans, rural educators, and informal-sector workers
3. The role of **cultural attitudes** and digital literacy in shaping adoption
4. Lack of **longitudinal studies** tracking the evolution of immersive tech usage over time
5. Minimal research linking **immersion and construction documentation**, especially in low-resource environments

Most available studies tend to emphasize university students and urban youth—groups more likely to have access to smartphones, stable internet, and global media trends. However, this focus overlooks a wide portion of the Nigerian population, including workers in the **Nigerian Construction Industry (NCI)**. In practice, professionals and tradespeople across Nigeria often face challenges interpreting **2D working drawings and specification sheets**, especially on busy or informal sites. These communication barriers can lead to **project delays, budget overruns, and execution errors**.

Despite the clear value of VR/AR for enhancing **visualization, interpretation, and real-time clarification of construction specifications**, current literature rarely examines how immersive technologies are (or could be) adopted in the Nigerian construction context. This study seeks to bridge that gap by analyzing demographic patterns of immersive tech adoption—particularly as they relate to **the interpretation and usability of working drawings and digital specifications in NCI workflows**.

Demographic Factor	Global Trends	Nigerian Trends	Key Insight
Age	Youth (18–34) are primary users of VR/AR, especially Gen Z and Millennials.	Similar pattern; university students most likely to adopt, rural youth less exposed.	Young people are early adopters globally and locally, but exposure is limited by access in rural Nigeria.
Gender	Males dominate VR adoption (especially in gaming); females lead AR (social media).	Nigerian males more exposed to VR; females use AR on platforms like Instagram and Snapchat.	Gendered usage patterns mirror global trends but are affected by culture and device access.
Education	Higher education correlates with greater adoption and digital literacy.	Private university students more exposed; public and rural schools lack ICT tools and training.	Education level is a major determinant of adoption, worsened by Nigeria's uneven school infrastructure.
Income	Middle- to high-income groups afford VR/AR tools; cost remains a barrier globally.	Headsets cost ₦150k+; unaffordable for most. Data/internet access also expensive.	Affordability is a stronger limiting factor in Nigeria than in most developed countries.
Location	Urban areas have higher adoption due to better infrastructure and exposure.	77% of AR/VR activity in Lagos, Abuja, PH; rural Nigeria has very limited adoption.	Urban–rural divide in Nigeria is severe and infrastructure-driven.
Access to Devices	VR headsets, AR-ready smartphones common among middle-class users.	Low headset ownership; reliance on smartphones for limited AR exposure.	Device access is limited in Nigeria, especially in low-income and rural communities.
Institutional Support	Governments fund immersive education in schools and public labs.	Minimal government support; NGOs and startups (e.g., Imisi 3D) fill the gap.	Lack of policy and funding restricts institutional adoption in Nigeria.
Motivations	Learning, entertainment, productivity, design, therapy.	Similar motivations: anatomy learning, architectural modeling, AR shopping, and training.	Use cases are similar, but Nigerian content is limited and infrastructure often constrains engagement.
Cultural Acceptance	Rapid acceptance in developed countries; immersive tech seen as mainstream.	Tech adoption slower in rural or older populations; skepticism about relevance.	Awareness campaigns needed to improve understanding and relevance in Nigeria.

Table 1: Comparative Overview – Global vs. Nigerian VR/AR Adoption by Demographics

Source: Authors' Compilation, 2025

METHODOLOGY

This study adopted a descriptive survey research design, which is suitable for exploring and documenting current trends, opinions, behaviors, and demographic characteristics of a target population. According to (Nworgu 2015), descriptive surveys are effective in obtaining factual information and are appropriate when investigating the relationships among variables and generalizing from a sample to a population. The choice of this method was driven by the study's objective to investigate demographic influences on the adoption and use of Virtual

Reality (VR) and Augmented Reality (AR) technologies in Nigerian construction industry. This design allowed the researchers to compare patterns across multiple groups (age, gender, income, education, and location) and to analyze both quantitative and qualitative feedback from participants. Similar approaches have been used in construction industry research to assess specification adoption, digital tools, and smart technology integration (Adewumi, B. J., Onamade, A. O., David-Mukoro, K. D., Bamilooye, M. I., Otuonuyo, G. A., Chukwuka, O. P., & Oru, T. O. 2025; Alugbue, W. K., Otuonuyo, G. A., Adewumi, B. J., Onamade, A. O., & Asaju, O. A.., 2024).

