International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

THE ASSESSMENT OF THE LEVEL OF INNOVATION ON SUSTAINABLE SMART BUILDING SPECIFICATION WITHIN THE NIGERIAN CONSTRUCTION INDUSTRY (NCI)

AMOO MOSUNMOLUWA ADETUTU[1], ADEBOYE PRAISE MOSADOLUWA[2], SALAMI AYODEJI ADELEKE[3], ADEWUNMI BAMIDELE.J[4], OGUNNAIKE ADEKUNLE O [5]

adekunle.ogunnaike@calebuniversity.edu.ng. amoo.mosunmoluwa@calebuniversity.edu.ng, praizjoseph59@gmail.com, aayodeji@rocketmail.com
Department of architecture, Caleb university, Imota, Lagos State, Nigeria

ABSTRACT :

The Nigerian Construction Industry (NCI) is recognized as a critical engine for economic development and urban transformation. With an anticipated annual growth rate of 3.1% from 2025 to 2028, the sector holds vast potential. However, it is simultaneously faced with multiple structural and operational challenges such as inflation, material cost fluctuations, poor infrastructure, project delivery inefficiencies, and regulatory constraints. These issues continue to affect the quality, duration, cost, and overall performance of construction projects, intensifying the demand for innovative, sustainable approaches. A major area of concern is the limited integration of innovation in building specifications—the detailed documents that govern construction standards and material selections. Most current specifications in Nigeria remain prescriptive rather than performance-based and rarely reflect the modern demands of sustainable and smart building practices. This has hindered the adoption of energy-efficient systems, smart technologies, and environmentally responsible construction methods. Sustainable smart building specifications combine green design strategies—such as low-energy systems, renewable energy integration, and material sustainability—with digital tools like Internet of Things (IoT), Building Management Systems (BMS), and automation. These enable real-time monitoring, energy optimization, and improved user comfort. Unfortunately, in the Nigerian context, adoption is slow due to a lack of technical expertise, limited access to certified sustainable materials, minimal policy enforcement, and high upfront costs.

Nonetheless, there is growing momentum among industry stakeholders. Private sector players and some public institutions are beginning to implement Building Information Modeling (BIM), digital construction tools, and collaborative delivery models to improve specification quality and project outcomes. Emphasis is increasing on creating high-performance buildings that meet both environmental and technological benchmarks. While this shift is encouraging, widespread impact requires stronger policy frameworks, professional capacity building, increased awareness, and investment in locally adapted specification standards.

Keywords: Sustainability, Nigerian construction industry, Architectural conservation, specifications

INTRODUCTION

The Nigerian construction industry plays an important role in the country's economic growth by contributing greatly to GDP and providing numerous employment opportunities (Asaju, Adewunmi, Onamade, 2023). However, the industry is surrounded by numerous issues which are not limited to but includes inadequate infrastructure, fluctuating material costs, sustainability concerns, and quality and cost management issues (Adewunmi, Onamade,, Asaju, Adegbile, 2023). The Nigerian construction industry significantly influences the country's growth and development (Ashokumar, 2014). Although it is evident to point out that this sector's contribution to the economic state is to an extent dependent on the quality and quantity of project executed over a given time frame which must balance cost and time as well (Onamade, Asaju, 20220). (Bhattaacharjee, 2018). Sustainable buildings are changing the construction industry by introducing green design, smart technologies and proper symmetry of nature and its environmental components as well as ultra-low energy optimization and concepts in general.Sustainability has evolved through innovative smart practices, Over the years there have been various instances of sustainable smart buildings within the Nigerian construction industry (Adewunmi et al 2023). It is important to state that observing these practices will show how far sustainability has come and its continuous practices in the Nigerian construction industry for the posterity.(Adewunmi, Asaju et al, 2024).

This study investigates the current state of the Nigerian construction industry, identifying key challenges and opportunities for growth and development of sustainable smart building specifications. The research will explore the adoption of sustainable construction practices and building specifications, the use of cutting-edge technologies, and the impact of stakeholder engagement and policy support on industry performance. By examining the complex interplay of factors influencing the industry, this study seeks to provide insights and recommendations for improving project outcomes, promoting sustainable growth, and contributing innovative sustainable smart building specifications. The findings of this research will have implications for industry stakeholders, policymakers, and researchers, informing strategies for addressing the industry's challenges and capitalizing on its potential.

