# EXAMINING THE ROLE OF ARTIFICIAL INTELLIGENCE IN CLIMATE RESILIENCE: APPLICATIONS FOR ARCHITECTURAL TECHNOLOGISTS IN SOUTHEAST NIGERIA

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## Abstract

*There is no gainsaying the role architectural technologists play in determining the nexus between technology and architecture. This intricately specialized role which incorporates the entire lifespan of buildings ensures that buildings remain cost-effective, well-organized and functional. However, the plethora of challenges confronting the Nigerian milieu, which include overwhelming housing deficits, rapid slum purlieus that results in inordinate waste generations, and overall indiscriminate land-use patterns collectively pose a bane to the architectural technologists' practice. The purpose of this paper is to examine the level of preparedness to tackle issues of decarbonisation and potential challenges for implementation of climatic-resilient architecture. The aim is to ensure that adopting advanced technology leads to providing design and construction solutions that promote climate resilience peculiar to the Nigerian built environment. Survey research method was adopted; wherein structured questionnaires were used to capture quantitative description of developments, and assessments of two (2) research populations, comprising the schools and registered architectural firms. 63 architectural firms and 4 schools offering architectural technology programmes were randomly selected within the zone. The study revealed over 68% of students have not received any formal training in AI, 79% of technologists work in sync with AI using predominantly ChatGPT. This paper recommends that departments and stakeholders engage in proactive co-creation of a systemic framework to reflect the new specialisms of architectural technology and provide the requisite skills required to navigate the challenging work environment and demands characteristic of study area. This should embrace robust application of AI for climate-resilient architecture.*

**Keywords:** Architectural Technologist, Artificial Intelligence, Climatic resilience, Decarbonisation

## INTRODUCTION

Many scholars have observed that one of the central issues in architectural education is the relationship between what is taught in schools and the skills required for practice (Armstrong & Allwinkle, 2017; Marcel-Okafor, 2024) . This is an underlying concern in architectural technology education in Nigeria. It requires an understanding of the dynamics of practice, which could necessitate relevant changes in the curriculum of the programme. Proficiencies with advanced digital design and construction solutions such as building information modelling (BIM) hold an indispensable opportunity for technological advancement in the building industry. These skills are germane to the architectural technologists' practice in order to remain relevant and suitable for emerging social, economic and cultural needs within the Nigerian milieu.

However, the entry and ensuing frenzy of artificial intelligence (AI), cannot be ignored in architectural technology practice, particularly since AI is progressively being adopted to augment climate resilience in vast fields. Studies have shown that AI is on a race to capture all spheres of human activity, with its ability to process and compute information tremendously progressing and transforming man's activities (Davis, 2024) . Recent studies have also revealed that 35% of companies have resorted to AI services in order to mitigate shortages in specialised human labour, and approximately 40% target AI usage in the near future (Howarth, 2025). AI presents robust potential to reform methods of design conception, development, and actualisation of modern structures. Hence, AI is becoming progressively indispensable in architectural technology to facilitate climate resilience architectural solutions through generative designs, building performance simulation, material selection, and integration with BIM. It is therefore mandatory, that architectural technologists leverage AI to facilitate key aspects of their profession.

Architectural technology practice in Nigeria is increasingly shaped by the need to adopt advanced technology as responsive tools for addressing polarising social and economic variables associated with overwhelming housing deficits, rapid slum purlieus resulting in inordinate waste generations, and overall indiscriminate land-use patterns. These variables significantly contribute to activities that exacerbate global warming, especially since the dearth of adequate infrastructure in such environs lead to air and water pollution that impact human health and ecosystems. Of even greater concern is the Southeast zone of the country, which features one of the highest population densities and widest spread rural-urban shifts (Geo-ref.net, 2024) . A situation that helps to explain the explosive rise in challenges associated with the built environment that are characteristic of the region. The zone, which is one of the six geopolitical zones in the country, constitutes the study area for this study. It is made up of five (5) states namely; Abia State, Anambra State, Ebonyi State, Enugu State, and Imo State. The zone is one of the most homogenous and cohesive zones in Nigeria comprising a single ethnic group; the Igbo ethnic group. By territorial size, the Southeast zone is the smallest in Nigeria, accounting for 3.2% of the national landmass. The zone has a population of approximately 21 million persons which represents about 12% of the entire national population (Okafor, Awuzie, Otasowie, & Aigbavboa, 2024).

Rapid urbanisation and industrialisation simultaneously occurring within the zone create a cycle of ecological disruptions that impact on the overall climate, with approximately 2000 gully erosion sites distributed sporadically within the region (Egboka, Orji, & Nwankwoala, 2019) . These factors contribute to undulating and bad land use patterns that trigger soil degradation and greenhouse gas emissions that negatively impact the macro and micro climatic conditions of the region. The rampant use of carbon-intensive materials like cement and steel, the inefficient building designs resulting in high energy utility, spontaneous building demolitions, as well as uncoordinated waste management and disposal of construction debris all contribute to carbon emissions within the region. However, the required technologies that challenge the architectural technologists and promote implementation of applications that optimise sustainable designs and climate-resilient architecture are yet to be explored particularly in Southeast Nigeria. This is evident in the present construction processes, as approximately 90% of structures in the region are still constructed in-situ from concrete blocks (Raheem, Momoh, & Soyingbe, 2012; Marcel-Okafor & Okafor, 2020).

Albeit, there is an increasing emphasis on adopting designs that ensure energy efficiency, and the academic curriculum for architectural technology programmes indicates efforts in training to conform with international best practices of technologically advanced nations. This is particularly crucial since studies have shown that because architectural practice in Nigeria has been largely computerised, only the graduates proficient in CADD are relevant and employed (Oladapo, 2017) . Yet, many scholars have pointed out the gap between what is taught in schools and industry demand for effective practice as evident in certain dissatisfactions expressed by employers of the graduates (Adekunle, John, & Aigbavboa, 2019; Aliu & Aigbavboa, 2020) . This supports the assertions of previous studies that graduates of architectural technology must be synced with demands in practice in order to attain significant levels of career success, in addition to satisfactory service delivery (Marcel-Okafor & Okafor, 2022; Marcel-Okafor U. O., 2024; Adekunle S. , et al., 2024).

The purpose of this paper is therefore, to examine potential challenges for implementation that address the level of preparedness to tackle issues of decarbonization, and climatic change adaptation. The aim is to ensure that advanced technologies are strategically integrated into design and construction solutions in order to promote and enhance climate-resilient architecture, whilst capturing the peculiarities associated with the built environment in Southeast Nigeria. To achieve the aim, the study pursued two objectives; To examine the level of preparedness to tackle pressing issues of decarbonization. To examine the awareness and application of AI algorithms in enhancing building designs for climate resilience. It is therefore expedient to determine how architectural technologists in Southeast Nigeria interact with AI in training and in practice for effective delivery of sustainable and climate-resilient architecture.

## REVIEW OF RELATED LITERATURE

Advanced developments in computer aided design and draughting (CADD) such as building information modelling (BIM), have accentuated the roles of architectural technologists from the outset of drawing proposal to the entire lifespan of buildings. The prominence of BIM is closely associated with the specialisations of architectural technologists, which is anchored on design and project management procedures interconnected with the lifespan of buildings through the complex connection of technology (Emmit, 2009). As a profession, architectural technology strategically controls design in relation to construction processes during the lifecycle of buildings, and ensures that buildings remain cost-effective, well-organized and functional (Armstrong & Allwinkle, 2017).

Climate change, on the one hand, can be described as ongoing alterations in climate conditions (Amaglo, Takyi, Asibey, Amponsah, & Mensah, 2022; Dimuna, Ekhaese, & Ndimako, 2024) . Rising temperatures, increased rainfall and ensuing flooding in cities represent key contributory factors (Hallegatte, et al., 2016; Tabari, 2020; Dimuna, Ekhaese, & Ndimako, 2024). Over time, these changing climatic conditions, constitute hazards to the entire ecosystem. Furthermore, man-made activities such as deforestation, inordinate waste disposals, poor drainage systems and overall indiscriminate land-use patterns exacerbate climate change and is evident in the notorious cases of gully erosions (Ike, 2017; Okenmuo, Ibeh, & Obalum, 2023). Dimuna, et al. (2024) asserted that environmental degradation has become commonplace, particularly in southern Nigeria's rainforest humid region. Climate resilience, on the other hand, is the capabilities of individuals, communities and ecosystems to weather the impacts arising from climate change, and furthermore establish preventive measures that will impede more negative impacts (Intergovernmental Panel on Climate Change, 2022; Dimuna, Ekhaese, & Ndimako, 2024)..

Energy consumption is a key factor in the economy of resources, and within the built-up environment, the race to adopt active energy systems to generate conditions that ameliorate thermal comfort has reached a tipping point, majority of electricity consumers are concentrated in the building sector with residential buildings accounting for over 70% of total electricity consumption nationwide (IAEA, 2009). The energy supply crisis characterised by incessant power shortages is experienced by approximately 60% of residential buildings, with approximately 43% of the population disconnected from the national grid (Arup (Madrid & Lagos offices), 2010) . However, clear reduction of energy necessary to cool and light buildings can be achieved with passive energy systems that rely on adoption of eco-friendly design techniques. Hence, climate change has heightened the drive to shift towards integrating design strategies that are responsive to climatic conditions, by way of adopting energy-efficient systems and sustainable building materials. Hu (2017) , observed that the paucity of conversation and empirical data of prevailing building technology brought to light barriers to advancements in sustainable building technologies. Again, Kouider, Salman, and Paterson (2018) revealed from their study, that specific tools taught in schools studied had direct link to the area of curriculum with the discipline, noting that AutoCAD/Photoshop and Revit were taught to architecture and architectural technology students, who displayed exceptional abilities in adapting to the BIM software applications. Consequently, to mitigate the impact of climate change, requires the creation of sustainable, resilient and eco-friendly strategies that facilitate decreased energy consumption for optimised thermal comfort.

**Artificial Intelligence in climate resilience**

The swift entrance and ensuing prominence of AI, has given societies little or no time to ruminate on the potentials and constraints of this latest technology. However, like in all spheres of human activity, AI has penetrated environmental systems, making it a must use technology for enhancement of climate-resilient strategies. These include weather forecasting, ability to determine initial signs of climate change such as heatwaves, potential flood-prone areas as well as areas of unstable land formations. Studies have shown that AI applications in the energy sector have led both directly and otherwise to emissions reductions (IEA, 2025). Further studies indicate that AI technologies offer significant potential to reduce greenhouse gas emissions, minimize energy waste, optimize energy consumption and distribution by improving grid efficiency, forecast power demand and enhance the deployment of renewable energy sources (UN Climate Change, 2025). However, the paucity of critical analysis data on AI, dearth of general operational knowledge, as well as AI algorithmic bias constitute critical limitations for efficient adoption (UN Climate Change, 2025). The architectural technologists' practice is enhanced by AI in areas of advanced generative designs, repetitive tasks robotics, as in multilayered structures, increased precisions for maximum performance, minimal errors which lead to minimised wastages, actual simulations that enable quick augmented execution of optimal design solutions. The UN report concludes by recommending priority actions that include addressing the digital divide by investing in AI capacity-building programmes that empower local experts and institutions and others (UN Climate Change, 2025).

## METHODOLOGY

The survey research design was adopted in this study. Four departments of architectural technology from tertiary institutions and 63 architectural firms, all within the region were randomly selected using the stratified sampling method. Structured questionnaires were used to elicit data from the respondents that comprised students in the graduating class, and the architectural technologists practicing in architectural firms across Southeast Nigeria. The first batch of questionnaires administered to the graduating class students concentrated on key aspects of eco-friendly design principles that focused on economy of resources; orientation, fenestration, and preference for locally available building materials, as variables used to measure the students' ability to make informed decisions about design principles anchored on energy efficiency in relation to the environment. The next batch of questionnaires elicited data on degree of exposures to AI and areas of application to enhance climate-resilient designs.

Pilot survey conducted revealed a total of 242 students in the graduating class, and a total number of 473 graduates which formed the population size 'N' respectively. The study adopted the approach based on precision rate and confidence level which availed it of a mathematical solution for determining sample size 'n' (Kothari, 2012) . Hence using the Yamane's simplified formula to calculate sample size with 95% precision level 'e' and the population size 'N', the sample size was determined as follows:

$$n = \frac{N}{1+N(e)^2} \qquad \text{Equation 1}$$

Applying the above formula, a sample size of 151 students for the graduating class group was derived. However, Taherdoost (2017) affirmed that sample size reflects the number of positive responses, and not necessarily the number of questionnaires distributed; which is often augmented to make allowance for non-response. Hence, with an allowance of 5% given for envisaged low response, a total of 160 copies of structured questionnaires were proportionately administered to the students in the graduating class. In the case of the graduates, the study considered the fact that not all the graduates are working in firms within the study area and not all are working under registered firms. Therefore, an assumption of 50% of the total number of HND graduates (237 graduates) was used to determine the population size 'N'. Again, applying the above formula, a sample size of 149 graduates was derived. Still maintaining the 5% allowance, a total of 156 copies of structured questionnaires were administered to graduates in practice within the five states that constitute the study area.

The number of architectural firms was based on desired accuracy with a population percentage or variability of 50%, confidence level of 95%, and a 5% margin of error (Gill, Johnson, & Clark, 2010) in (Taherdoost, 2017) . Gill et al. (2010) presented sample size suitable for specific variations of precision, confidence levels and a population percentage or variability of 50%. Hence, the study adopted 63 registered architectural firms as the sample size. However, owing to the uneven spread of the firms across the study area, copies of the questionnaire were randomly administered to 3 firms in Abia State, 5 firms in Anambra State, 43 firms in Enugu State and 12 firms in Imo State. This was done according to first contact basis which was obtained from the list of graduate members registered with the respective state chapters of the Nigerian Institute of Architects (NIA), and some were sent as softcopies via their email address.

## FINDINGS

The extents of the responses across available categories were specified as aggregated data obtained from the sampled institutions as illustrated in Figure 1.

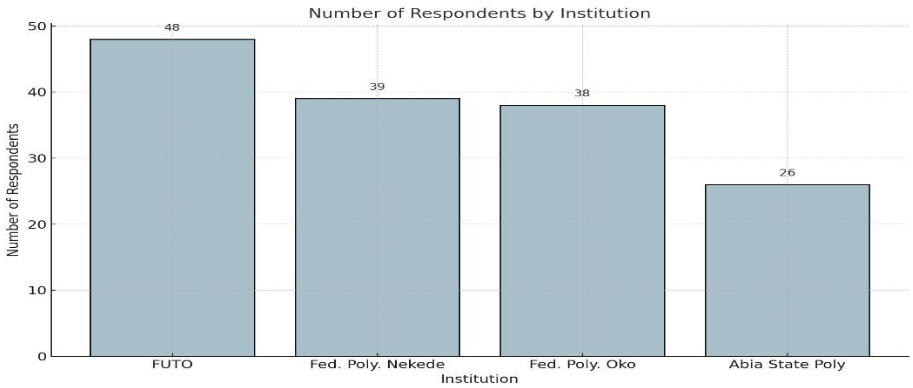


**Figure 1: Distribution of respondents across the institutions**

Using the numeric rating scale, on a 1 – 10 scale; results of analysis carried out revealed the awareness and level of importance students ascribed key aspects of design principles that critically relate to the climatic conditions of the region. As shown in Figure 2, more than two-thirds (82%) of the total proportion of respondents spread across the tertiary institutions indicate very strong consensus showing they had keen interests and considered key aspects of eco-friendly design principles that focused on energy efficiency in relation to the environment; orientation, fenestration, and preference for locally available building materials, as highly important aspects at the outset of every design.

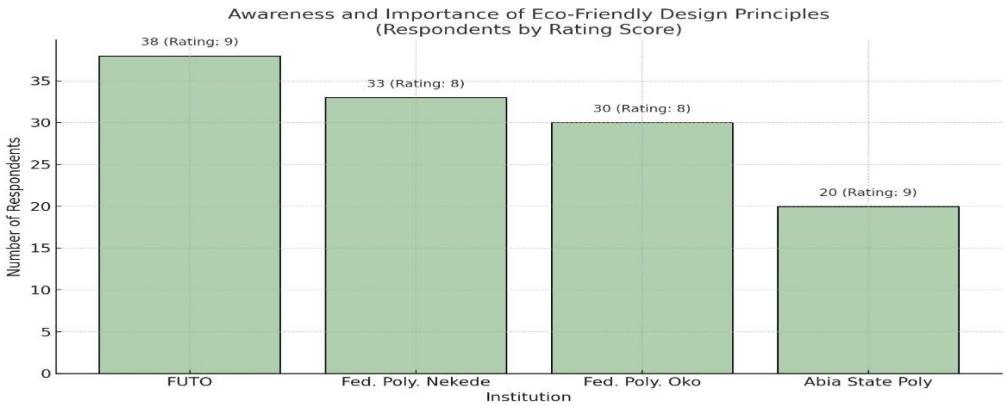


**Figure 2: Awareness and importance of energy efficient design principles**

From the results of the analysis of aggregated data on *Formal training or workshops related to AI tools in architecture* revealed a significant deficiency in formal AI education within the institutions. As shown in Figure 3, over two-thirds of the respondents revealed that they have not received any formal training or workshops related to AI tools in architecture.

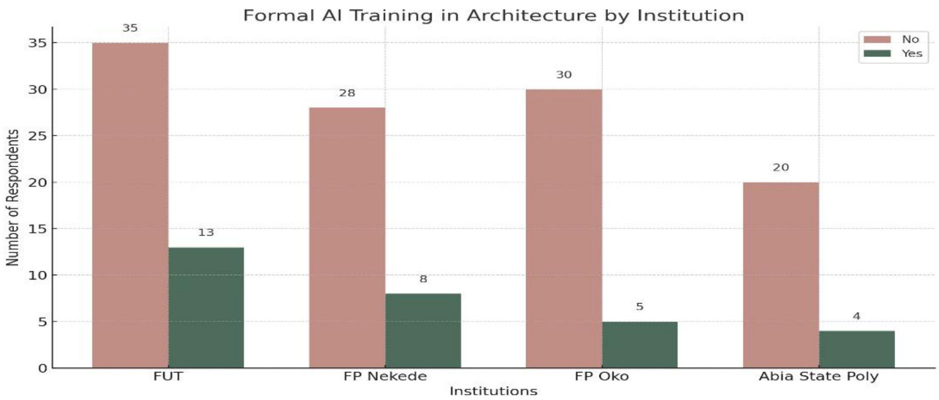


**Figure 3: Formal AI Training in Architecture by Institution**

The extents of the responses across available categories were specified as aggregated data obtained from the sampled architectural firms and presented in percentages (%) as follows: The results of data gathered showed the spread of the architectural firms where the respondents practice across the study area. Table 1 showed that the largest proportion of the respondents worked in architectural firms located in Enugu State. This was followed by respondents that practiced in firms located in Imo State. The least proportions of the respondents practiced in firms located in Abia and Anambra States respectively.

**Table 1: Aggregated data V1- Location of Firms**

| Value label | Valid Percent | Cumulative Percent |
|---|---|---|
| **Abia State** | 6.6 | 6.6 |
| **Anambra State** | 6.6 | 13.1 |
| **Enugu State** | 67.2 | 80.3 |
| **Imo State** | 19.7 | 100.0 |
| **Total** | 100.0 | |

*Source:* (Marcel-Okafor, 2021)

From the results of the analysis of aggregated data on *Frequency of AI use among graduates* revealed a high frequency of AI use among graduates. As shown in Figure 4, over two-thirds of the respondents revealed that they frequently use AI tools in architecture.

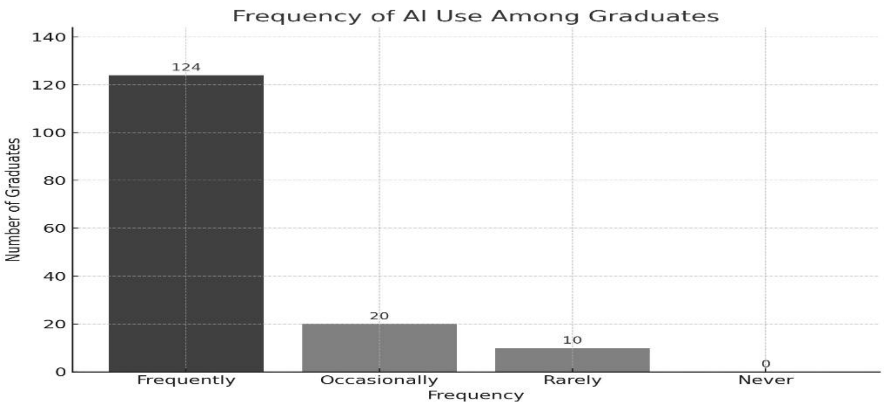


**Figure 4: Frequency of AI use among graduates**

## DISCUSSIONS AND IMPLICATIONS

The data collected has shown an 82% prevalence of strong consensus among students on the importance of energy-efficient design in relation to climate resilience. This indicates the abilities to make informed design decisions at the outset of the design process geared towards developing designs and resultant buildings that contribute to climate-resilient architecture of the region. This implies that future generation in the profession will prioritise energy-efficient and climate-resilient design strategies. This would potentially influence the options and demand for building materials that are responsive to the peculiarities of the region.

However, data also revealed obvious deficiencies in exposure to formal AI training and workshops as over two-thirds of the respondents showed that they have not received any formal training related to the innovative technology. This implies a gap in the curriculum, which may be attributed to the fact that the technology is nascent. This also implies that the graduates may enter the labour market, unskilled for the demands of the industry. Considering the ubiquitous AI presence and relevance in decision-making, generative design, planning, and execution, the lack of skilled architectural technologists will amount to a significant gap in skills required to navigate the industry. This particularly so since the graduates in practice have shown that majority rely on AI in practice. This study supports the findings of previous studies for systemic and periodic exposure of students to practical demands of their industry (Marcel-Okafor & Okafor, 2022; Marcel-Okafor U. O., 2024; Adekunle S. , et al., 2024).

## RECOMMENDATIONS

The ever-increasing global demand for graduates skilled in technologically advanced solution-oriented techniques coincides with evolving technological advancements. There is a yawning need for architectural technologists to be abreast with constantly developing techniques which have gained prominence globally as effective problem-solving tools needed to efficiently deliver services in the challenge-ridden industry of the region. Artificial intelligence (AI) has emerged amidst latent biases, and in other to remain relevant, the architectural technologist burdened with the responsibilities of linking architecture with technology, must brace up to acquire the skillsets required of this nascent technology. In the light of the current conditions the study recommends;

1. That departments should undertake the responsibility of bridging the observed gap between what is taught in the programme and the relevant skillsets needed to navigate the challenging work environment characteristic of the study area. This is primarily done through building capacity. Hence, regular staff development programmes are crucial in order to match the constantly changing technological advancements in the field with appropriately informed teaching staff. Departments should set guidelines for regular and periodic workshops to encourage staff as well as students to showcase new concepts which should be recognised and adopted.
2. Departments should foster boisterous relationship with private practitioners within the study area, known for their commercial adventures so as to attract patronage and sponsorship in key areas where new concepts are likely to attract public interest. This should include introducing AI workshops in all schools of architecture in the region in areas of modification of materials, recycling building materials, discovering renewable features of existing building materials and so on.

## CONCLUSION

The role of architectural technologists in fostering climate-resilient architecture through the strategic use of AI cannot be overstated. The apparent deficiencies in AI training among students points to a gap in the educational curriculum for training architectural technology students. This situation demands urgent attention so as to ensure that in future strong and skilled design responses to climate risks are available and implemented. It is therefore mandatory that reviews in the curriculum address this gap and ensure that students are equipped with the relevant skills, tools, and mindset to leverage AI in decision-making, design conceptualisation and constructing buildings that are climate-resilient.

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