The population for this study consisted of two main groups:

1. Built Environment Professionals

This group included architects, engineers, project managers, interior designers, surveyors, and urban planners. These individuals are directly involved in the design and execution of construction and digital modeling processes, making them ideal for analyzing the technical application and perception of AR/VR tools and the;

2. General Public

This included a cross-section of Nigerian citizens aged 18 and above, including students, civil servants, artisans, business owners, and unemployed youth. The aim was to capture varying levels of exposure and engagement with immersive technologies across diverse socioeconomic backgrounds. The two populations were selected to ensure a multi-perspective understanding of immersive tech usage: one from the professional/practitioner point of view and one from the everyday user side.

A total of 539 professionals were selected using purposive sampling, a non-probability method that involves selecting respondents based on their knowledge and active use of digital tools. This method was deemed appropriate due to the specificity of the research and the need to gather insights from individuals who are experienced in using architectural technologies, BIM platforms, or digital visualization tools. For the public, 278 respondents were selected using stratified random sampling. This ensured proportional representation based on key demographic variables such as:

- Age groups: 18–25, 26–35, 36–50, and 51+
- Gender: Male and Female
- Location: Urban and Rural.
- Education level: Secondary, Tertiary, Postgraduate; and
- Income bracket: Low, middle, and high income

This sampling framework allowed the researchers to identify patterns across demographic groups and perform comparative analysis.

In order to achieve a dataset for this purpose two structured questionnaires were designed and pre-tested.

Firstly For Professionals:

The instrument assessed:

- Background demographics
- Familiarity and frequency of BIM, CAD, and VR/AR usage
- Perceptions of immersive tools in design and construction
- Readiness to integrate AR/VR into professional workflows; and

- Challenges faced in implementation

Questions were structured using closed-ended items with a 5-point Likert scale (Strongly Disagree to Strongly Agree) and a few open-ended prompts for additional insight.

Secondly For Public Respondents:

The instrument measured:

- Awareness of immersive tech
- Past usage experiences and frequency
- Common access points (social media, mobile apps, educational institutions)
- Perceived usefulness
- Barriers to access; and
- Motivations and willingness to adopt

These questionnaires were developed based on previous tools used in tech adoption studies (e.g., Davis, 1989; Shin, 2018) and adapted to the Nigerian context using references from Techpoint Africa (2023) and Stears Data (2023).

A pilot test was conducted with 30 respondents (15 professionals and 15 members of the public) across Lagos and Kaduna to:

- Test for clarity of language and phrasing
- Identify ambiguous or technical terms that required explanation; and
- Evaluate the logical flow and time to completion

Feedback from the pilot led to modifications in language simplicity for rural respondents and expanded the options in the “use-case” categories to include religious and cultural experiences (e.g., virtual church tours).

The data collection procedure includes;

Firstly the Professionals:

- Questionnaires were distributed during industry events, site meetings, and via email
- Some respondents were contacted through professional WhatsApp groups and LinkedIn

Secondly the Public:

- Surveys were shared online (via WhatsApp, Instagram, Facebook)
- In rural areas, printed forms were delivered by local facilitators; and
- Ethical consent was obtained verbally or via form introduction

Data collection spanned four weeks in April 2025.

The collected data were analysis using the following:

- Data was entered into SPSS Version 27

- Descriptive statistics: frequencies, percentages, mean, standard deviation
- Inferential statistics: cross-tabulations, correlation (for demographic comparison)
- Likert scale responses were processed into Mean Score and Relative Importance Index (RII); and
- Bar graphs, pie charts, and tables were used to visualize trends

The following ethical considerations were put in place;

- Ethical clearance was granted by Caleb University
- Participation was voluntary, anonymous, and confidential
- No sensitive personal data was collected; and
- Participants were informed of their right to withdraw at any time

RESULTS AND DISCUSSION

4.1 Demographic Profile of Respondents

This study involved two primary respondent groups: professionals in the built environment and the general public.

Among the **professionals** (N = 539), 51% were male while 49% were female. In terms of age, the majority (34%) fell within the 31–40 year range. Regarding educational attainment, 36.4% of respondents held a Master’s degree, while 23.8% had a Bachelor's degree. Professionally, architects made up the largest share (32.1%), followed by contractors (14.3%) and engineers (11.3%). In terms of work experience, 27.6% of professionals had between 11 and 15 years of practice in the industry.

For the **general public** sample (N = 278), 58.3% were male and 41.7% female. The largest age group was 18–25 years, representing 41% of respondents, followed by 26–35 years at 34.5%. In terms of residential location, 71.6% lived in urban areas while 28.4% resided in rural communities. Educationally, 60% had attained tertiary education, 32% had completed secondary school, and 8% held postgraduate qualifications. Income distribution revealed that 55% were low-income earners, 32% fell into the middle-income bracket, and 13% were high-income earners.

4.2 VR/AR Awareness and Exposure

Awareness of immersive technologies was relatively high among the public, with 77% of respondents

stating they had heard of Virtual Reality (VR) or Augmented Reality (AR). However, only 37.4% had personally used these technologies.Exposure to VR/AR primarily came from social media filters**,** mobile applications**, and** educational demonstrations**.** Urban respondents were significantly more likely to have experienced immersive technologies than rural residents, with urban users reporting three times more usage.

The most common use of immersive tools was through social media platforms that offer AR filters, accounting for 52.9% of reported usage. Other popular applications included gaming (19.2%), educational or training purposes (15.4%), virtual tourism (7.7%), and AR-supported online shopping experiences such as virtual try-ons (4.8%).

4.3 Professional Tool Usage and Perceptions

Among professionals in the built environment, the use of digital tools such as Building Information Modeling (BIM) and digital fabrication was common. The average agreement scores for these tools ranged between 3.27 and 3.47 on a 5-point Likert scale. Respondents agreed that these tools enhance communication with clients, reduce errors in construction drawings, speed up the design revision process, and improve the overall accuracy and quality of construction projects.

Regarding VR/AR tools, professionals reported a mean usage perception score of approximately 3.40. These tools were primarily used for architectural visualization, and in some cases, for interactive client walkthroughs and design reviews. While respondents acknowledged the value of immersive tools, many noted that they are not yet widely adopted in everyday professional workflows. These findings align with previous research by (Alugbue et al. 2024), which emphasized the importance of digital specification tools in improving project efficiency and precision within Nigeria's construction industry.

4.4 Barriers to Adoption

Respondents identified several key barriers to the adoption of immersive technology in Nigeria. The most cited challenge was the **high cost of VR headsets**, mentioned by 81.3% of participants. This was followed by the **high cost of internet and mobile data**, reported by 74.6% of respondents.

Limited awareness and understanding of immersive technology was also a major factor, with 68.9% of respondents stating that they or people they knew did not fully understand the potential applications of AR/VR. Other notable barriers included frequent power outages (52.1%) and cultural resistance or skepticism towards new technologies (38.6%). Professionals in the study further highlighted the lack of local technical support and insufficient training opportunities as obstacles to fully integrating immersive tools into their workflows.

Similar challenges hinder the adoption of digital tools for architectural and engineering specifications and engineering specifications and working drawings in Nigeria. Just as high costs limit access to VR headsets, expensive software such as AutoCad, Revit and BIM tools to remain out of reach for many small firms and independent professionals, the recurring expenses of licences hardware upgrades, and cloud-based services further exacerbate the issue, creating a financial barrier to modernization. Awareness and training gaps also play a significant role,

Similar challenges hinder the adoption of digital tools for architectural and engineering specifications and working drawings in Nigeria. Just as high costs limit access to VR headsets, expensive software such as AutoCAD, Revit, and BIM tools remain out of reach for many small firms and independent professionals. The recurring expenses of licenses, hardware upgrades, and cloud-based services further exacerbate this issue, creating a financial barrier to modernization. Awareness and training gaps also play a significant role. Many professionals still rely on manual drafting methods, either due to habit or a lack of exposure to the efficiency and precision offered by digital solutions. Frequent power outages and unreliable internet connectivity compound these problems, disrupting workflows that depend on consistent electricity and online collaboration. Additionally, resistance to change—particularly among seasoned professionals accustomed to traditional techniques—slows the transition to digital drafting and modeling.

To overcome these barriers, targeted interventions are necessary. Affordable or open-source software alternatives could make digital tools more accessible, while vocational training programs and workshops could bridge the knowledge gap. Improved infrastructure, particularly stable electricity and internet access, would enhance usability, and industry-wide advocacy could help shift perceptions toward embracing digital transformation. By addressing these challenges, Nigeria’s architecture and engineering sectors can better integrate modern design tools, improving efficiency and competitiveness in the global market.

4.5 Motivators for Use

Despite the challenges, many respondents expressed a strong interest in adopting immersive technologies. The most common motivation was the **educational potential** of AR/VR, which 69.8% of participants identified as a reason for their interest. This was followed by **entertainment purposes** (61.2%), **career development and upskilling** (42.7%), and **creative or design-related projects** (35.4%). A smaller but notable group (21.5%) indicated that they found immersive tools useful for enhancing convenience in online shopping, particularly in trying on products virtually.

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