LITERATURE REVIEW

Energy efficiency, sustainable materials, and smart building technology are only a few of the essential characteristics of sustainable smart buildings. IoT-enabled sensors, data analytics, and automated systems are examples of smart building technologies that maximize safety, comfort, and energy use (Taboado-Orozco et al., 2024). In order to improve energy efficiency and cost-effective building maintenance, energy management systems that monitor consumption patterns, automate HVAC schedules, and control lights depending on occupancy are used (Ejidike & Mewomo, 2023). Environmental effect is decreased by using sustainable materials as carbon-capturing concrete, facades made of algae (Green building), and biomimetic building skins (Wealth Wise Report, 2024). Generally, specifications require very significant amount of time with attention to detail. As the Nigerian construction industry continues to evolve, more innovative and digital ways are been discovered in order to enhance precision, speed and efficiency.

There are several advantages to sustainable smart buildings which also have different ways of specification. They can reduce their energy use by up to 18% for HVAC, 28% for equipment, and 33% for lighting (Panduit, n.d.). Eco-friendly construction methods are encouraged by sustainable materials, green building certifications, and a smaller carbon footprint (Yitmen et al., 2024). By creating optimum indoor settings, smart buildings also improve occupant comfort, productivity, and safety (Wealth Wise Report, 2024). Dynamic space allocation and improved facility management are made possible by Building Information Modeling (BIM) data analytics that track space consumption (Wealth Wise Report, 2024). Machine learning and artificial intelligence improve security procedures, forecast equipment breakdowns, and optimize energy utilization (Wealth Wise Report, 2024). Real-time monitoring, intelligent waste management, and efficient waste collection are made possible by IoT devices.

However, there are issues with smart buildings that are sustainable. It can be difficult to invest in and secure finance for smart building technology (Yitmen et al., 2024). Another difficulty is the requirement for qualified experts to plan, execute, quote spefcify, and manage smart building systems (Yitmen et al., 2024). To safeguard critical building data, strong cybersecurity measures are necessary (Yitmen et al., 2024).

CONCEPTUAL REVIEW

There is growing demand on Nigeria's construction sector to use smart technology and sustainability in building design and construction. The need for sustainable smart buildings is growing as global trends shift toward digitally connected and climate-responsive design. Innovative building specifications—technical papers that convert design intent into precise, legally binding construction requirements—are crucial to this change.

The link between conceptual design and actual implementation is provided by specifications. They guarantee that performance criteria, technical innovation, and sustainability concepts are all incorporated into construction projects. Specifications for sustainable smart buildings include performance-based criteria such energy efficiency measurements, the usage of eco-friendly materials, intelligent control systems, and adaptive technology, going beyond simple descriptions (Kibert, 2016; Bibri, 2019). The use of green technology, such as solar panels, water-saving fixtures, energy-efficient windows, and intelligent building management systems, is governed by these documents. Nigerian specifications frequently fall short of international best practices, despite their crucial importance. Prescriptive specifications, which describe materials and construction techniques without explicitly indicating the desired performance outcomes, are still used in the majority of building projects. Because of this, a lot of sustainable initiatives are either not pursued at all or are implemented badly. Furthermore, standard requirements seldom ever contain smart building elements like automation systems, IoT-enabled controls, and performance monitoring technologies (Ajayi et al., 2020). The lack of regional standards for smart and green technology, professional ignorance, and a lack of specialized training in specification authoring are the main causes of this disparity.

Nonetheless, some progress is being made in high-end developments in cities like Lagos and Abuja, where performance-based specifications are starting to appear in commercial and luxury residential projects. These often include requirements for energy modeling, environmental product declarations (EPDs), smart metering, and building automation systems. However, these examples are few and primarily driven by foreign investment or clients with international exposure (Olanrewaju & Anigbogu, 2021).

THEORETICAL REVIEW

Several theoretical frameworks, such as systems theory, sustainable development theory, and technological determinism theory, can be used to understand sustainable smart buildings. According to systems theory, buildings are intricate systems that interact with their surroundings and inhabitants. Smart building technologies may be viewed as a means of enhancing these systems' functionality. Sustainable smart buildings can support sustainable development by lowering their environmental impact and enhancing occupant well-being. Sustainable development theory highlights the importance of balancing economic, social, and environmental factors in building design and operation (Yitmen et al., 2024). Sustainable smart buildings also heavily rely on the idea of smart expansion. Sustainable smart buildings may support smart growth by lowering energy consumption and environmental impact. Smart growth highlights the need for effective and sustainable resource utilization in urban development. Sustainable smart buildings also use green building concepts, which emphasize the design of structures that minimize environmental effect through the use of sustainable materials, energy-efficient technologies, and decreased waste (Wealth Wise Report, 2024). Sustainable smart buildings use cutting-edge technology to maximize performance, taking green building concepts to the next level.

Building Information Modeling (BIM) is a key enabler of sustainable smart buildings, providing a platform for data-driven decision-making and performance optimization. BIM involves using digital models to design, construct, and operate buildings, and can help optimize building performance and reduce environmental impact. The study of sustainable smart buildings can contribute to several theoretical areas, including understanding the impact of technology on sustainability and developing new theories of building performance (Panduit, n.d.).

Research on sustainable smart buildings can shed light on the role of technology in driving sustainable development and reducing environmental impact. It can also inform the development of new theories that explain how buildings perform and interact with their occupants and environment. Furthermore, research on sustainable smart buildings can contribute to a better understanding of how urban planning and development can be designed to promote sustainability and resilience.

INNOVATIVE SUSTAINABLE THEORETICAL FRAMEWORKS

A. Systems Theory

Systems theory views. This theory views systems as complex, interconnected, and dynamic entities that consist of multiple components and relationships. In the context of sustainable smart buildings, systems theory can help us understand how different building systems (e.g., HVAC, lighting, security) interact with each other and with the building's occupants and environment.

Systems theory can be applied to sustainable smart buildings in several ways:

- **Holistic approach:** A comprehensive approach to building design and operation that takes into account the interconnections between various building systems and components is encouraged by systems theory.
- **Interconnectedness:** In order to maximize building performance and sustainability, systems theory emphasizes how building systems and components are interrelated.
- **Feedback loops:** The significance of feedback loops in building systems is emphasized by systems theory, which may assist building managers and operators in pinpointing areas for enhancement and maximizing building performance.

B. BUILDING INFORMATION MODEL (B.I.M)

Building Information Modeling (BIM) is a computerized method for infrastructure or building design, management, and construction. Azhar (2011). BIM is a data-intensive, collaborative approach to the design, development, and management of built assets. BIM enables sophisticated construction modeling and scheduling by offering a digital 3D representation that encompasses a building's functional and physical features. Exmples of B.I.M software tools used by professionals in the construction industry are not limited to but includes are Autodesk AutoCAD, Autodesk Revit, Auto desk 3ds Max. These tools and many more enhance innovative and collaborative smart building designs (Adenubi, 2025). While AutoCAD is use for basic 2D drafting and detailing (Adewunmi, 2025) there are quite a few others that interface with 3D interfaces and they are not limited to but includes Sketchup, rhino to mention a few. Additionally, BIM enables multiple stakeholders to work together on a single platform, promoting better communication and coordination. B.I.M has various benefits which are not limited to but includes the following;

- BIM facilitates collaboration and communication among architects, engineers, contractors, and other stakeholders (Adewunmi, 2025)
- BIM also reduces errors and inconsistencies by providing a single source of truth for project data (Adewunmi, 2025)
- BIM can be used to optimize building performance, reduce energy consumption, and promote sustainable design

C. SUSTAINABLE DEVELOPMENT THEORY

In regard to sustainable smart buildings, sustainable development theory can help us understand how buildings can be designed and operated to minimize environmental impact while promoting economic and social benefits. It highlights the importance of choosing decisions that balance economic, social, and environmental factors.

- **Triple bottom line:** The triple bottom line (TBL) of economic, social, and environmental advantages should be taken into account while designing and operating buildings, according to sustainable development theory.
- **Stakeholder engagement:** Sustainable development theory highlights the importance of stakeholder engagement and participation in building design and operation, which can help ensure that buildings meet the needs of occupants and the wider community.
- **Life cycle assessment:** Sustainable development theory encourages a life cycle assessment approach to building design and operation, considering the environmental and social impacts of buildings over their entire life cycle.

INNOVATIVE SUSTAINABLE BEST PRATICES

Sustainability in general could on a long run improve and prolong the life span of a building or structure.(Adenubi, 2025)Hence, its application by professionals in the built environment on buildings and structures in this present era. Sustainable features are made of of various components which are not limited to but includes Trees, shrubs, and plant. Trees generally can serve as shade and add aesthetic value to a building or structure (Adenubi, Adewunmi). These componets generally comprise what is known to most as landscape, greeney (Dayomi, 2025).

A. Landscape

The term Landscape refers to a large area of land with specific natural features, such as mountains, hills, rivers, and forest, that can be seen from a particular point. (forman and Gordan 1986). Landscape encompasses both artistic and design context which includes landscape and landacape design, Ecological and environmental context, urban planning and development context.

Fig 1.5.2 Landscape

- **Urban Landscape;** The physical environment of a city or town, including buildings, streets, parks, and other public spaces (Lynch, 1960).
- **Landscape Architecture;** The profession of designing and managing outdoor spaces, such as parks, gardens, and public spaces, to create functional aesthetically pleasing environments (ASLA, 2020).

DESIGN STRATEGIES

1. **Incorporate Native Plant Species**: Incorporate native plant species, which require less maintenance and support local biodiversity.
2. **Use Rainwater Harvesting:** Use rainwater harvesting systems to collect and reuse rainwater for irrigation and other non-potable purposes.
3. **Implement Energy-Efficient Lighting:** