NILE UNIVERSITY OF NIGERIA
HONORIS UNITED UNIVERSITIES

5TH INAUGURAL LECTURE

Titled

BEYOND CONCEPTS AND CONCRETE: PATHWAYS FOR ADVANCING SUSTAINABLE BUILDINGS AND INFRASTRUCTURE IN 21ST CENTURY NIGERIA

To be delivered by

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October 30, 2025

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5th Inaugural Lecture

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Professor of Civil Engineering, Nile University of Nigeria, Abuja

October 2025

NATIONAL ANTHEM

Nigeria we hail thee
Our own dear native land,
Though tribe and tongue may differ,
In brotherhood, we stand,
Nigerians all, and proud to serve
Our sovereign Motherland.

Our flag shall be a symbol
That truth and justice reign,
In peace or battle honour'd,
And this we count as gain,
To hand on to our children
A banner without stain.

O God of all creation,
Grant this our one request,
Help us to build a nation
Where no man is oppressed,
And so with peace and plenty
Nigeria may be blessed.

DEDICATION

This Inaugural Lecture is dedicated:
To Allah, the source of all knowledge and the guide on every path.
To my father, who gave me a good name.
To my mother, whose struggles were my foundation.
And to my wife and children, the future I build for.
To my teachers, in faith and in science, who taught me to build beyond concrete.
To Nigeria, and the generations who will build her sustainable future.

PROTOCOL

The Chairman of Council and Pro-Chancellor
Members of the Governing Council
The Vice Chancellor
Deputy-Vice-Chancellor (Academics)/Director of Academic Planning
Deputy-Vice-Chancellor (Central Administration)
The University Registrar
The Chief Financial Officer
The Chief Peoples' Officer
The Chief Marketing Officer
The Bursar
The University Librarian
Provost, College of Health
Dean, School of Postgraduate Studies
Deans of Faculties
Professors and other Members of Senate
Dean of Student Affairs
Directors
Head of Departments
Academic Staffs
Members of Congregation
My Family Members
Great Students of Nile University of Nigeria
Members of Alumni
My Lords, Spiritual and Temporal
Esteem Guests and Friends
Gentlemen of the Press
Distinguished Ladies and Gentlemen

PREAMBLE

"And do not cause corruption upon the earth after it has been set in order. And invoke Him in fear and aspiration. Indeed, the mercy of Allah is near to the doers of good." — Surah Al-A'raf (7:56)

"The greatest threat to our planet is the belief that someone else will save it." — Robert Swan

The Vice Chancellor, esteemed colleagues, honoured guests, ladies and gentlemen.

As we gather here today, we stand at a pivotal moment in our shared journey toward a sustainable future. The challenges we face are daunting: climate change, urbanization, and resource depletion loom large over our aspirations. Yet, within these challenges lies an extraordinary opportunity—an opportunity to redefine our built environment and to forge pathways that lead us toward resilience and harmony with our planet.

This inaugural lecture, titled "Beyond Concept and Concrete: Pathways for Sustainable Buildings and Infrastructure in 21st Century Nigeria," invites us to transcend abstract ideals and concrete structures. It is a clarion call for action, urging us to integrate sustainability into the very fabric of our communities and to innovate boldly in the face of adversity.

Today, we will explore not just the urgent need for change but the actionable pathways that can lead us there. Together, we will envision a Nigeria where sustainable practices are the norm, where our cities breathe life rather than consume it, and where every building is a testament to our commitment to future generations.

Let us embark on this journey together, fuelled by hope, guided by knowledge, and united in purpose. The time to act is now, and each of us has a role to play in shaping a sustainable legacy for our beloved country. Welcome to this important dialogue and let us begin.

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INTRODUCTION:
THE WEIGHT OF THE MOMENT

The Vice-Chancellor, Deputy Vice-Chancellors, Registrar and other Principal Officers of the University, Deans of Faculties, Heads of Departments, distinguished members of the academic community, royal fathers, captains of industry, my cherished mentors, esteemed colleagues, proud family members, friends, and the bright students who represent our future – a very good evening to you all.

There are moments in history when civilizations stand at crossroads so profound that the choices made echo through generations. Ancient Rome faced such a moment when choosing between expansion and sustainability. The Maya confronted it when their cities outgrew their environment's capacity. Industrial Britain encountered it when coal smoke darkened their skies. Today, Nigeria stands at its own pivotal crossroads.

Mr. Vice Chancellor sir, it is with a profound sense of humility, gratitude, and considerable excitement that I stand before you today to deliver the 5th inaugural lecture. This moment is not merely a personal milestone, marking my accession to the professorial chair; it is, more importantly, an opportunity to share a journey of intellectual inquiry, to reflect on pressing national challenges, and to collectively envision a more sustainable and resilient future for our beloved country.

The title of my lecture, "Beyond Concept and Concrete: Pathways for Sustainable Buildings and Infrastructure in 21st Century Nigeria," is a deliberate call to action. It urges us to move past abstract ideas and the mere physical act of construction, towards tangible, actionable strategies that will redefine our built environment.

For too long, the discourse on development in Nigeria has, at times, felt tethered to grand concepts that struggle to find purchase in the everyday reality of our communities, or it has been overwhelmingly focused on the sheer quantity of concrete poured, often with insufficient regard for long-term viability, environmental harmony, or human well-being. Today, I want to explore how we can bridge this gap, embed sustainability not just as an afterthought, but as the foundational principle guiding the design, construction, operation, and decommissioning of our buildings and infrastructure.

Nigeria stands at a critical juncture. We are a nation of immense dynamism, youthful energy, and vast potential. Yet, we face significant developmental headwinds: rapid, often chaotic urbanization, the escalating impacts of climate change, and an urgent need to provide dignified housing and functional infrastructure for a growing population. At its current population of approximately 220 million, Nigeria faces a housing deficit of around 28 million units, necessitating the construction of about 1 million new homes annually over the next 20 years. Alarmingly, about 75% of existing buildings do not meet standard construction criteria. Furthermore, projections indicate that by 2050, Nigeria's population could surpass 400 million (1), making it the third most populous country in the world. Where will these millions live, work, and thrive? And how can we ensure that their environment supports, rather than undermines, their quality of life and the health of our planet? These are not abstract questions; they are existential challenges that demand our most rigorous intellectual engagement and our most committed practical action. This lecture is my contribution to that urgent conversation.

PART 1:
THE SCIENCE BEHIND THE CHALLENGE

Why Sustainability is not Optional

Every time we switch on a light, adjust the thermostat, cook a meal, or use an elevator or escalator in our buildings, we consume operational energy—the energy required to run buildings for lighting, heating, cooling, appliances, and vertical or horizontal transport. In addition, considerable embodied energy is consumed during the production, transportation, and installation of building and infrastructure components throughout the construction process.

In Nigeria, like in many countries around the world, the energy mix (figure 1) is still heavily dependent on fossil fuels such as natural gas, diesel, and petrol. This means that behind every watt of electricity consumed or every litre of diesel, petrol and kerosene or kilograms of coal and firewood used, there is a typical chemical reaction at play:

$$\text{Fuel} + \text{Oxygen} \rightarrow \text{Energy} + CO_2$$

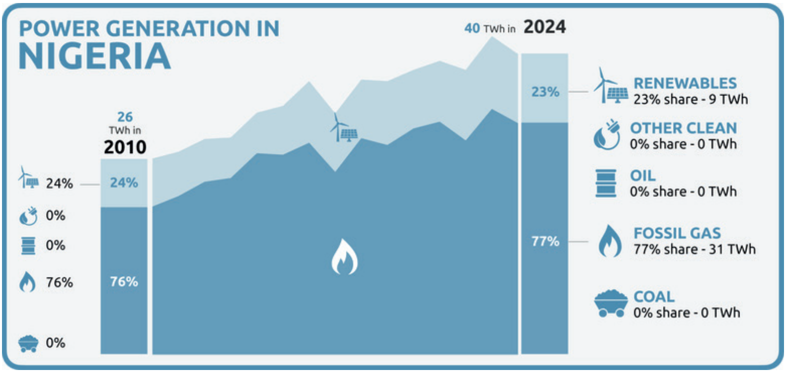


Figure 1: Nigeria's sources of power (climateactiontracker.org)

Carbon dioxide (CO_2), a major greenhouse gas, is released into the atmosphere as a by-product of energy generation. Over time, increasing emissions from our buildings, transportation systems, industries, and energy sources have led to a build-up of greenhouse gases (GHGs) in the atmosphere.

These gases form a thickening blanket (figure 2) around the Earth, trapping heat that would otherwise be emitted back into space. Under natural conditions, a portion of the sun's radiant energy is absorbed by the Earth while the rest is radiated back into space. However, the growing concentration of CO_2 and other GHGs reduces the planet's ability to release heat, leading to the greenhouse effect and, ultimately, global warming.

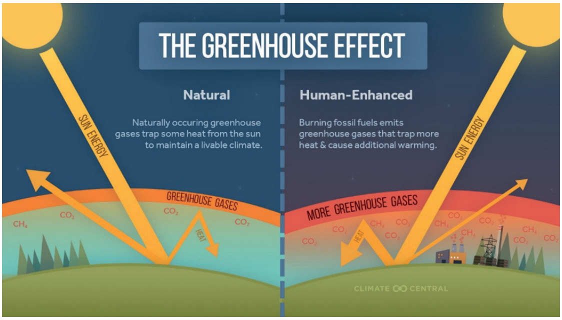


Figure 2- The greenhouse gas effect. (www.climatecentral.org)

Over the past century, the steady rise in global mean temperatures has shown a strong positive correlation with increasing atmospheric carbon dioxide (CO_2) concentrations. This correlation (Figure 2) is well-documented in climate science literature(2,3) and has been driven primarily by anthropogenic activities(4). The trend began with the Industrial Revolution, particularly with the invention of the diesel and gasoline engine in the late 19th century(5), followed by the mass production and widespread adoption of the motor car in the early 20th century (6). These developments significantly increased the combustion of fossil fuels. In the latter half of the 20th century, the rapid expansion in electricity generation—largely reliant on coal, oil, and natural gas and largely used in powering buildings and infrastructures further accelerated CO_2 emissions, contributing substantially to global warming(7).

This sequence of technological and industrial developments underscores the historical link between fossil fuel use and climate change. The Intergovernmental Panel on Climate Change (8) reports that the current global average temperature is approximately 1.1°C higher than pre-industrial levels, largely due to anthropogenic greenhouse gas emissions, with CO_2 being the primary contributor. 2024 was the warmest year in the 175-year observational record, with a global temperature of 1.55 ± 0.13 °C above the pre-industrial baseline(9) shown in Figure 3.

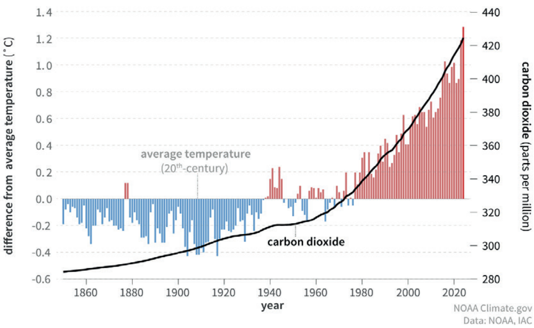


Figure 3 - Correlation between mean global CO_2 and temperature levels(10)

This warming is not without consequence. Rising global temperatures are causing(11,12,13):

- More extreme weather events (floods, droughts, heatwaves)
- Desertification and land degradation
- Increased energy demand (especially for cooling)
- Reduced agricultural productivity and food insecurity
- Rising sea levels that threaten coastal communities

The world is racing to prevent average global warming from exceeding critical Earth system thresholds that could trigger irreversible climate tipping points. Nigeria is a signatory to Kyoto Protocol and the Paris Agreement. Under the Paris Agreement, Nigeria pledged to achieve a 20 per cent unconditional reduction and a 47 per cent conditional reduction in greenhouse gas (GHG) emissions by 2030(14). Consequently, Nigeria is internationally obligated to incorporate climate change measures into its national policies, including the enactment of laws to fulfil its climate change commitments(15).

