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Digital Transformation in Architecture: How ICT is Reshaping Design and Project Management in South-west Nigeria

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ABSTRACT

The architectural profession is witnessing transformative shifts globally, driven by Information and Communication Technology (ICT). In Nigeria, particularly in the South-west region, the adoption of ICT remains uneven, presenting both challenges and opportunities for architects. This study investigates the understanding and implementation of architectural ICT tools among architects in Oyo and Osun States, exploring their impact on design processes and project management. The research adopts a quantitative methodology, employing a descriptive survey approach. A total of 60 usable questionnaires were collected from architects affiliated with the Nigerian Institute of Architects (NIA) in the two states. The survey assessed respondents' socio-economic characteristics, familiarity with ICT tools, extent of usage, and perceived barriers to adoption. Findings reveal that while basic ICT tools like Computer-Aided Design (CAD) software are widely utilized, advanced systems such as Building Information Modelling (BIM), Virtual Reality (VR), and energy simulation tools remain underused. The most frequently employed tools are CAD and rendering software, facilitating design precision and visual communication. However, challenges such as high costs, limited access to infrastructure, and inadequate training hinder broader adoption. Notably, ICT tools significantly enhance design workflows, communication, collaboration, and project accuracy, particularly during sketch and working drawing phases. Despite these benefits, their application in implementation-focused tasks like site supervision and project management is limited. This study concludes that while ICT adoption has positively impacted architectural practice in South-west Nigeria, its full potential remains unrealized due to systemic barriers. Addressing these challenges requires targeted interventions, including affordable access to advanced tools, robust training programs, and improved digital infrastructure. By fostering broader adoption, Nigeria's architectural sector can align more closely with global trends, enhancing efficiency, creativity, and sustainability in practice.

Keywords: Architects; Building Information Modelling (BIM); Computer-Aided Design (CAD); ICT tools; South-west Nigeria.

1. INTRODUCTION

The practice of architecture has always been multifaceted, evolving from the ancient Egyptian period to modern times, with architects taking on numerous roles (Abdulkarim, 2014; Abdurashidovna, 2023), including design, construction oversight, and client management. Today, architecture encompasses the design, construction, and management of buildings, requiring a multidisciplinary approach that includes design principles, building materials, construction techniques, and project management (Emmitt, 2010; Gofwen, Ola-Adisa and Daniel, 2018). As building designs have become more complex, so too has the architectural process, involving the analysis of large volumes of data before final designs are shared with consultants for their input. A critical factor in enhancing architectural productivity is the effective management of information flows between project participants and the systematic storage of project data (Mohamed & Stewart, 2003). Unlike their predecessors, 21st-century architects benefit from the advent of Information and Communication Technology (ICT), which has revolutionized the practice by improving design efficiency, communication, and collaboration with stakeholders (Oladapo, 2006).

The adoption of ICT in architecture has facilitated the development of innovative designs, streamlined project management, and enhanced collaboration across disciplines. However, in Nigeria, particularly in the South-west region, the integration of ICT tools has been gradual and fraught with challenges (Ogunmakinde, 2014). Traditional manual processes still dominate, but the growing demand for modern, sustainable architecture is driving increased interest in ICT adoption. Despite this interest, barriers such as limited access to advanced tools and a shortage of technical expertise may be clogging the digital transformation of the architectural sector in Nigeria. This study explores the understanding and deployment of Architectural ICT tools amongst Nigerian architects and the way this is reshaping design and project management in South-west Nigeria, highlighting the challenges and opportunities associated with its adoption.

From Traditional to Digital

The shift from traditional methods to digital tools in architecture was gradual but transformative. CAD systems evolved from basic two-dimensional drafting tools into highly sophisticated software capable of three-dimensional modelling and parametric design. The development of building information modelling (BIM) in the late 1990s was a key turning point in this shift, as it introduced a holistic digital model of the building process that integrated design, construction, and operational data (Azhar, 2011). BIM represents a radical departure from traditional methods, enabling architects to visualise, analyse, and simulate their designs before construction begins.

The transition to digital tools also affected project management. With the rise of cloud computing and collaborative platforms, architects now manage projects in real-time, with stakeholders from across the globe able to access and edit documents simultaneously. These technologies have drastically improved communication and coordination, reducing errors and increasing efficiency in complex architectural projects (Gu & London, 2010). Several key milestones have marked the adoption of ICT in global architectural practice. The first major development was the introduction of CAD in the 1960s and 1970s, which replaced manual drafting with computerised precision (Eastman et al., 2011). This innovation was followed by the widespread adoption of personal

computers in the 1980s, which made digital design tools more accessible to architects worldwide (Schodek et al., 2005).

Another significant milestone was the emergence of BIM in the 1990s. BIM not only revolutionised design practices but also introduced new standards for data exchange and collaboration, such as the Industry Foundation Classes (IFC) format. This format allowed different software systems to communicate, further streamlining the design and construction process (Azhar, 2011). More recently, the integration of artificial intelligence (AI), machine learning, and generative design into architectural workflows has marked the next phase of ICT in architecture. These technologies enable architects to explore design possibilities that were previously unimaginable, with AI-assisted tools automating repetitive tasks and generative design allowing for more complex and innovative solutions (Del Campo, 2021). The growing use of virtual and augmented reality is also shaping the future of architectural design and visualisation, providing immersive experiences that bridge the gap between conceptualisation and real-world implementation (Pietsch, 2012).

Influence of ICT on Design Creativity and Innovation

ICT has profoundly impacted architectural creativity by expanding the boundaries of what architects can design and achieve. The use of digital tools such as parametric design software, 3D modelling, and generative algorithms allows architects to explore complex forms and structures that would be impossible or impractical to design using traditional methods. Parametric design, in particular, enables architects to create designs based on algorithmic thinking, where parameters influence the geometry and configuration of buildings. This fosters an iterative and experimental design process, encouraging innovation and exploration (Oxman, 2017). Generative design, which uses algorithms to generate design variations, has emerged as a significant trend in contemporary architecture. It allows architects to specify design goals and constraints, leaving the software to explore numerous design possibilities. This process not only enhances creativity but also allows for optimisation in terms of material efficiency, structural integrity, and environmental performance (Burry, 2011).

The role of artificial intelligence (AI) in architectural design is also growing, with AI tools assisting in analysing design patterns and generating novel forms, further pushing the creative boundaries of the profession (Del Campo, 2021). The digital shift has also encouraged interdisciplinary collaboration, integrating architectural practice with fields like engineering, computer science, and environmental design. This convergence of disciplines has sparked new forms of innovation, where ICT tools allow architects to simulate building performance, energy consumption, and environmental impact, enabling more sustainable and responsive design practices (Azhar, 2011).

2. CURRENT STATE OF ICT ADOPTION IN NIGERIA ARCHITECTURAL SECTOR

The adoption of ICT in Nigeria's architectural sector has been relatively slow, yet there are signs of steady progress. Several studies indicate that while awareness of ICT tools such as Computer-Aided Design (CAD) and Building Information Modelling (BIM) is high among architects in Nigeria, the level of actual utilisation remains moderate to low (Olatunji, 2011; Laryea & Ibem, 2014). Many architectural firms in Nigeria still rely heavily on traditional methods, including manual drafting and physical models, although there is a growing recognition of the benefits offered by digital tools. Research shows that CAD is the most widely used ICT tool in Nigeria, primarily for 2D drafting and documentation (Ibrahim, 2013). However, more advanced ICT tools such as BIM, which enable collaboration, data integration, and life-cycle management of projects, are still in their nascent

stages of adoption. Studies reveal that while BIM awareness is increasing, its use is hindered by several factors, including high costs, lack of training, and inadequate infrastructure (Olatunji, 2011; Oke et al., 2017). This indicates a significant gap between awareness and practical implementation of ICT in Nigeria's architectural practice.

Additionally, the adoption of ICT tools beyond design, such as project management software, remains limited. Tools that enhance project planning, resource allocation, and communication are underutilised, suggesting a fragmented approach to ICT adoption, where certain aspects of architectural practice benefit from digitalisation while others lag behind (Laryea & Ibem, 2014). When compared to global trends, the adoption of ICT in Nigeria's architectural sector is significantly behind. In developed economies, digital tools such as CAD, BIM, and Virtual Reality (VR) are now standard in architectural practices, with firms leveraging these technologies to enhance efficiency, accuracy, and collaboration across multidisciplinary teams (Eastman et al., 2011). In contrast, Nigeria's architectural sector has been slower to integrate these tools into everyday practice due to challenges such as infrastructural limitations, cost barriers, and a lack of skilled professionals (Oke et al., 2017). Also, BIM has gained traction as a key tool for managing complex construction projects, particularly in terms of improving communication between architects, engineers, contractors, and clients in many advanced countries (Azhar, 2011). However, in Nigeria, while there is a growing interest in BIM, its application remains limited, and most firms still rely on CAD for design processes. Advanced tools such as parametric design software, which are being used by leading architectural firms worldwide to explore complex geometries and sustainable solutions, have seen minimal adoption in Nigeria (Adewuyi & Odesola, 2015).

Moreover, developed countries are increasingly adopting cloud-based platforms and collaborative tools that allow real-time data sharing and project management, which are crucial for global architectural practices working across different time zones and regions. In Nigeria, the lack of reliable internet infrastructure and high costs associated with cloud services present significant barriers to the adoption of these advanced ICT solutions (Ibrahim, 2013). In the area of training the architects, most Nigerian universities and technical institutions still place a greater emphasis on traditional architectural techniques, with only a few offering specialised courses in digital tools and technologies (Adewuyi & Odesola, 2015). As a result, many architects enter the profession with little to no experience in using advanced software like BIM or parametric design tools. Although some firms offer in-house training, the cost and time involved in upskilling employees can be prohibitive, particularly for smaller firms with limited resources (Oke et al., 2017).

3. METHODOLOGY

The paper adopted the quantitative research and descriptive study. Architects from two South-west states of Nigeria were sampled using the questionnaire as the instrument for data collection. There are six southwest states in Nigeria with Lagos, the economic capital of Nigeria being one of the six. The architects sampled were (from the more hinterland states of Osun and Oyo States) members of the local Nigeria Institute of Architect (NIA) in the two states – Osun and Oyo States. A total of ninety questionnaires were sent out and 60 of them were retrieved and considered usable for the study. The questionnaire had among other sought personal information of the architects, their firms or place of work. Another section sought to understand the architects' ICT tools related to their profession and their knowledge of these tools and usage. The impact of the identified ICT tools used on architectural practice and the perceived obstacles to the deployment of Architectural ICT tools.

Fig 1: Figure 1: Map of Southwest Nigeria Showing Capital Cities
Source: Aderogba, et al., (2012)

4. RESULTS

Table 1 presents the socio-economic distribution of architects in the practice of architecture in Oyo and Osun States who participated in this study. The results showed that the majority (85.0%) of the architects were males. The modal age group (46.7%) was 50 – 59 years and 43.3% of them were between 40 – 49 years old while some (21.7%) of them were between 20 – 29 years old. Results showed that two-fifth (20.0%) of the architects who participated in this study had B.Sc qualifications. Furthermore, the most prevalent academic qualification was reportedly M.Sc/M.Arch/M.Tech (71.7%) of the respondents. At least 30.0% of the respondents reported obtaining their highest qualification between 2020 and the present. Moreover, the results revealed that a little above half of the respondents were reportedly ARCON certified, while 15.0% of them claimed that they were in the process of acquiring ARCON certification. In the same vein, 30.0% of the architects who participated in this study had been certified by ARCON between 2010 and 2019 (see Table 2).

Table 1: Socio-economic distribution of architects in Oyo and Osun States in the course of practice (n = 60)

	Frequency n	Percent %
Gender:		
Male	51	85.0
Female	9	15.0
Age in years:		
20 – 29 years	13	21.7
30 – 39 years	8	13.3
40 – 49 years	26	43.3
50 – 59 years	10	46.7
60+ years	3	5.0
Highest academic qualification:		
HND	3	5.0
B.Sc.	12	20.0
PGD	2	3.3
M.Sc/M.Arch/M.Tech.	43	71.7
Year of qualification attainment:		
2020 till date	18	30.0
2010 – 2019	31	51.7
2000 – 2009	6	10.0
1990 – 1999	5	8.3
ARCON certified:		
Yes	32	53.3
No	19	31.7
In the process	9	15.0
	60	**100.0**

Table 2: Nature of architectural practice among architects in Oyo and Osun States (n = 60)

	Frequency n	Percent %
Years practicing architecture in Nigeria:		
<5 years	12	20.0
5 – 10 years	8	13.3
11 – 15 years	14	23.3
16 – 20 years	7	11.7
>20 years	19	31.7
Type of architectural practice:		
Sole practitioner	39	65.0
Partnership	21	35.0
Position at firm:		
Principal Architect	31	51.7
Chief Architect	1	1.7
	60	**100.0**

Table 3: How often respondents are involved in the architectural project typologies (n = 60)

	Always n (%)	Often n (%)	Rarely n (%)	Never n (%)	Mean±SD
Residential buildings	0 (0.0)	29 (48.3)	23 (38.3)	8 (13.3)	2.35±0.7
Estate development	9 (15.0)	37 (61.7)	11 (18.3)	3 (5.0)	2.87±0.7
Commercial buildings	14 (23.3)	26 (43.3)	15 (25.0)	5 (8.3)	2.82±0.9
Religious buildings	11 (18.3)	23 (38.3)	23 (38.3)	3 (5.0)	2.70±0.8
Institutional/Educational buildings	2 (3.3)	24 (40.0)	28 (46.7)	6 (10.0)	2.37±0.7
Sporting/Recreational buildings	7 (11.7)	18 (30.0)	23 (38.3)	12 (20.0)	2.33±0.9

Table 4: ICT tools employed among practising architects in Oyo and Osun States (n = 60)

	Not at all n (%)	<25% of time n (%)	25-50% of time n (%)	50-75% of time n (%)	75-100% of time n (%)	Mean±SD
Computer-Aided Design (CAD) software (e.g AutoCAD, ArchiCAD, Sketchup etc)	0 (0.0)	1 (1.7)	14 (23.3)	16 (26.7)	29 (48.3)	4.22±0.8
Building Information Modelling (BIM) software (e.g BIM 360, BIMCollab, Dalux etc)	27 (45.0)	12 (20.0)	11 (18.3)	6 (10.0)	4 (6.7)	2.13±1.2
3D modelling and visualization software (e.g 3DS Max, Maya etc)	6 (10.0)	15 (25.0)	14 (23.3)	13 (21.7)	12 (20.0)	3.17±1.2
Virtual Reality (VR) and Augmented Reality (AR) software (e.g Unreal Engine 4, Unity etc)	41 (68.3)	4 (6.7)	7 (11.7)	6 (10.0)	2 (3.3)	1.73±1.2
Geographic Information System (GIS) software (e.g ArcGIS, GeoServer, MapWindow etc)	22 (36.7)	24 (40.0)	9 (15.0)	4 (6.7)	1 (1.7)	1.97±0.9
Energy analysis and simulation software (e.g ACCA, StruSoft etc)	50 (83.3)	5 (8.3)	5 (8.3)	0 (0.0)	0 (0.0)	1.25±0.6
Structural analysis software (e.g Tekla, STAAD, Prokon etc)	41 (68.3)	10 (16.7)	7 (11.7)	2 (3.3)	0 (0.0)	1.50±0.8
Project management and collaboration software (e.g Emails, Jira, Trello, Notion, Slack etc)	31 (51.7)	14 (23.3)	9 (15.0)	4 (6.7)	2 (3.3)	1.87±1.1
Estimation and cost management software (e.g Stack, Sage, Clear Estimates etc)	43 (71.7)	11 (18.3)	5 (8.3)	1 (1.7)	0 (0.0)	1.40±0.7
Rendering software for producing photorealistic images and animations (e.g Lumion, V-Ray, Corona etc)	9 (15.0)	11 (18.3)	21 (35.0)	11 (18.3)	8 (13.3)	2.97±1.2
Databases for managing building materials and equipment (e.g SiteMate, SiteMax, Radar etc)	23 (38.3)	14 (23.3)	16 (26.7)	3 (5.0)	4 (6.7)	2.18±1.2
Mobile applications for on-site data collection, communication and collaboration (e.g WhatsApp, Fulcrum, TracerPlus etc)	9 (15.0)	9 (15.0)	19 (31.7)	7 (11.7)	16 (26.7)	3.20±1.3
Cloud-based software for storage, sharing and collaboration (e.g., Google Drive, Google Meet, Zoom, Dropbox etc)	12 (20.0)	17 (28.3)	13 (21.7)	5 (8.3)	13 (21.7)	2.83±1.4

4.1 Involvement in Various Architectural Project Typologies

In Table 3, none of the architects reported always being involved in residential buildings (0.0%). However, a significant proportion (48.3%) noted that they were often engaged in residential buildings, while 38.3% indicated rare involvement. A smaller group (13.3%) reported never working on residential projects. The mean response for this typology was 2.35 ± 0.7, suggesting moderate engagement overall but with considerable variability. This distribution indicates that residential buildings are a common but not universally prioritised project type among the respondents.

Estate development projects were more frequently undertaken, with 15.0% of respondents reporting always being involved and 61.7% often engaged. Additionally, 18.3% noted rare involvement, while only 5.0% indicated they were never involved in estate development. The mean response was 2.87 ± 0.7, reflecting a higher level of overall engagement with relatively lower variability compared to other typologies. Estate development clearly represents a central area of practice for most of the architects surveyed.

In the case of commercial buildings, 23.3% of respondents reported always being involved, while 43.3% were often engaged. A smaller group (25.0%) noted rare involvement, and 8.3% indicated no involvement at all. The mean response was 2.82 ± 0.9, indicating a high level of overall engagement, albeit with a wider spread of responses. This finding highlights that commercial buildings constitute an important focus for many practitioners but are not a universal area of engagement. Religious buildings saw 18.3% of respondents always involved and 38.3% often engaged. Another 38.3% reported rare involvement, while 5.0% noted no involvement in such projects.

The mean response was 2.70 ± 0.8, reflecting a moderate level of engagement and suggesting that the design of religious buildings is a significant but not dominant area of focus for architects in the region. The equal distribution between those often and rarely engaged demonstrates the diverse roles of respondents in this category.

Institutional or educational buildings were less commonly undertaken, with only 3.3% of respondents reporting always being involved and 40.0% often engaged. A larger group (46.7%) noted rare involvement, and 10.0% reported no involvement at all. The mean response was 2.37 ± 0.7, highlighting generally low levels of engagement with moderate consistency in responses. This suggests that while some architects do focus on institutional projects, they are not a widespread priority within the group surveyed. Finally, sporting and recreational buildings saw relatively low involvement overall. Only 11.7% of respondents reported always being involved in such projects, and 30.0% noted frequent engagement. A larger proportion (38.3%) rarely worked on these projects, while 20.0% indicated no involvement at all. The mean response of 2.33 ± 0.9 underscores low engagement levels with high variability, indicating that these projects are niche and not a major focus for most respondents.

4.2 ICT tools employed among practising architects in Oyo and Osun States

Table 4 presents the types of ICT tools employed among practising architects in Oyo and Osun States who participated in this study. The results showed that 1.7% of the architects reportedly used less than 25% of their time to deploy Computer-Aided Design (CAD) software (e.g AutoCAD, ArchiCAD, Sketchup etc) in their projects, with mean response of 4.22±0.8. It was also revealed that 10.0% of the respondents claimed they used 50-75% of their time on Building Information Modelling (BIM) software (e.g BIM 360, BIMCollab, Dalux etc), with mean response of 2.13±1.2. Similarly, 23.3% of the architects reportedly used 25-50% of their time on 3D modelling and visualization software (e.g 3DS Max, Maya etc), with mean response of 3.17±1.2.

Results showed that 68.3% of the architects who participated in this study reportedly had no time to spare on Virtual Reality (VR) and Augmented Reality (AR) software (e.g Unreal Engine 4, Unity etc), with mean response of 1.73±1.2. Moreover, results showed that 16.7% of the architects reportedly used less than 25% of their time on Structural analysis software (e.g Tekla, STAAD, Prokon etc), with mean response of 1.50±0.8. It was also revealed that 1.7% of the respondents claimed they used 50-75% of their time on Project management and collaboration software (e.g Emails, Jira, Trello, Notion, Slack etc), with mean response of 1.87±1.1.

In the same vein, 13.3% of the architects reportedly used 75-100% of their time on Rendering software for producing photorealistic images and animations (e.g Lumion, V-Ray, Corona etc), with mean response of 2.97±1.2. Results showed that 15.0% of the architects who participated in this study reportedly had no time to spare on Mobile applications for on-site data collection, communication and collaboration (e.g WhatsApp, Fulcrum, TracerPlus etc), with mean response of 3.20±1.3.

Table 5: Mean rate of impact of the deployment of ICT tools on each aspect of architectural practices

	Ease of work	Cost management	Maximization of profits	Increase in productivity	Streamlining of workflow	Client satisfaction	Aids communication, coordination, and collaboration among design professionals	Speedy completion of jobs in a timely manner	Improved accuracy in work done
Sketch designs	4.07	3.67	3.50	4.27	4.00	**4.28**	**4.48**	**4.38**	4.27
Presentation drawings	**4.65**	3.90	3.90	4.30	4.22	**4.38**	4.38	**4.42**	4.35
Working drawings	**4.57**	4.22	3.85	4.28	4.37	4.37	**4.57**	4.38	4.43
Contractual documentation	4.28	4.00	3.88	4.13	4.22	4.10	**4.40**	**4.35**	**4.33**
Tendering	4.05	3.90	3.70	4.02	3.98	4.02	**4.08**	4.07	4.03
Costing and specification	4.07	3.83	3.77	3.90	3.93	3.93	4.13	3.98	**4.18**
Site supervision	3.93	3.88	3.83	3.93	3.92	3.83	**4.05**	3.97	3.88
Contractual management	3.88	3.82	3.73	3.83	3.83	3.78	**4.05**	3.92	3.95
Project management	3.97	3.93	3.92	**4.02**	3.97	**4.02**	**4.03**	3.97	3.98

4.3 Assess the impact imposed by ICT tools on the architectural profession in Oyo and Osun States

Table 5 presents the mean rates of the impact of the deployment of ICT tools on each aspect of architectural practices among practicing architects in Oyo and Osun States who participated in this study. The results showed that the impact of ICT tools on sketch design was rated highest (4.48) for its impact in aiding communication, coordination, and collaboration among design professionals.

The second rated impact (4.38) on sketch designs was in its speedy completion of jobs in a timely manner. Furthermore, it was revealed that the impact of ICT tools on presentation drawing was rated highest (4.65) for its ease of work. The second rated impact (4.38) on presentation drawing was in its speedy completion of jobs in a timely manner. The results showed that the impact of ICT tools on working drawings was rated highest (4.57) for its ease of work, and its impact in aiding communication, coordination, and collaboration among design professionals.

The second rated impact (4.43) on working drawings was in its improved accuracy in work done. Furthermore, it was revealed that the impact of ICT tools on contractual documentation was rated highest (4.65) for its impact in aiding communication, coordination, and collaboration among design professionals. The second rated impact (4.35) on contractual documentation was in its speedy completion of jobs in a timely manner.

Moreover, results further showed that the impact of ICT tools on tendering was rated highest (4.08) for its impact in aiding communication, coordination, and collaboration among design professionals. The second rated impact (4.07) on tendering was in its speedy completion of jobs in a timely manner. Furthermore, it was revealed that the impact of ICT tools on costing and specification was rated highest (4.18) for its improved accuracy in work done. The second rated impact (4.13) on costing and specification was in its impact in aiding communication, coordination, and collaboration among design professionals.

The results continued to show that the impact of ICT tools on site supervision was rated highest (4.05) for its impact in aiding communication, coordination, and collaboration among design professionals. The second rated impact (3.97) on site supervision was in speedy completion of jobs in a timely manner. Furthermore, it was revealed that the impact of ICT tools on contractual management was rated highest (4.05) for its impact in aiding communication, coordination, and collaboration among design professionals. The second rated impact (3.95) on contractual management was in its improved accuracy.

5. DISCUSSION

The study demonstrates that ICT tools have significantly impacted architectural practices in South-west Nigeria by enhancing communication, improving project accuracy, and streamlining workflows, particularly in tasks such as sketch designs, presentation drawings, and contractual documentation. These findings align with previous studies showing that ICT adoption improves productivity and project management across various regions and architectural contexts. For instance, Mohamed and Stewart (2003) highlighted the role of ICT in enhancing information flow and transaction speed, which parallels this study's observation that ICT tools aid in the speedy completion of tasks.

Similarly, Oladapo (2006) found that ICT tools greatly facilitate design processes, allowing architects to work more collaboratively and efficiently with other stakeholders, a benefit confirmed by the high impact scores related to communication and collaboration observed in this study. In contrast, certain ICT tools, like Building Information Modeling (BIM) and Virtual Reality (VR) software, are less widely adopted among Nigerian architects, with limited engagement due to factors such as cost and training needs. This underutilization mirrors findings in the Turkish construction sector by Acar et al. (2005), who reported that ICT was often applied in a piecemeal fashion due to organizational constraints.

Love et al. (2004) similarly noted that in the Australian construction industry, ICT adoption was often constrained by costs and training, which affected both employee adaptation and the full realization of potential ICT benefits. The limited use of BIM in Nigeria also reflects Ogunmakinde's (2014) findings on the slow but steady adoption of ICT in the country's architecture sector, primarily due to the lack of technical expertise and advanced tools.

Ultimately, this study supports the growing body of literature underscoring the transformative potential of ICT in architecture. However, it also emphasizes the unique challenges faced in Nigerian practice, including resource limitations and skill gaps. Addressing these issues could further maximize the advantages of ICT, leading to broader adoption and potentially reshaping architectural practice in Nigeria.

6. CONCLUSION

This study successfully examined the understanding and deployment of architectural ICT tools among Nigerian architects in South-west Nigeria, offering a comprehensive perspective on their impact on design and project management. The findings reveal that while tools such as CAD software are widely adopted, more advanced technologies like BIM, VR/AR, and energy simulation software remain underutilised. This disparity highlights a gap between awareness and practical implementation, influenced by factors such as high costs, insufficient training, and inadequate infrastructure. ICT tools have significantly reshaped architectural workflows, particularly in enhancing communication, coordination, and collaboration among design professionals. The tools have been instrumental in improving productivity, accuracy, and efficiency, especially during the early design stages, such as sketch and working drawings. However, the lower adoption rates in implementation-focused phases, such as site supervision and project management, indicate barriers that still need to be addressed.

The challenges identified, including limited access to tools and a lack of technical expertise, underscore the need for targeted interventions. Opportunities exist to leverage ICT to align Nigeria's architectural practices more closely with global trends. To fully realise these benefits, strategies such as affordable access to advanced tools, robust training programmes, and infrastructure improvements must be prioritised. This would foster a broader and more impactful integration of ICT across all stages of architectural practice.

Conflict of Interest

The authors declare no conflict of interest associated with this study.

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