Nigeria's Vulnerability

Climate change represents an urgent and immediate threat to global stability and prosperity. According to the Sustainable Development Goals (SDGs) Index, Nigeria ranks a concerning 146th out of 166 countries, with a score of 54.3 (16). These ranking highlights significant challenges in meeting the SDGs, despite some progress in policy alignment. Overall, the implementation of these goals in Nigeria remains average, indicating a pressing need for further action.

Nigeria's vulnerability to climate change is starkly illustrated by its low position on the ND-GAIN Index, which assesses a country's exposure to climate hazards and its readiness to respond (17). The nation is experiencing notable changes in its climate, characterized by rising temperatures, erratic rainfall patterns, and increasing sea levels. These changes are further aggravated by underlying issues such as widespread poverty, limited environmental awareness, and inadequate institutional capacity(18).

To address these challenges, Nigeria must enhance its climate change adaptation and mitigation strategies. As civil and building engineers, while we may not directly influence fuel types or engine efficiency, we play a crucial role in shaping how fuel is utilized within the construction and built environment. By promoting sustainable practices and innovative design, we can significantly reduce the carbon footprint of our projects and contribute to a more sustainable future.

Why This Matters in the Built Environment

According to the United Nations Environment Programme (UNEP), buildings and construction are responsible for approximately 37% of global energy-related CO_2 emissions(19). Between 2022 and 2030, an estimated forty billion square meters of floor space will be added globally(20). This is equivalent to adding five times the current floor area of Indonesia. In other words, the world is constructing the equivalent of a new Paris every week(21). Much of this expansion is occurring in emerging markets(22) like Nigeria (figure 4), where building stock is projected to nearly double within the next 20 to 30 years(23).

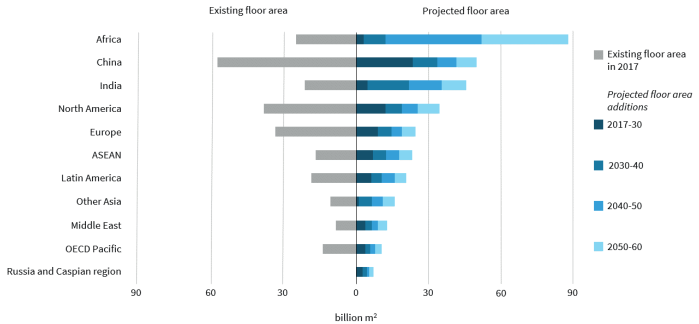


Figure 4: Existing and Projected Floor Areas by Region

What exactly is sustainable infrastructure? It is the planning, design, construction, operation, and decommissioning of physical assets—our roads, bridges, energy systems, water supply, and buildings—in a manner that ensures economic and financial viability, social equity, environmental stewardship, and institutional resilience over their entire lifecycle. It moves beyond simply building structures; it focuses on building a future (24).

It is crucial to acknowledge the scale of the sustainability challenges confronting the building and construction industry, both globally and here in Nigeria. This sector, the engine of development, is simultaneously a significant contributor to environmental degradation. It consumes vast amounts of natural resources, contributes substantially to greenhouse gas emissions, and produces an alarming portion of global waste.

Consider the sheer volume: the construction industry is estimated to consume around half of all non-renewable resources mankind utilizes (25,26). It is a sector that is hugely resource-intensive, using an estimated 400 million tonnes of resources each year in some regions, making it one of the single biggest users in the entire economy (27). This relentless demand for virgin materials exacerbates resource depletion, leading to habitat destruction, biodiversity loss, and increased energy consumption for extraction and processing.

Furthermore, the industry's contribution to climate change is undeniable. Buildings are responsible for a staggering 39% of global energy-related carbon emissions, with 28% stemming from operational emissions (heating, cooling, and powering buildings) and the remaining 11% from materials and construction processes (28). The manufacturing of core building materials like cement and steel is particularly energy-intensive, with cement production alone contributing approximately 8% of total global CO2 emissions annually (29). This "embodied energy" and "embodied carbon" – the energy and carbon emitted during the extraction, manufacturing, transportation, and installation of building materials – represent a significant, often overlooked, environmental footprint (30,31).

Beyond resource and energy consumption, waste generation is another critical issue. Globally, more than two billion tonnes of construction and demolition (C&D) waste are generated every year (32). This waste, comprising concrete, bricks, wood, metals, and other debris, often ends up in landfills, occupying valuable land, polluting soil and water, and releasing harmful gases(33,34). The environmental impacts of improper C&D waste management include increased air, water, and soil pollution, as well as noise pollution(33). The linear "take-make-dispose" model of construction is simply unsustainable in the long run.

These key issues – the embodied energy and carbon footprint of building materials, the high operational energy demand for heating, cooling, and lighting, and the pervasive environmental impacts of construction and demolition waste – paint a stark picture.

The Concrete Reality

For centuries, concrete has been the undisputed king of construction, a material synonymous with strength, durability, and the very fabric of modern civilization. From towering skyscrapers to vast networks of highways, dams, and bridges, its ubiquitous presence is a testament to its unparalleled versatility and low cost. Indeed, it has facilitated human progress on an unprecedented scale, shaping our skylines and connecting our communities. Yet, as we stand at the precipice of the 21st century's most pressing environmental challenges, it is imperative that we cast a critical, unblinking eye upon the full lifecycle of this pervasive material. While its benefits are undeniable, we must now acknowledge, with urgent clarity, the profound and escalating sustainability burden that concrete imposes on our planet. This is not a call for abandonment, but a necessary reckoning, a prelude to innovation, and an essential step towards a truly sustainable future.

The sheer scale of concrete production is staggering. It is, by volume, the most consumed material on Earth after water, with an estimated 30 billion tons produced annually (35,36). This can build a road 10 feet wide and 1 foot thick that will go around the earth 300 times. This colossal demand places immense pressure on our finite natural resources. The primary aggregates – sand and gravel – are extracted from rivers, coastlines, and quarries, leading to significant ecosystem degradation, habitat destruction, and altered hydrological patterns. Riverine systems are particularly vulnerable, with extensive sand mining contributing to bank erosion, aquifer depletion, and the loss of biodiversity. Limestone, the key ingredient for cement production, is also quarried in vast quantities, transforming landscapes and generating dust pollution(37). The cumulative effect of these extraction activities is a relentless depletion of natural capital, leaving scars on our planet that are slow, if not impossible, to heal.

Beyond the impact of raw material extraction, the energy-intensive process of cement production stands as a singular environmental challenge. Cement, the binding agent in concrete, is manufactured by heating limestone and other materials in kilns to extremely high temperatures, often exceeding 1450°C (figure 5), to produce clinker. This process is enormously energy-intensive, primarily relying on fossil fuels (38). Consequently, cement production is a major contributor to global greenhouse gas emissions. As mentioned earlier, It is estimated to account for approximately 8% of global CO2 emissions, a figure comparable to the emissions from the entire global aviation industry (39). A significant portion of these emissions comes from the chemical reaction itself (calcination of limestone), making it an inherent part of the production process, irrespective of the fuel source. Furthermore, the transportation of raw materials to plants and finished concrete to construction sites adds another layer of carbon footprint, contributing to air pollution and traffic congestion.

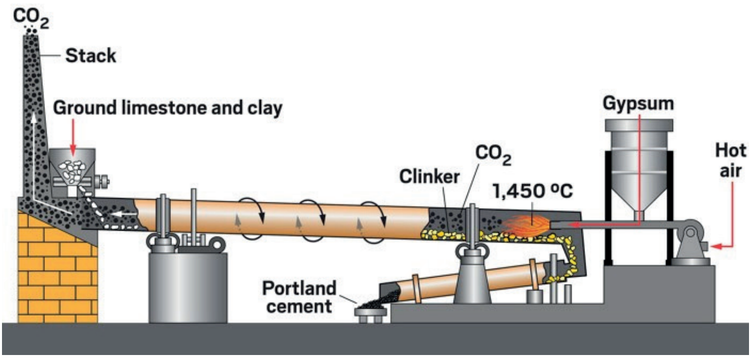


Figure 5: Schematic of a typical cement production process(40).

Water, a resource increasingly under stress globally, is also heavily consumed throughout concrete's lifecycle. From the washing of aggregates to the mixing of the concrete itself and its subsequent curing, vast quantities of water are required. While the exact figures vary, some estimates suggest that producing one ton of cement can require several hundred litres of water, and the subsequent mixing of concrete adds significantly more. Concrete production was responsible for approximately 20% of global industrial water withdrawals, equating to about 5.3% of total global water withdrawals (41). In regions facing water scarcity, this demand places additional strain on local water supplies, competing with agricultural needs and human consumption. As climate change intensifies droughts and unpredictable rainfall patterns, the reliance on a water-intensive material like concrete becomes a critical vulnerability for urban development and infrastructure projects worldwide.

Finally, we must confront the end-of-life challenges posed by concrete structures. While concrete is celebrated for its durability, even the most robust buildings and infrastructure eventually reach the end of their functional lifespan or are demolished to make way for new developments. The resulting demolition waste, often mixed with other materials, presents a significant disposal challenge. Concrete is bulky and heavy, consuming vast amounts of landfill space. While crushing and recycling concrete into aggregates for new construction is technically feasible, the current rates of recycling remain relatively low globally due to economic barriers, logistical complexities, and a lack of standardized practices (42,43). This perpetuates a linear "take-make-dispose" model, rather than embracing a circular economy where materials are continually reused and recycled, minimizing waste and resource depletion.

In summary, the sustainability burden of concrete is multi-faceted and profound. It encompasses the relentless depletion of natural resources, a substantial contribution to global greenhouse gas emissions, significant water consumption, and an ongoing challenge of waste management. This is not to diminish concrete's historical role or its inherent strengths. Rather, it is an urgent recognition that the environmental cost of our reliance on this material is no longer tenable in a world grappling with climate change, resource scarcity, and ecological degradation. As we look ahead, this clear-eyed assessment of concrete's environmental footprint becomes the very foundation upon which we must build our strategies for a truly sustainable built environment – a future where innovation allows us to move "Beyond Concrete" and forge pathways for buildings and infrastructure that are in harmony with our planet.

Global Research Efforts

The Vice Chancellor and distinguish invited guest. let us delve into effort at addressing these problems, exploring how we can move from concept to concrete, literally and figuratively, and build a truly sustainable future for Nigeria. Here are the five pillars of sustainable Infrastructure:

1. The Materials Revolution: From Waste to Wealth

The journey towards sustainable infrastructure must begin with the very building blocks we use. Traditional construction relies heavily on virgin resources, leading to significant environmental degradation. However, a huge materials revolution is underway, offering pathways to transform waste into valuable resources.

Consider recycled aggregates. Instead of sending demolition waste to overflowing landfills, we can process concrete and other construction debris into high-quality aggregates for new construction. This not only conserves natural resources like sand and gravel but also drastically reduces landfill burden and the energy associated with extracting new materials. Studies have shown that recycled aggregates can perform comparably to natural aggregates in various applications, making them a viable and environmentally sound alternative, often at a lower cost, especially when transportation distances are minimized (44). This approach aligns perfectly with circular economy principles by keeping materials in use and reducing the demand for virgin resources.

Furthermore, the embrace of engineered wood products, such as Cross-Laminated Timber (CLT) and Glued Laminated Timber (Glulam), presents a compelling case for Nigeria. Timber, when sourced sustainably from well-managed forests, is a renewable resource that sequesters carbon, making it a powerful tool in combating climate change. It boasts a high strength-to-weight ratio and excellent insulating properties (26). While challenges like lack of awareness, initial cost, outmoded building codes, and negative perceptions of wood exist, research highlights timber's immense potential as a sustainable building material, offering a significantly lower carbon footprint compared to steel and concrete, and even potentially reducing construction times (25,26). Imagine multi-story buildings rising from sustainably managed Nigerian forests, embodying both strength and ecological stewardship. Beyond these, we can explore bio-bricks made from agricultural waste, or even the strategic use of treated bamboo as a structural element, tapping into our local abundance and fostering local industries. Other advancements include geopolymers, which are binders made from industrial by-products like fly ash and slag, offering a low-carbon alternative to traditional cement. Research into self-healing concrete is also gaining traction, utilizing embedded capsules or bacteria that release healing agents when cracks appear, significantly extending the lifespan of concrete structures and reducing maintenance needs (45). Similarly, the integration of nanomaterials like carbon nanotubes and graphene is enhancing the mechanical, chemical, and electrical performance of existing construction materials, leading to stronger, more durable, and adaptable infrastructure(45). These innovations promise to reduce the frequency of repairs and replacements, thereby lowering embodied energy and waste over the infrastructure's lifecycle.

2. Intelligent Design and Energy Optimization

The energy consumed by buildings throughout their lifecycle, from construction to operation, is a major contributor to greenhouse gas emissions. Innovative design and smart technologies offer profound opportunities for energy optimization, particularly given that operational energy use accounts for a significant portion of global final energy use in buildings(46,47).

Energy-efficient designs move beyond mere aesthetics, integrating passive strategies that harness natural forces. This includes optimizing building orientation to maximize natural daylight and minimize solar heat gain, implementing effective natural ventilation systems to reduce reliance on air conditioning, and utilizing high-performance insulation and fenestration. These design choices can significantly lower operational energy demand, leading to substantial cost savings and reduced emissions over the building's lifespan. For instance, in temperate climates, improved insulation has drastically reduced heat loss, making embodied energy a larger proportion of the total energy footprint (47).

Coupled with intelligent design, smart building technologies represent the nervous system of truly sustainable infrastructure. The Internet of Things (IoT) sensors can monitor everything from occupancy and indoor air quality to energy consumption in real-time. Artificial intelligence (AI) algorithms can then analyze this data to optimize HVAC systems, lighting, and other building functions, ensuring energy is used only when and where it is needed. Predictive maintenance, enabled by these systems, can identify potential equipment failures before they occur, extending asset lifespans and preventing costly, energy-intensive repairs. Moreover, smart buildings can seamlessly integrate with renewable energy sources like solar photovoltaic (PV) panels, becoming active participants in a decentralized, resilient energy grid(28,48). This shift from passive consumers to active energy managers is crucial for Nigeria's energy future, allowing for demand-side management and greater grid stability.

3. Water Wisdom: A Precious Resource Preserved

Water scarcity is a growing global concern, and Nigeria is not immune. Sustainable buildings and infrastructure must embody a profound respect for this vital resource, promoting conservation and intelligent reuse.

Rainwater harvesting offers a straightforward yet powerful solution. By collecting and storing rainwater from rooftops, we can provide a supplementary source for non-potable uses such as irrigation, toilet flushing, and cleaning. This reduces the strain on municipal water supplies and lowers water bills. Similarly, greywater recycling systems can treat water from sinks, showers, and laundry for reuse in similar non-potable applications. This significantly reduces the volume of wastewater discharged and conserves potable water. Research in Nigeria has highlighted the instrumental role of rainwater harvesting and greywater recycling in minimizing water use in green buildings(32,49).

Figure 6: Layout for rainwater harvesting(50)

Moving further, advanced systems for blackwater treatment and reuse, utilizing bioreactors and membrane filtration, innovations such as anaerobic digestion, are enabling higher rates of water reuse for non-potable applications and even energy generation from biosolids. Nature-based solutions (NbS), such as constructed wetlands and riparian buffers, are increasingly being integrated into water management strategies for natural filtration, flood attenuation, and ecosystem restoration, offering cost-effective and environmentally beneficial alternatives to traditional grey infrastructure (49,51). The aim is to move towards a more circular water economy, where water is seen as a resource to be continually reused and managed efficiently. Beyond these systems, promoting water-efficient fixtures, drought-resistant landscaping and flood alert systems are simple yet effective measures that contribute to overall water wisdom and resilience in our built environment. Implementing these practices at scale can significantly enhance water security, especially in rapidly urbanizing areas facing increasing water stress.

4. The Circular Economy: Building Without End

The linear "take-make-dispose" model of construction is fundamentally unsustainable. A circular economy approach, however, seeks to minimize waste and maximize material reuse throughout the entire lifecycle of a building or infrastructure project. This is a critical paradigm shift to address the massive waste generated by the industry.

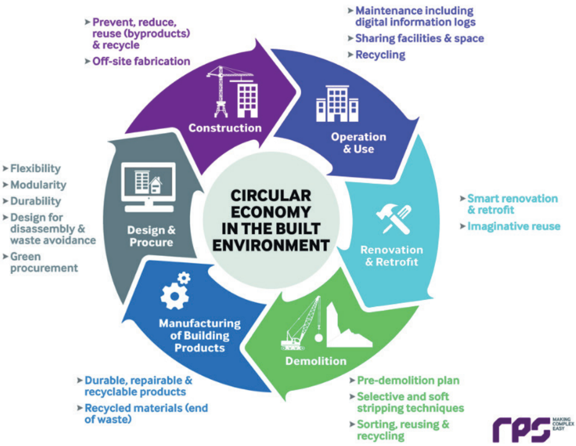


Figure 7: Circular Economy in the built environment(52)

This paradigm shift begins at the design phase, with design for disassembly. Buildings are conceived not as permanent structures but as material banks, where components can be easily deconstructed and reused or recycled at the end of their service life. The creation of material passports – digital inventories of a building's components and their properties – facilitates this process, making it easier to identify and recover valuable materials (53,54). This ensures that valuable resources are not lost to landfills but retained within the economic cycle.

On construction sites, rigorous waste minimization strategies are essential, from efficient material ordering to on-site sorting and recycling. But the true power of the circular economy lies in urban mining – the systematic recovery of materials from existing buildings and infrastructure. This transforms demolition from a waste problem into a resource opportunity, driving local economies and reducing the need for virgin materials(30,31). While challenges exist, particularly in the limited availability of infrastructure and technology for sorting, recycling, and reuse in some regions, the potential for economic and environmental benefits is immense(31). Promoting collaboration among stakeholders and incentivizing circular practices are vital steps towards overcoming these barriers.

5. Digital Transformation: BIM, Digital Twins, and Virtual Reality

Ultimately, the digital revolution provides powerful tools to optimise resource utilisation and enhance project management, ultimately fostering a more sustainable and resilient built environment.

Building Information Modeling (BIM) is no longer just a design tool; it is a comprehensive digital representation of a building's physical and functional characteristics. BIM facilitates integrated design, enabling architects, engineers, and contractors to collaborate seamlessly, detect clashes early, optimize material quantities, and accurately estimate costs. This holistic approach reduces errors, minimizes rework, and streamlines the construction process, leading to significant resource efficiencies(55). By providing a "single source of truth," BIM enhances coordination and minimizes errors across all project phases, from design to operations.

Taking BIM a step further, digital twins create a virtual replica of a physical asset, updated in real-time with data from sensors and other sources. For buildings and infrastructure, digital twins enable continuous monitoring of performance, predictive maintenance, and simulation of various scenarios. Imagine a digital twin of a bridge that can predict when maintenance is needed, or a building that can simulate energy performance under different climate conditions. This real-time intelligence allows for proactive management, optimizing operational efficiency, extending asset lifespans, and enhancing resilience against environmental stressors (56,57). By leveraging BIM and digital twins and Virtual Reality (VR), we can move beyond reactive maintenance to proactive, data-driven sustainability management, ensuring that our infrastructure remains efficient and robust throughout its entire lifecycle.

The concept of resilient infrastructure is paramount in an era of climate change. This involves designing and constructing assets that can withstand extreme weather events – floods, droughts, heatwaves – and recover quickly from disruptions (58,59). This includes incorporating climate risk assessments into planning, utilizing flexible designs that can adapt to changing conditions, and integrating early warning systems. Digital advances, such as Building Information Modeling (BIM) and virtual reality (VR) in construction, play a crucial role here. BIM, as previously discussed, provides a comprehensive digital model that can be used for detailed climate risk assessments and the simulation of various scenarios, allowing engineers to design for greater resilience from the outset. Virtual reality can further enhance this by providing immersive visualizations of proposed infrastructure projects, allowing stakeholders to experience and evaluate designs under simulated extreme conditions, identifying vulnerabilities and optimizing resilience strategies before construction even begins. Nature-based solutions, like restoring mangroves for coastal protection or creating urban green spaces for flood absorption, are increasingly recognized as vital components of resilient infrastructure, offering multiple co-benefits for communities and ecosystems (60). The focus is not just on preventing failure but on ensuring continuity of essential services in the face of climate shocks.

VR in Construction (61)

It is clear that sustainable buildings and infrastructure in the 21st Century demand a commitment to innovation, a willingness to embrace new technologies, and a collaborative spirit that transcends traditional silos. By championing recycled materials and engineered wood, by designing intelligently and integrating smart technologies, by conserving every drop of water, by embracing circular economy principles, and by harnessing the power of BIM, VR, AVR and digital twins, we can construct a future that is not only robust and functional but also deeply sustainable.

PART 2:
MY SCHOLARLY JOURNEY – FOUNDATIONS AND INSPIRATIONS

My path to this professorial chair, and indeed to the heart of today's topic, has been a journey of gradual awakening, persistent inquiry, and collaborative learning. It was not a single epiphany, but rather a series of observations, academic explorations, and practical engagements that solidified my conviction in the imperative of sustainability.

My earliest memories are intertwined with the vibrant, sometimes overwhelming, tapestry of Nigerian rural life. Growing up in Koton Karfe and Lokoja and later in Abuja and Minna in the north central region of Nigeria, I had the privilege of visiting several villages where I witnessed firsthand the ingenuity of our people in creating shelter, often with limited resources. I saw the communal efforts in building, the adaptive use of spaces, and the inherent understanding of local climate in traditional architectures – the cool, shaded courtyards, the thermally efficient mud walls, the canoe and stilt houses of our riverine communities responding to flood plains. These were not labelled 'sustainable' in the modern academic sense, but they embodied principles of resourcefulness and climate responsiveness that we are, in many ways, striving to rediscover today.

However, I also saw the flip side: the strain of rapid growth, the proliferation of poorly planned settlements, the challenges of inadequate sanitation, unreliable power, and buildings that seemed to fight against, rather than work with, our tropical climate, becoming heat traps that demanded ever-increasing energy for cooling. These formative experiences planted a seed of curiosity: surely, there had to be a better way to build, a way that respected both people and planet.

This nascent interest found fertile ground during my undergraduate studies in Civil Engineering at the Federal University of Technology, Minna, between 2001 to 2006. It was here that I began to acquire the technical language and analytical tools to dissect these challenges. My Bachelor's project, which investigated the performance of sawdust as an aggregate for lightweight concrete, was an early foray into questioning the uncritical adoption of building materials paradigms.

The desire to delve deeper led me to Loughborough University in the United Kingdom for an M.Sc. Building Services Engineering, graduating with a Distinction– Here also, my thesis was on Buildings titled "Investigating the potential of onsite renewables for Zero Carbon Emission in UK's Domestic buildings". This research involved the simulation of a typical domestic building using real-world energy data to establish a baseline scenario. Various energy efficiency interventions were then incrementally applied. One key finding that profoundly shaped my outlook was that, with existing technologies and energy-conscious occupants, energy consumption can be reduced by up to 60% (62).

My doctoral research on "Occupancy-driven supervisory control of indoor environment systems to minimize energy consumption of airport terminal buildings" was conducted as part of the £746,200 EPSRC sponsored 'Sandpit- Integration of active and passive indoor thermal environment control systems to minimise the carbon footprint of airport buildings' project—a multidisciplinary collaboration involving 16 researchers from Brunel, Loughborough, De Montfort, City, and Bath universities, with Manchester Airport Group providing industrial support and access to the Terminal buildings for data collection. This research developed an AI-powered fuzzy logic controller that optimizes energy consumption in airport terminals by dynamically adjusting temperature, airflow, and lighting systems based on real-time passenger flow, flight schedules, and weather conditions, achieving significant cost reductions while maintaining occupant comfort. The methodology encompassed comprehensive physical evaluation of built environment systems, strategic sensor installation for data collection, systematic analysis to identify environmental performance issues, and the development of a novel indoor climate control system specifically designed for airport environments. It also involved creating a thermal model of airport building fabric, indoor environments, and associated control systems using state-of-the-art modelling and simulation software. Results confirmed achievement of substantial energy savings, and the scalable approach demonstrates applicability to other high-occupancy buildings such as stadiums and shopping malls, offering a smart, sustainable solution for managing large spaces with predictable occupancy patterns (63–66). It was here, under the guidance of mentors like Prof. Mahroo Eftekhari, Prof. Steven Firth, Prof. Mohammed Osmani, Prof. Jacqueline Glass and Prof. Denis Loveday, that I truly began to understand sustainability not as a niche concern, but as a holistic framework encompassing environmental stewardship, economic viability, and social equity.

Post-doctoral work at Loughborough University in the UK allowed me to broaden my perspective. I worked on 2 exciting projects: Mitsubishi Electric R&D Centre Europe's 'Trend of the heating and control of Heat pumps in European Buildings', A $20,000 research grant. A suitable control system for heat pumps in domestic buildings was investigated. The second project is the Bill & Melinda Gates Foundation 'Reinvent the Toilet' challenge, $60,000 research grant. I worked under the guidance of the renowned Professor of Sustainable Infrastructure, Prof. Muhammad Sohail. In this project, the models of mass and heat balances of a low-cost and energy self-sustaining toilet system for developing countries were investigated. While in FUT Minna, collaborations with international research teams on projects like the $25,000 research grant from UN-Habitat to develop an energy and resource efficiency building code for Nigeria exposed me to global best practices but also reinforced the critical need for context-specific solutions. What works in temperate Europe or arid Arizona cannot simply be transplanted to humid Port Harcourt or the dry savannas of Maiduguri without careful adaptation.

Throughout this journey, my understanding of "sustainable buildings" has evolved. Initially, like many, my focus was perhaps more narrowly on energy efficiency and green technologies. But experience and research have taught me that true sustainability is far richer and more complex. It is about creating buildings that breathe, that connect occupants with nature, that are healthy and productive places to live and work. It's about circularity – minimizing waste, using resources wisely, and designing for adaptability and disassembly. It is about resilience – the ability of our built environment to withstand shocks and stresses, whether from climate change or economic volatility. And crucially, it's about justice and equity – ensuring that the benefits of sustainable development are shared by all, not just a privileged few.

Seminal projects, such as my collaboration with UN-Habitat in 2017 on "Energy and Resource Efficiency Measures and Regulations for the Building Sector in Nigeria"—an addendum to the Nigerian Building Code commissioned by the Federal Ministry of Power, Works and Housing—represent pivotal efforts to translate evolving research insights into tangible policy outcomes.

From November 2022 to November 2024, I served as co-chair of the Green Building Council Nigeria's Research & Development Team, where I helped establish the proposal for the Nigeria Built Environment Carbon Database—an initiative designed to provide essential resources for informed decision-making on carbon reduction in the built environment, reflecting my unwavering commitment to sustainability and innovation.

Building on this foundation, I was elected for a 3-year tenure starting from 2024 to serve as Chairman of the National Mirror/Technical Committee (NM/TC) for Sustainability in Buildings, Cities and Communities Standards for the Standards Organisation of Nigeria (SON). In this capacity, I lead a multidisciplinary team of 23 experts from diverse backgrounds across the country to review and evaluate international standards related to sustainable buildings, cities, and communities, determining their suitability for adoption in Nigeria with appropriate modifications where necessary.

Only last year, I was the project lead for the EU/GIZ-sponsored Abuja Urban Lab project. This initiative marks the first application of an urban lab approach to address urban challenges in the ECOWAS region, setting a new standard for academic engagement with real-world issues. By focusing on the transformation of waste governance in the Abuja Municipal Area Council (AMAC), the project demonstrates the profound potential for harnessing academic expertise to drive tangible, sustainable societal change. Through its innovative, collaborative, and sustainable methodologies, the Abuja Urban Lab not only tackles a critical urban challenge but also serves as a demonstration of how higher education institutions can be catalysts for meaningful impact, bridging the gap between theoretical knowledge and practical solutions in urban development. Following this, I was appointed to the Advisory Council of the Waste Pickers Association of Nigeria (WAPAN), allowing me to advocate for underserved communities.

These roles have positioned me at the forefront of Nigeria's efforts to harmonize global sustainability standards with local building practices and regulatory frameworks. These endeavours, though often challenging and fraught with practical hurdles, have proven invaluable learning experiences, reinforcing the central theme of today's lecture: the critical imperative to move beyond mere theoretical concepts and the physical act of laying concrete, toward creating enduring pathways for a truly sustainable built environment in Nigeria.

My Contributions to the Field of Sustainable Infrastructure Research

I am privileged to serve as both a scholar and practitioner in the field of sustainable infrastructure, with a dynamic academic trajectory and a growing portfolio of interdisciplinary research. Over the past decade and a half, my work has consistently advanced sustainable engineering solutions, particularly within the context of sub-Saharan Africa, while also contributing to global discourse.

My research spans a broad spectrum of critical areas, including energy-efficient building systems, waste valorisation, environmental pollution control, sustainable construction materials, and infrastructure resilience. These efforts have culminated in the authorship and co-authorship of over 60 peer-reviewed journal articles, conference papers, and technical reports—each rooted in real-world applications that address urgent global challenges such as climate change, carbon emissions, waste management, and resource scarcity.

Guided by a steadfast commitment to research that drives meaningful change, my scholarly contributions are aligned with several key Sustainable Development Goals (SDGs), notably:

- SDG 3: Good Health and Well-being
- SDG 4: Quality Education
- SDG 6: Clean Water and Sanitation
- SDG 7: Affordable and Clean Energy
- SDG 8: Decent Work and Economic Growth
- SDG 9: Industry, Innovation, and Infrastructure
- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production
- SDG 13: Climate Action
- SDG 14: Life Below Water
- SDG 15: Life on Land

I am proud to note that our collective research efforts have achieved a field-weighted citation impact of 2.29, indicating that our work is cited more than twice the global average in our fields. This metric underscores the relevance, influence, and transformative potential of our research in advancing sustainable development.

As we look ahead, this foundation serves not only as a testament to our progress but also as a springboard for deeper collaboration and innovation in addressing the complex challenges of tomorrow. Find more details of my research contributions listed as follows:

Energy Systems and Building Performance

One of the early pillars of my research was energy systems in buildings. I investigated the potential of onsite renewables as a pathway to zero carbon emissions in Dwellings (67); Published guides for energy efficiency building regulations for Nigeria (68); Co-authored paper on "the performance of a combined solar system with heat pump for houses" published in Energy and Buildings (69), which remains a critical contribution to energy efficiency research. This was followed by a collection of papers focused on airport terminal energy management systems, such as "Fuzzy supervisory control strategies to minimise energy use of airport terminal buildings"(65),"Occupancy-driven supervisory control strategies to minimise energy consumption"(70) and designing an occupancy flow-based controller for airport terminals(71). These studies pioneered occupancy-based supervisory controls that significantly reduce energy consumption and carbon footprints in high-use public buildings. My doctoral thesis from Loughborough University was centred on energy optimization in airport environments, indicating an early and consistent commitment to sustainability in complex systems.

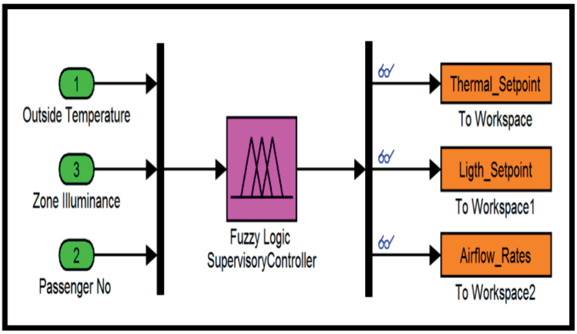


Figure 8: Model of the Supervisory Controller(65)

Under my supervision, Mr. Ibrahim Umar is conducting his Ph.D. research on the transformative potential of smart building technologies and renewable energy in Nigerian homes. This timely study addresses critical national challenges of energy inefficiency and environmental sustainability. It will empirically measure how these modern solutions can lead to significant energy savings, reduce carbon emissions, and improve the quality of life for Nigerian residents. Ultimately, the findings are intended to provide a robust framework for advancing sustainable residential development across Nigeria, offering valuable recommendations for government policy, real estate development, and future academic inquiry.

Sustainable Construction and Material Innovations

A strong theme in my body of work is the development and evaluation of sustainable and locally sourced construction materials. Our studies investigated alternative aggregates, binders, and reinforcements to conventional concrete and construction materials. For example, we authored studies on polypropylene fibre-reinforced concrete (72), which investigates the impact of polypropylene fibres (PPF) on the mechanical performance of concrete, demonstrating that PPF enhances key properties such as compressive strength, split tensile strength, and flexural strength, while also improving crack resistance and durability under dynamic loads. The study likely explores optimal fibre dosages (e.g., 3–5% by weight) and their correlation with improved structural integrity, aligning with findings from similar research where PPF-reinforced concrete showed superior toughness and thermal stability compared to conventional mixes. The work contributes to sustainable construction by validating PPF's role in mitigating brittle failure and extending pavement lifespan, particularly in high-stress environments like Nigeria's road infrastructure.

We conducted another Study on the mechanical behaviour of sugar in palm kernel shell concrete(73), investigates the effect of sugar as an admixture on lightweight concrete made with 30% palm kernel shell (PKS) as a partial replacement for coarse aggregate. The study reveals that increasing sugar content (0.00% to 0.10% by cement volume) enhances workability but reduces both density (1650–1869 kg/m^3) and compressive strength (2.56–11.01 MPa at 28 days), with optimal results at 0.03% sugar. The findings confirm PKS as a viable lightweight aggregate, though excessive sugar compromises strength, aligning with sustainable construction goals by utilizing agricultural waste.

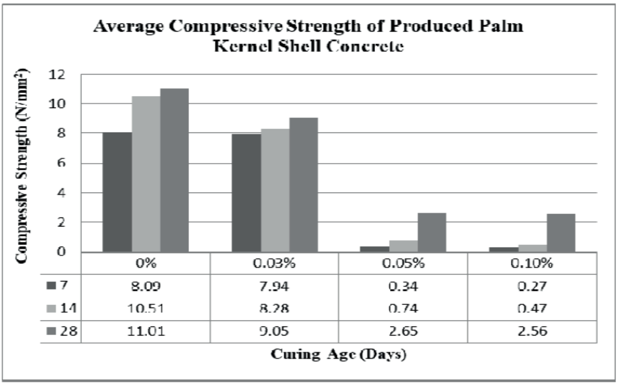
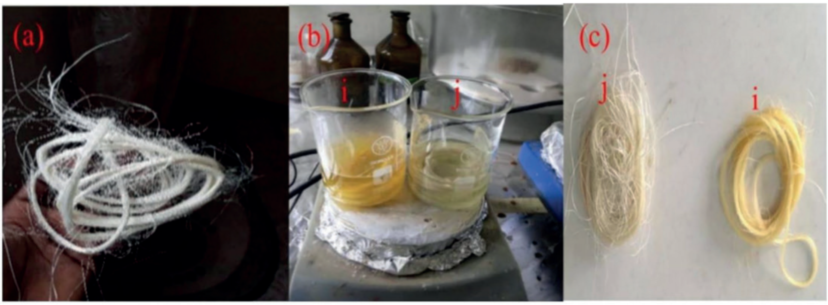


Figure 9: Average Compressive Strength for PKS(73)

We also investigated properties of composite plaster of Paris from locally grown sisal fibre plant(Fig.6)(74). The paper contributes to the field of sustainable construction by demonstrating that locally sourced sisal fibre, particularly when treated with 3 wt% NaCl, can effectively enhance the mechanical properties of Plaster of Paris (POP) ceiling boards. With a tensile strength of 259 MPa, the treated sisal fibre serves as a viable alternative to imported fibres, potentially reducing construction costs and promoting economic sustainability in Nigeria. The findings provide valuable insights into the performance of these composite materials, highlighting their suitability for construction applications while also advocating for the use of renewable resources to foster a greener building industry.



a Untreated LSF (b_i) LSF in NaOH solution (b_j) LSF in NaCl solution (c_i) treated SF with NaCl (c_j) treated SF with NaOH

Figure 10: Treatment of the local sisal fibre (74)

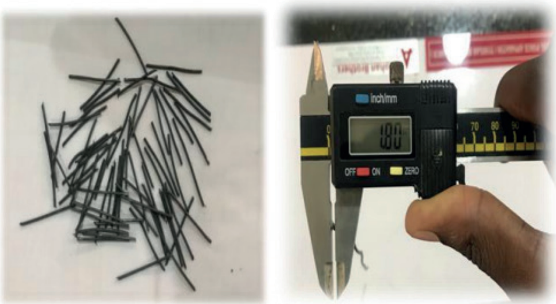


Plate 1: Cutting and measurement of 40mm steel fibers used

Plate 2: Mixing and casting of steel fiber reinforced concrete samples

Figure 11: Waste binding wires as reinforcement in concrete(75)

Additionally, research on the performance of stabilized laterite blocks(76), Transforming plastic waste into durable concrete(77), shear behaviour of sisal fibre infused in high-strength reinforced concrete slabs(78) waste plastic-modified lateritic soil for road construction(79), Utilization of Afara Saw Dust Ash as Partial Replacement for Cement in a C30 Concrete(80) This study investigated the properties of C30 concrete when cement was partially replaced with Afara wood Saw Dust Ash (SDA) at concentrations of 0% to 20%. While increasing SDA content generally reduced the concrete's workability and strength, a 5% replacement was found to be optimal. After 28 days, the 5% SDA mix showed improved compressive strength (34.09N/mm2 vs. 31.17N/mm2 for the control), as well as superior flexural (5.349MPa) and tensile (3.62MPa) strengths. The findings demonstrate that SDA can be effectively used as a sustainable supplementary cementitious material at low replacement levels. Others works include Sustainability Assessment of Construction and Demolition Waste Materials(81) demonstrates an enduring interest in resource-efficient and low-carbon building solutions.

My research also explores the life cycle assessment (LCA) and cost analysis of construction techniques. I collaborated on a research project on the life cycle cost analysis of the Abuja-Keffi Highway using Real Cost 3.0 software(82), which provided vital insights into infrastructure planning and maintenance. Similarly, we worked on the estimation of carbon footprint at Nile University of Nigeria (83,84). This research quantified the Greenhouse Gas (GHG) emissions at Nile University of Nigeria in Abuja, using IPCC guidelines. The university's total annual carbon footprint was estimated at 5,466.4tCO2e. Transportation was the primary source, responsible for 71% of emissions arising from the large numbers of vehicles coming into campus daily driven by staff, students and visitors, followed by electricity use (24.7%), cooking fuel (2.7%), and gardening (0.8%). Although the university's per capita emissions are below the levels suggested by the Kyoto Protocol, the study recommends further reductions by improving electricity and LPG efficiency and by providing and incentivizing mass transit options. Another study in this area is the assessment of zero-carbon emission potential in UK domestic buildings (62) which reflects my global perspective on climate-smart infrastructure.

Waste Management and Environmental Sustainability

I extended my research into the domain of waste management and environmental remediation. Notable among our contributions is the highly cited work, "Adsorption of abattoir wastewater contaminants by coconut shell-activated carbon" (Fig. 11-14)(85), with over 50 citations. This research provided a cost-effective, eco-friendly solution for treating industrial wastewater—a key environmental challenge in urban areas of Nigeria.

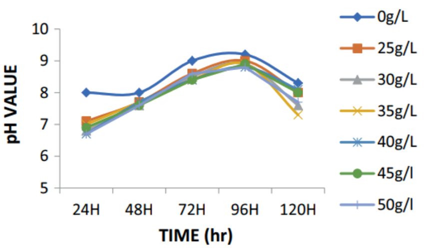


Figure 12: Influence of pH on ACS adsorption

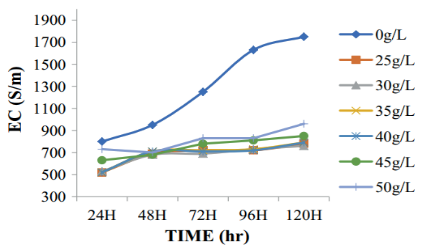


Figure 13: Effect of EC on ACS adsorption

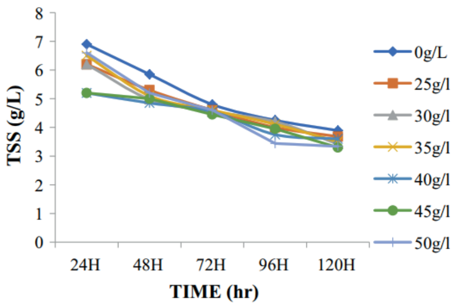


Figure 14: Effect of TSS on ACS adsorption

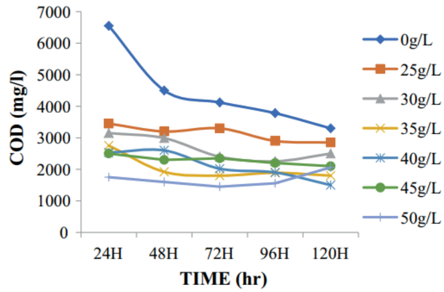


Figure 15: Effect of COD on ACS adsorption

I also co-authored significant studies evaluating solid waste-to-energy potentials(86), including energy value assessment of solid waste at Gosa dumpsite(86), and sustainability assessments of construction and demolition waste materials(81,87). My co-authored paper on municipal solid waste dumpsite capacity in Abuja(88) further exemplifies our drive to support evidence-based policymaking in urban waste governance. These contributions have had a direct impact on Nigeria's quest for improved waste management strategies and sustainable cities. I am happy to state that we have completed a comprehensive waste composition analysis for Nile University, currently under review for publication (Table 1). As much as 66% of the solid waste is recyclable, while 23% of the organic waste can be used to produce compost manure.

Table 1: Distribution of Waste Categories at Nile University

Waste Category	Description	Percentage
Food/Kitchen Waste	Organic waste from cafeterias and kitchens	23%
Plastic Waste	PET bottles, LDPE, PP, clamshells	35%
Paper Waste	Recyclable paper and cardboard	25%
Metal Waste	Primarily aluminum cans	4%
Glass	Clear bottles	2%
Sanitary Composites	Various sanitary materials	11%

Under my supervision, Engr. Musa Lawal Monguno's doctoral research is tackling the pressing issue of urban flood risk in Abuja's informal settlements. This study moves beyond simple assessment to create actionable solutions. By integrating advanced tools like ArcGIS for hazard mapping and hydrological modeling for risk analysis, the research will pinpoint the most vulnerable communities. A key component of the work involves simulating flood impacts to visualize potential damage, providing a powerful evidence base for intervention. The research will culminate in a tailored management framework designed to empower policymakers and community leaders to build a more flood-resilient urban future.

Interdisciplinary and Collaborative Approach

My research is fundamentally interdisciplinary, reflecting the complex, interconnected nature of sustainability and climate challenges that cannot be addressed through any single disciplinary lens. These "wicked problems" demand collaborative approaches that transcend traditional academic boundaries. Through partnerships across civil engineering, environmental science, computer science, and urban planning, my works integrates diverse methodologies and perspectives to develop comprehensive solutions for pressing environmental issues. I have worked alongside local and international researchers on a wide variety of cross cutting topics—from road traffic accident analysis using mobile applications(89) to cloud computing in construction project delivery(90), and spatiotemporal data techniques for traffic optimization(89). This paper addresses the severe socio-economic impact of Road Traffic Accidents (RTAs) in Abuja by developing a mobile application for safer route planning and accident analysis. The application was designed to analyse spatiotemporal RTA patterns, perform hotspot analysis to identify high-risk "black spots," and provide precise data to authorities. Using statistical analysis of reported accident data, the study identifies the human factor as the primary cause of accidents (50.5%), with dangerous driving being the main contributor (21%). The research also concludes that a noted decline in fatalities and injuries is largely attributable to the Federal Road Safety Corps' (FRSC) strict enforcement of seatbelt laws and effective public awareness campaigns. We also explored novel transportation models such as carpooling frameworks(91) aimed at reducing urban congestion and greenhouse gas emissions.

This broad interdisciplinary engagement not only underscores versatility but also ability to align engineering solutions with societal needs. My studies often incorporate both technical and behavioural dimensions, such as site management impacts on project success(92), and availability and utilization of firefighting equipment in public buildings(93).

Finally, I am supervising the doctoral thesis of Engr. James Babagbale, which addresses the critical urban challenge of traffic congestion. The research focuses on developing a deterministic model to translate traffic jams at high-density intersections into tangible economic and environmental figures. By meticulously analysing traffic patterns, measuring pollution, and calculating a wide spectrum of associated costs—from lost productivity to public health impacts—the study will create a powerful planning instrument. This model is designed to empower city planners and transportation authorities with the data-driven insights needed to justify infrastructure investments, optimize traffic flow, and build more efficient and sustainable urban centres.

Future Directions and Impact

My contributions are laying the foundation for resilient, inclusive, and sustainable infrastructure systems. I am positioned to further influence the fields of renewable energy, sustainable building design, circular economy, and 3D concrete printing, smart infrastructure through innovative research and strategic collaborations.

Moving forward, I am poised to contribute to the global discourse on the Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). My future research agenda promises to delve deeper into smart cities, digital engineering tools, and the integration of AI and IoT in infrastructure design and maintenance.

In sum, my research bridges sustainability science with engineering practice. My contributions are not only scholarly but profoundly practical, reflecting a career dedicated to solving real-world problems through innovation, collaboration, and community-oriented research. It is my hope that my works continues to inspire a new generation of engineers committed to building a greener, smarter, and more equitable world.

PART 3:
THE NIGERIAN IMPERATIVE – CONTEXT, CHALLENGES, AND OPPORTUNITIES

Having shared my personal and scholarly trajectory, let us now turn our gaze squarely to the Nigerian context. Why is the pursuit of sustainable buildings and infrastructure not just a desirable goal, but an absolute imperative for our nation in the 21st century?

Nigeria is currently experiencing unprecedented urban transformation. Cities like Lagos, Kano, Ibadan, Port Harcourt, and Abuja are magnets for aspiration, drawing millions in search of opportunity. Projections indicate that over 67% of Nigerians will reside in urban areas by 2050(94). While this demographic shift signifies economic dynamism, it also places immense strain on existing infrastructure and services. We witness the consequences daily: housing deficits, crippling traffic congestion, unreliable power supply necessitating a cacophony of generators, and mounting challenges in water provision and waste management. Each new building, road, or piece of infrastructure developed without considering sustainability principles further entrenches us in resource-intensive and environmentally damaging patterns.

The infrastructural challenges confronting Nigeria are significant and staggering in their scope and implications. The data below reflects a sobering reality that underscores the urgency for transformative action:

- **Housing:** Millions lack safe and affordable housing, with the World Bank estimating a shortage of over 28 million units in Nigeria to bridge the existing gap (94–96) . Alarmingly, more than 60% of urban residents reside in informal settlements(97) characterized by overcrowding, poor ventilation, and inadequate sanitation. This pervasive housing deficit traps families in cycles of poverty, compelling them to allocate up to 70% of their income to substandard living conditions(98). The ramifications extend far beyond inadequate shelter, adversely affecting health, productivity, and overall social well-being.
- **Transportation:** Deteriorating road networks, insufficient rail infrastructure, and a lack of access to reliable public transportation create formidable barriers to economic vitality and opportunity. According to the National Bureau of Statistics (2023), only 40% of Nigeria's vast 200,000 km road network is paved, and a staggering 35% of these paved roads are categorized as "poor" or "failed" (99). This poor transportation infrastructure drains Nigeria of approximately $7.8 billion annually through lost productivity and damaged goods(100). Furthermore, fewer than 10% of Nigerians have access to formal public transport systems, leaving the majority reliant on informal and often hazardous alternatives(101).
- **Water and Sanitation:** Access to clean water and adequate sanitation remains elusive for millions. Inadequate water and sanitation facilities are linked to high mortality rates, particularly among children. Presently, 60 million Nigerians lack basic drinking water

services, while 120 million are deprived of safely managed sanitation systems(102). Waterborne diseases, such as cholera, account for approximately 117,000 child deaths annually in Nigeria(103). Moreover, poor sanitation imposes an annual burden of $3 billion in healthcare costs and lost productivity on the nation(104). This cost represented US$20 per person or 1.3% of the national GDP.

- **Energy:** The inconsistent availability of reliable electricity stifles economic growth and poses significant hurdles for urban development. Only 58% of Nigerians have access to the national grid (105), experiencing an average of 6.7 power outages weekly(106). This unreliability incurs an annual loss of $29 billion for businesses, curbing industrialization efforts (106,107). Despite possessing a solar potential of 427,000 MW, Nigeria harnesses less than 1.6% of this resource(108). The implications of inadequate energy access ripple through entire sectors, inhibiting growth and innovation.
- **Waste Management:** Ineffective waste management systems in many urban centres result in pollution, environmental degradation, and health risks. Nigerian cities generate 32 million tons of waste each year, with 70% left uncollected and often discarded in open areas(109). The burning of waste contributes to 30% of air pollution in Lagos, drastically reducing life expectancy by 3–5 years(110). With less than 10% of plastic waste recycled, the threat to the environment is exacerbated(111).

These challenges, while particularly acute in Nigeria, resonate throughout numerous African nations grappling with similar infrastructural inadequacies. Collectively, these issues hinder economic growth, impede social development, and exacerbate inequality. The call for innovative and sustainable solutions has never been more pressing or essential.

Climate Change: An Amplifying Factor

Compounding these urbanization pressures are the undeniable impacts of climate change. Nigeria is acutely vulnerable. We are witnessing an increased frequency and intensity of flooding in our coastal and riverine areas, starkly evidenced by devastating floods in recent years in Maiduguri, Borno State affecting over 1 million persons (112,113), and Mokwa, Niger State where about 700 are believed to be dead (114). Conversely, desertification encroaches from the north, threatening livelihoods and exacerbating resource conflicts. Our cities are becoming urban heat islands, with buildings absorbing and radiating excessive heat, leading to increased energy demand for cooling and significant public health concerns. The agricultural sector, the bedrock of our food security, is also under threat.

Sustainable buildings and infrastructure are not just about reducing our carbon footprint; they are about adaptation, about building resilience to these already unfolding climatic shifts. A building designed with natural ventilation and shading is not just energy-efficient; it is also more habitable during a power outage or a heatwave. Infrastructure designed to manage stormwater effectively can save lives and protect property during extreme rainfall events.

The Current State of Building and Construction Practices

Nigeria's current building stock and construction practices presents a mixed picture. While we possess a rich heritage of climate-responsive traditional architecture, the dominant trend in recent decades has leaned towards imported designs and materials, often ill-suited to our local context. Concrete and sandcrete blocks, steel, and aluminium roofing sheets are ubiquitous. These materials have high embodied energy—the total energy consumed in their extraction, processing, manufacturing, transportation, and construction. Furthermore, many contemporary building designs pay scant attention to passive design principles, leading to a heavy reliance on artificial lighting and air conditioning. In a country with an already strained and predominantly fossil-fuel-based power grid, this has significant energy and environmental consequences.

The infrastructure deficit is another critical piece of this puzzle. Our roads, power grids, water supply systems, and sanitation services are struggling to keep pace with demand. This deficit directly impacts the sustainability of buildings. An energy-efficient building is of limited value if the grid supplying it is unreliable and polluting. A building designed for water conservation makes less impact if the municipal water supply itself is inadequate or non-existent, forcing reliance on boreholes that may deplete groundwater resources. Thus, sustainable buildings cannot be considered in isolation; they must be part of an integrated approach to sustainable urban infrastructure.

Navigating this complex terrain is fraught with specific challenges unique to or particularly acute in the Nigerian context:

1. **Policy and Regulatory Gaps:** While Nigeria has an old National Building Code established in 2006, it has no provisions related to energy efficiency and sustainability. The ones related to structural integrity are often not rigorously enforced. There's a need for more specific, locally adapted green building standards and a robust mechanism for compliance and verification.
2. **Economic Constraints:** The perception that sustainable buildings are significantly more expensive upfront is a major barrier. While some green technologies may have higher initial costs, the life-cycle savings (reduced energy and water bills, lower maintenance) are often overlooked. Access to affordable finance for green projects is also limited.
3. **Skills Gap:** There is a shortage of architects, engineers, technicians, and artisans trained in sustainable design principles, green building technologies, and construction practices. Our educational and vocational training institutions need to rise to this challenge.
4. **Cultural and Social Factors:** Awareness of the benefits of sustainable building is still relatively low among the public and even some developers. There can also be a preference for certain aesthetics or building styles that are not inherently sustainable, driven by status or perceived modernity.
5. **Material Sourcing and Supply Chains:** Nigeria has a wealth of potential local, sustainable building materials – laterite, bamboo, timber from sustainably managed forests, agricultural waste products. However, the industries and supply chains for

these materials are often underdeveloped, leading to a continued reliance on imported, energy-intensive alternatives.

6. **Data Scarcity:** Robust data on building performance, energy consumption patterns, and the environmental impact of construction materials in the Nigerian context is often lacking. This hampers evidence-based policymaking and design.

Yet, amidst these challenges, Nigeria is also a land of immense opportunities. It is these opportunities that fuel my optimism and drive my conviction that a sustainable built environment is achievable:

1. **Abundant Renewable Energy Resources:** Nigeria is blessed with vast solar potential across the entire country. The declining cost of solar photovoltaic technology presents a golden opportunity to power our buildings cleanly and reliably. We also have potential for biomass and wind energy in specific regions.
2. **Rich Heritage of Indigenous Knowledge:** As mentioned earlier, our traditional building practices offer a treasure trove of wisdom on climate-responsive design. Revitalizing and adapting these principles with modern science and materials can lead to uniquely Nigerian sustainable solutions.
3. **A Large and Youthful Population:** Our youth are increasingly environmentally conscious and technologically savvy. They can be the drivers of innovation and the champions for the adoption of sustainable practices.
4. **Growing Awareness and Advocacy:** The global discourse on climate change and sustainability is resonating more strongly in Nigeria. Civil society organizations, professional bodies, and even some government agencies are increasingly vocal about the need for change.
5. **Leapfrogging Potential:** As a developing nation, Nigeria has the propensity to leapfrog outdated, inefficient technologies and practices and adopt the latest sustainable solutions without being encumbered by entrenched, obsolete infrastructure.
6. **Economic Diversification:** Investing in a green building sector can create new industries, generate green jobs (in manufacturing of local materials, installation of renewable energy systems, energy auditing, etc.), and contribute to the diversification of our economy.

Mr. Vice Chancellor sir, the imperative, therefore, is clear. The challenges are significant, but not insurmountable. The opportunities are vast, waiting to be harnessed. The question is not whether Nigeria should pursue sustainable buildings and infrastructure, but how we can accelerate this transition effectively and equitably.

PART 4:
BEYOND CONCEPT AND CONCRETE – PATHWAYS TO A SUSTAINABLE FUTURE

Mr. Vice Chancellor sir, if we are to truly move "beyond concept and concrete," we need clearly defined, actionable pathways. These pathways are not mutually exclusive; they are interconnected and mutually reinforcing, requiring a concerted effort from all stakeholders. I propose a five-pronged approach to navigate towards a sustainable built environment for 21st Century Nigeria:

Pathway 1: Policy, Governance, and Institutional Strengthening

The foundation for a sustainable built environment rests upon a robust and enabling policy and governance framework. Without clear direction, incentives, and effective enforcement, even the best intentions and technologies will falter.

- **Develop and Enforce Context-Specific Green Building Codes:** Nigeria needs to move beyond the general provisions of the current outdated National Building Code to develop and legislate comprehensive Green Building Standards tailored to our diverse climatic zones and socio-economic realities. These standards should cover energy efficiency, water conservation, material selection, indoor environmental quality, and site sustainability. Critically, these codes must be backed by a well-resourced and transparent enforcement mechanism, including trained building inspectors and a clear process for certification. We could explore a tiered system, perhaps starting with mandatory minimums for all new constructions and offering incentives for higher performance levels.
- **Strategic Incentivization:** "Carrots" are often more effective than "sticks." Government should introduce a suite of incentives to encourage the adoption of sustainable building practices. These could include tax rebates for developers who achieve green building certifications, import duty waivers for essential green technologies not yet manufactured locally, density bonuses for sustainable projects, and streamlined approval processes. Green mortgages with preferential interest rates for homebuyers purchasing certified sustainable homes can also stimulate demand.
- **Integration with Urban and National Planning:** Sustainable building and infrastructure cannot be an isolated endeavour. It must be integrated into broader urban development plans and national infrastructure strategies. This means promoting compact, mixed-use developments that reduce reliance on private vehicles, investing in sustainable public transportation, and ensuring that new building projects are supported by green infrastructure for water, waste, and energy.
- **Strengthening Public-Private Partnerships (PPPs):** The scale of investment required for sustainable infrastructure and building transformation is immense. Government cannot do it alone. We need to foster genuine PPPs that leverage private sector innovation and finance, while ensuring public interest and environmental safeguards are upheld. Clear regulatory frameworks and risk-sharing mechanisms are essential for

successful PPPs in the green building sector.

- **Capacity Building within Government Agencies:** Relevant ministries, departments, and agencies (MDAs) at federal, state, and local government levels need to be equipped with the knowledge and skills to champion, implement, and monitor sustainable building initiatives. This includes training for policymakers, urban planners, and regulatory staff.

Pathway 2: Technological Innovation, Adaptation, and Dissemination

Technology and innovation are key enablers of sustainability, but they must be appropriate, accessible, and adaptable to the Nigerian context.

- **Championing Passive Design Strategies:** Before resorting to active systems, we must maximize the potential of passive design. This means designing buildings that respond intelligently to our climate: optimal orientation to minimize solar heat gain and maximize natural light, effective cross-ventilation, appropriate shading devices (overhangs, louvers, screens), green roofs, and cool roof technologies. These strategies are often low-cost and can significantly reduce energy demand for cooling and lighting. Our architectural schools and professional bodies have a key role in reviving and promoting these principles.
- **Promoting Energy-Efficient Active Systems and Renewable Energy Integration:** Where active systems are necessary (e.g., air conditioning in specific building types, specialized lighting), we must insist on high-efficiency models. Critically, we need to aggressively promote the integration of renewable energy, particularly solar PV, into buildings at all scales – from small residential systems to large commercial and institutional installations. Policies like net metering and feed-in tariffs can accelerate this adoption. Solar water heating is another low-hanging fruit with significant energy-saving potential.
- **Sustainable Water Management:** With increasing water stress, buildings must become water efficient. This involves promoting rainwater harvesting systems (for which our climate is well-suited), greywater recycling for non-potable uses like irrigation and toilet flushing, and the use of water-efficient fixtures and appliances.
- **Advancing the Circular Economy in Construction:** The "take-make-dispose" model of construction is unsustainable. We must transition towards a circular economy by minimizing construction waste, promoting the use of recycled and reclaimed materials, and designing buildings for adaptability, durability, and eventual disassembly and reuse of components.
- **Research, Development, and Commercialization of Local Sustainable Materials:** Nigeria is rich in potential sustainable building materials. Laterite, bamboo, sustainably harvested timber, and even agricultural waste (like rice husks or bagasse for board production) offer low-carbon alternatives to conventional materials. We need targeted R&D to improve their properties, develop appropriate construction techniques, establish quality standards, and support the growth of local industries to produce and distribute them at scale. Universities like ours must be at the forefront of this research.
- **Embracing Digitalization, Smart Building Technologies and AI:** Building Information Modeling (BIM) can improve design efficiency and reduce waste. Smart building

technologies (sensors, automated controls for lighting, HVAC) can optimize energy performance and enhance occupant comfort, though their application must be considered within the context of our current infrastructure reliability and maintenance capacity.

Pathway 3: Human Capital Development, Education, and Awareness

A sustainable built environment can only be realized by people with the right knowledge, skills, and mindset.

- **Mainstreaming Sustainability in Education:** Sustainability principles must be deeply embedded in the curricula of architecture, engineering, urban planning, building technology, and vocational training programs across Nigeria. This is not just about adding a new course but about integrating sustainability as a core philosophy across all relevant disciplines.
- **Upskilling and Reskilling the Existing Workforce:** We need massive programs to upskill architects, engineers, contractors, artisans (masons, plumbers, electricians), and facility managers in green building techniques and technologies. Professional bodies have a crucial role to play in continuous professional development (CPD) and certification.
- **Public Awareness and Advocacy:** Creating demand for sustainable buildings requires raising public awareness about their benefits – not just environmental, but also economic (lower utility bills, higher property values) and health-related (better indoor air quality). Media campaigns, demonstration projects, and community engagement initiatives are vital.
- **Fostering a Culture of Research and Innovation:** Universities and research institutions must become hubs for cutting-edge research in sustainable building materials, technologies, and design strategies relevant to Nigeria. This requires funding, collaboration, and a supportive ecosystem for innovation.

Pathway 4: Innovative Financing and Economic Models

The perceived high cost of green buildings is a significant hurdle. We need innovative financing mechanisms and a clearer articulation of the economic case for sustainability.

- **Developing Green Financing Instruments:** This includes encouraging commercial banks to offer green loans and mortgages with favourable terms, exploring the issuance of green bonds to finance large-scale sustainable infrastructure and building projects, and establishing dedicated green funds. Development finance institutions and international partners can play a key role here.
- **Lifecycle Costing as Standard Practice:** The focus on upfront costs is often misleading. We must promote lifecycle costing analysis, which considers not just the initial construction cost but also the operational costs (energy, water, maintenance) and even end-of-life costs over the entire lifespan of a building. This often demonstrates that green buildings are more economical in the long run.
- **De-risking Investments:** Government can help de-risk private sector investment in sustainable buildings through partial risk guarantees, supporting pilot projects, and

providing clear, stable policy signals.

- **Quantifying Co-Benefits:** The economic case for sustainable buildings extends beyond direct financial returns. We need to better quantify and communicate the co-benefits, such as improved public health (reducing healthcare costs), enhanced productivity in green offices and schools, job creation in green industries, and increased climate resilience (avoided losses from extreme weather events).

Pathway 5: Community Engagement, Social Equity, and Indigenous Knowledge Integration

Sustainable development is fundamentally about people. Therefore, community engagement and social equity must be at the heart of our efforts.

- **Participatory Design and Planning:** Communities should be actively involved in the planning and design of buildings and infrastructure that affect them. This ensures that solutions are culturally appropriate, meet local needs, and foster a sense of ownership.
- **Learning from and Integrating Indigenous Knowledge:** As I mentioned in my journey, traditional Nigerian architecture holds valuable lessons in climate adaptation and resource efficiency. We should respectfully study, document, and integrate these principles with modern scientific knowledge to create hybrid solutions that are both sustainable and culturally resonant. This is not about romanticizing the past, but about learning from its wisdom.
- **Ensuring Affordability and Accessibility:** Sustainable buildings should not be a luxury for the elite. We must focus on developing affordable, sustainable housing solutions for low- and middle-income Nigerians. This involves exploring low-cost local materials, innovative construction techniques, and appropriate financing models. Universal design principles, ensuring accessibility for people with disabilities, must also be integral.
- **Promoting Social Sustainability:** Buildings and neighbourhoods should be designed to foster community interaction, safety, and well-being. Access to green spaces, community facilities, and safe pedestrian environments is all part of a holistic vision of sustainability.

These five pathways, pursued concurrently and with unwavering commitment, can transform Nigeria's built environment from a liability into a powerful asset for sustainable development.

PART 5:
A VISION FOR 21ST CENTURY NIGERIA – MY COMMITMENT AND CALL TO ACTION

The Vice Chancellor, ladies and gentlemen, as I draw towards the conclusion of this lecture, I want to share with you not just an analysis of problems or a list of solutions, but a vision – a vision of what Nigeria's built environment could become in this 21st century if we dare to move beyond concept and concrete.

Imagine Lagos, Abuja, Kano, and Port Harcourt, not defined by perennial traffic jams, power outages, and buildings that swelter in the tropical sun, but by vibrant, walkable neighbourhoods with shaded streets and lush green spaces. Imagine homes that are naturally cool and filled with daylight, powered by the abundant sunshine, harvesting the seasonal rains, and built with materials sourced sustainably from our own land. Picture schools where children learn in healthy, inspiring environments, and hospitals where patients heal faster because the buildings themselves contribute to well-being. Envision industries powered by clean energy, housed in efficient structures, and contributing to a circular economy where waste is a resource. This is not a utopian fantasy; it is a tangible possibility if we embrace the pathways I have outlined.

Nile University of Nigeria has a pivotal role to play in realizing this vision. As a centre of learning, research, and innovation, It is uniquely positioned to drive the intellectual and practical advancements needed. My commitment, through this professorial chair and in collaboration with my esteemed colleagues across faculties, is to make our department and indeed our university a leading force in sustainable built environment research and education in Nigeria and Africa. We will strive to:

- **Champion cutting-edge, context-relevant research:** Focusing on local materials, passive design, renewable energy integration, and sustainable urbanism tailored to Nigeria's unique challenges and opportunities.
- **Develop and deliver transformative educational programs:** Nurturing the next generation of architects, engineers, planners, and policymakers equipped with the skills and passion to build sustainably.
- **Forge strong partnerships:** Collaborating with government, industry, professional bodies, communities, and international organizations to translate research into practice and policy.
- **Serve as a living laboratory:** Implementing sustainable practices on our own campus, showcasing what is possible and providing learning opportunities for our students and the wider community.
- **Advocate relentlessly:** Using our academic platform to champion the cause of sustainable development and to inform public discourse and policy decisions.

This is my personal and professional commitment, but this vision cannot be realized by one person, one department, or one university alone. It requires a collective awakening, a shared responsibility, and a unified call to action.

- **To our Policymakers at all levels of government:** I implore you to demonstrate bold leadership. Create the enabling policy environment, invest strategically in sustainable infrastructure, and champion the passing and enforcement of green building codes. Your decisions today will shape Nigeria for generations to come.
- **To our Captains of Industry, Developers, and Financiers:** I urge you to see sustainability not as a cost, but as an investment – an investment in resilience, in efficiency, in long-term value, and the future of Nigeria. Embrace innovation and partner with us to scale up sustainable solutions.
- **To my fellow Academics, Researchers, and Professionals in the built environment:** Let us redouble our efforts in research, teaching, and advocacy. Let us challenge old paradigms, develop new solutions, and mentor the young minds who will carry this torch forward.
- **To our students, the vibrant hope of Nigeria:** You are the inheritors of the built environment we create today. I urge you to be curious, to be critical, to be innovative, and to become the passionate champions of a sustainable future. Demand more, learn more, and do more.
- **And to every Nigerian citizen:** Sustainability begins with each of us. In the choices we make about where we live, how we consume energy and water, and the kind of future we demand from our leaders. Let us all become advocates for a healthier, more resilient, and more beautiful Nigeria.

CONCLUSION

Vice-Chancellor sir, distinguished guests, ladies and gentlemen, we have journeyed this evening from personal reflections to national imperatives, from dissecting complex challenges to charting actionable pathways. The task of transforming Nigeria's built environment to align with the principles of sustainability is undoubtedly monumental. It requires a paradigm shift – a move away from short-term expediency towards long-term vision, from isolated projects to integrated systems, and from a purely utilitarian view of buildings and infrastructure to one that embraces ecological wisdom, social equity, and economic prudence.

Moving "Beyond Concept and Concrete" means instilling a new ethic of stewardship for our land and other natural resources. It means recognizing that the buildings we erect and the infrastructure we lay down are not just physical structures; they are the very fabric of our society, shaping our lives, our health, our economy, and our planet's future. They are a legacy we leave for generations to come.

The pathways are illuminated, though the journey will require perseverance, innovation, and unprecedented collaboration. Nigeria possesses the human capital, the natural resources, and, I believe, the latent will to embark on this transformative journey. Let us not shy away from the scale of the challenge but rather be inspired by the magnitude of the opportunity – the opportunity to build a 21st-century Nigeria that is not only prosperous and dynamic but also sustainable, resilient, and truly life-affirming for all its citizens.

Let the conversations started here today resonate beyond these walls. Let them translate into tangible actions, into new collaborations, and into a renewed commitment to building a better Nigeria, one sustainable brick, one green policy, one empowered community at a time.

Thank you for your attention. May God bless you all, and may God bless the Federal Republic of Nigeria.

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BRIEF PROFILE OF THE INAUGURAL LECTURER

Academic Leadership and Current Position

Professor Abdulhameed Danjuma Mambo stands as an exemplary leader in Civil Engineering and Environmental Sciences. He currently serves with distinction as Dean of the Faculty of Environmental Science and Head of the Department of Civil Engineering at the prestigious Nile University of Nigeria, Abuja. His pioneering spirit is evident in his role as the founding Head of the Department of Architecture at the same institution.

Early Life and Foundation

Born 47 years ago in the historic city of Lokoja, Kogi State, Professor Abdulhameed Danjuma Mambo hails from a lineage steeped in scholarship, service, and cultural richness. His father, Alhaji Muhammadu Mambo—a Barebari native of Maiduguri—spent all his life in Lokoja as a respected businessman. He was the son of Mallam Suleiman Wanzami, an esteemed Islamic scholar, and a traditional Wanzami (barber-surgeon), who served in the court of His Royal Highness, the late Maigari of Lokoja, Alhaji Muhammadu Maikarfi I. On his maternal side, Professor Mambo draws heritage from Hajiya Maryam Umar, a Hausa woman from Kofa Bebeji LGA of Kano State, whose father, Mallam Umaru Aliyu Mabuga, once held the revered position of Mallamin Jumu'ah in Koton Karfi Kogi State. Mallam was among the disciples who migrated alongside Emir Aliyu Babba of Kano exiled to Lokoja after the British conquest of Kano in 1903.

This distinguished ancestry, blending intellectual pursuit with traditional service, endowed Professor Mambo with a profound cultural and religious foundation—one that has shaped his worldview, informed his values, and inspired his lifelong commitment to excellence in academia and public service.

His academic excellence manifested early when he graduated as the best student from Central Primary School, Koton Karfi, where he served as Assistant Headboy, achieving the remarkable distinction of being the second-best graduating pupil in Kogi Local Government Area in 1987. This early promise continued through his secondary education at Government Secondary School Karshi, Abuja, where he completed his studies in 1993 while serving as Vice President and later President of the Muslim Students' Society of Nigeria.

Educational Excellence and Leadership Development

Professor Mambo's tertiary education began at Kogi State Polytechnic, Osara, where he earned his National Diploma in Mineral Resources Engineering while demonstrating exceptional leadership as Speaker of the Student Representative Assembly (SRA) in 1997 and President of the Muslim Students' Society. His undergraduate journey at Federal University of Technology, Minna, culminated in a Bachelor of Engineering degree in Civil Engineering with a Second Class upper division in January 2006.

During his university years, his outstanding merit earned him multiple prestigious scholarships, including the Islamic Development Bank (IDB) Merit Scholarship, the Jackie-Ogbeha Foundation Scholarship, Federal and Niger State Government Scholarships. His leadership capabilities were recognized through various positions: Academic Secretary of Muslim Student Society of Nigeria, Chairman of the Student Caretaker Committee, Vice President of the National Association of Civil Engineering Students, and President of the IDB Student Association. These achievements earned him the Vice Chancellor's Certificate of Appreciation for outstanding leadership and the Excellent Performance Award from the Islamic Development Bank, conferred on him at the corporate headquarters of the bank in Jeddah, Kingdom of Saudi Arabia giving him the opportunity to travel abroad for the first time in December 2003.

He began his professional career in January 2006 as Secretary of the IDB Scholarship program at the Islamic Education Trust (IET) in Minna. His exemplary performance led to his appointment as Personal Assistant to the National President of IET, Late Sheikh Dr. Ahmed Lemu, OFR. After three months of distinguished service in this role, he was transferred to Abuja to assume the position of Awqaf (Endowment) Development Officer. In this capacity, he oversaw the construction and maintenance of numerous residential and religious buildings and infrastructure projects under the IET's jurisdiction.

Synthesis of Islamic and Western Education

Professor Abdulhameed Mambo's formative years were shaped by a harmonious blend of Western and Islamic education. From an early age, he immersed himself in Islamic religious studies under the guidance of distinguished scholars across northern Nigeria.

In Lokoja, he studied under the tutelage of revered teachers, including late Mallam Haruna Na Mallam Baba and late Mallam Aliyu Shabayagi, while in Koton Karfi, he benefited from the wisdom of his uncle, late Baba Maikasuwa, his maternal grandfather, Mallam Umaru Aliyu and late Mallam Isa. Under their careful instruction, he completed the recitation of the Glorious Quran and commenced his study of Qawaid, laying a solid foundation in Islamic jurisprudence and theology.

His scholarly journey continued in Koton Karfi under As-Sheik Justice Idris Abdullahi, who guided him through the intricacies of Akhdari and the Bugyatul Muslimīn Hadith literature. In Minna, he had the privilege of learning from esteemed scholars As-Sheikh Idris Muhammad, Imam of Bosso Road Masjid, and As-Sheikh Zakariyya Ibn Salihu, each contributing to his deepening understanding of Islamic scholarship.

During his university years, Professor Mambo found invaluable mentorship in As-Sheikh Dr. Imam Ahmad Yankuzo, The Chief Imam of FUT Minna and As-Sheik Umar Dada Paiko whose guidance proved instrumental in shaping his academic and spiritual development. Perhaps most significantly, he briefly served as Personal Assistant to the late Sheikh (Dr.) Ahmad Lemu, OFR in the Islamic Education Trust, an experience that afforded him the rare privilege of witnessing firsthand how true religious scholars seamlessly weave together knowledge, unwavering dedication, and the fear of Allah in building institutions destined to endure through generations.

This unique educational foundation—bridging classical Islamic scholarship with modern academic excellence—has equipped Professor Mambo with the wisdom, integrity, and vision necessary to lead with both scholarly rigor and spiritual consciousness. It is this synthesis of learning that will guide his tenure as he works to build lasting institutions that honour both our rich intellectual heritage and our collective aspirations for the future.

International Academic Distinction

Professor Mambo's pursuit of excellence led him to compete for and win the prestigious Petroleum Technology Development Fund (PTDF) M.Sc. merit scholarship in October 2008 to travel to England for his master's degree. At Loughborough University, United Kingdom, he completed his M.Sc. in Building Services Engineering with Distinction in December 2009. This performance earned him the Loughborough University Studentship to do his PhD in Civil and Building Engineering which he completed in June 2013.

During his doctoral studies, he engaged in extensive professional development, completing numerous specialized training programs with leading institutions including the European Energy Centre in Edinburgh, Building Research Establishment in Watford, MathWorks in Cambridge, National Instruments in Newbury, and the Chartered Institute of Building Services Engineering at Leicester. He presented his research at prestigious international conferences in Marseille, France, Stockholm, Sweden and throughout the United Kingdom while serving as a teaching assistant in Loughborough University and occasional Jumuah Imam for the Loughborough University Islamic Society.

His exceptional performance during the PhD Viva earned him immediate employment from his internal examiner, Prof. Mohammed Sohail and his supervisor, Prof. Mahroo Eftekhari as a Post-Doctoral Research Associate, working on significant projects including Mitsubishi Electric R&D Centre Europe's heating and control systems research and the Bill & Melinda Gates Foundation's 'Reinvent the Toilet Challenge.'

Professional Career and Research Excellence

Returning to Nigeria in January 2014, Professor Mambo served at Federal University of Technology Minna and Federal University Birnin Kebbi, rising from Lecturer II to Senior Lecturer. During this period, he served as Departmental Examination officer, Faculty Examination officer and associate consultant with UN-Habitat, contributing to Nigeria's energy and resource efficiency building code development.

Since joining Nile University of Nigeria in 2016, Professor Abdulhameed Danjuma Mambo has distinguished himself through unwavering dedication to academic excellence and institutional development. Rising through the ranks to attain full professorship, he has served with distinction as the pioneer Dean of the Faculty of Environmental Sciences since May 2022, and as Head of the Department of Civil Engineering since August 2017. Under his visionary leadership, the faculty has witnessed remarkable growth, including the facilitation of international collaborations such as the successful coordination of the Mount Ohio University, USA student visit in 2022, and the implementation of various development initiatives sponsored by the European Union and the French Embassy.

Prof. Mambo has taught courses such as Engineering Drawing, Engineering Graphics and Solid modelling, Building Services Engineering, Design for Sustainability, Sustainable Infrastructure and Advanced Sustainable Civil Engineering Design. He has mentored many upcoming academics, supervised several projects and thesis at Undergraduate, master's and PhD levels. He also served as the founder for Nigeria University Engineering Student Association (NUESA) and Nigeria Institution of Civil Engineers Student Association of Nile University and currently served as one of the patrons of Muslim Student Society of the University.

Professor Mambo's influence extends beyond Nile University. In 2024, he served as Team Lead for the Outcome-Based Education (OBE) accreditation exercise conducted by COREN at Odumegwu Ojukwu University, Oka. His expertise is also sought after internationally and nationally as an external examiner. Notably: Ph.D. and Master's External Examiner, Department of Civil Engineering, University of Abuja, Master's External Examiner, professorial and associate professorial assessor, Department of Civil Engineering, Federal University of Technology, Minna, Ph.D. External Examiner, Department of Civil Engineering, Karunya Institute of Technology, India, Ph.D. External Examiner, B.S. Abdur Rahman Crescent Institute of Science and Technology, Chennai, Tamil Nadu, India – March 2025 and Ph.D. External Examiner, Department of Civil Engineering, SRM Institute of Science and Technology, Delhi, India.

These roles reflect his standing as a scholar of international repute and a mentor committed to nurturing the next generation of engineers and academics.

Community Service

Mambo currently serves as the Chairman of the National Mirror/Technical Committee (NM/TC) for Sustainability in Buildings, Cities and Communities Standards for the Standards Organisation of Nigeria on a 3-year tenure. The Foundation Chair of Nile Staff Multipurpose Cooperative Society, Member Advisory Board of the Waste Pickers Association of Nigeria, member Board of Trustee, Islamic Development Bank (IDB) Educational Foundation, Technical Chair, World Council of Civil Engineers 2025 General Assembly, Editor, Nile Journal of Engineering and Applied Science and the General Secretary of Mambo Charity Foundation.

Research Impact and Professional Recognition

Professor Mambo's research encompasses sustainable infrastructure, energy efficiency, and building management systems. His publication record includes peer-reviewed journals, conferences, and books. He has delivered keynote addresses at major national and international forums, addressing critical topics from infrastructure vandalism to artificial intelligence in construction.

His sustained excellence and leadership have been consistently recognized by his peers, mentors, and the institutions he has served, as illustrated by a remarkable collection of honours:

Leadership and Professional Excellence Awards:

- Honoris Value Award 2024 of the Honoris United Universities for the outstanding achievements in the Abuja Urban Lab Project
- PWC Best Book Review Award 2024 for demonstrating commendable business writing skill at the NUN leadership development program
- Fellowship, Nigerian Institution of Civil Engineers (FNICE) (2020): The highest honour from his professional peers, recognizing his significant contributions to the field of civil engineering in Nigeria.
- Commendation Award, World Council of Civil Engineers (2023), in recognition of support to the development of Civil Engineering in Africa at it 2023 regional conference in Abuja
- Fellowship, European Alliance for Innovation (FEAI) 2023 in recognition of outstanding achievement in civil engineering, underserved areas and sustainable infrastructure and for major contribution and leadership to the EAI community.
- Appreciation Award, Nigeria Society of Engineers, Bwari Branch (2024): For insightful Keynote Address.
- Distinguish Award of Honour, Nigeria Institution of Environmental Engineers (NIEEE) for serving as the Guest Speaker on the 2024 World Environmental Day Abuja
- Appreciation Award, Nigerian Institution of Building (NIOB), FCT Chapter (2024). For insightful Keynote Address.
- Appreciation Award, Nigerian Institution of Civil Engineers (NICE) (2022).
- Meritorious Award of Honour, President, IDB Scholarship Graduate Association of Nigeria (2021): Acknowledging his leadership in mentoring and guiding the next generation of scholars.
- Recognition & Appreciation Awards, Nigerian Institution of Civil Engineers (2020): Honoured for his dual roles as Chair of the Technical Committee and a key member of the Conference Planning Committee.
- Award of Honour, Nigeria Institution of Civil Engineers Student Chapters, Award of excellence in recognition for visionary leadership 2023/24 academic session

Academic and Mentorship Honours:

- Meritorious Award of Honour, Nigeria Universities Engineering Student Association (NUESA) (2019): Celebrating his dedication to student development and mentorship.
- Vice Chancellor's Certificate of Appreciation, Federal University of Technology Minna (2004): An early recognition of his outstanding leadership potential during his

undergraduate years.

- Excellent Performance Award, Islamic Development Bank, Jeddah, KSA (2004): An international award highlighting his exceptional academic and personal conduct.

Prestigious Scholarships and Certifications:

- Ph.D. Merit Scholarship, Loughborough University (2010 - 2013).
- M.Sc. Merit Scholarship, Petroleum Technology Development Fund (PTDF), Nigeria (2008 - 2009).
- B.Eng. Merit Scholarship 2001-2005 Islamic Development Bank Jeddah Saudi Arabia

His professional affiliations include Fellowship of the Nigerian Institute of Civil Engineers, Fellowship of the European Alliance for Innovation, membership in the Nigerian Society of Engineers, Green Building Council of Nigeria, European Energy Centre, and World Society of Sustainable Energy Technologies. He is registered with the Council for the Regulation of Engineering in Nigeria (COREN).

Vision for Leadership

This unique synthesis of classical Islamic scholarship and cutting-edge engineering expertise, combined with proven leadership abilities and international exposure, positions Professor Mambo to lead with both scholarly rigor and spiritual consciousness. His commitment to building lasting institutions that honour intellectual heritage while pursuing collective aspirations makes him uniquely qualified for the responsibilities ahead.

Personal Life

Professor Mambo is married to Rakiya Ibrahim Ladan and is blessed with five children: Ahmad, Maryam, Ibrahim Khalil, Khadijah, and Farhan, reflecting his commitment to family values alongside professional excellence.

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Professionally, I have been blessed with a supportive and intellectually stimulating environment at the Nile University of Nigeria and Honoris United Universities. I am profoundly grateful to the Vice-Chancellor for his visionary leadership, which is transforming this institution into a beacon of excellence. His confidence in me has been both humbling and motivating. My sincere appreciation also goes to the Deputy Vice-Chancellors (Academic and Administration), the Registrar, the esteemed members of the Executive Management Board, the Provost of the College of Health Sciences, the Deans of Faculties, Directors of Units, Heads of Departments, and all my respected colleagues. Your camaraderie and collaboration have created a truly remarkable academic community.

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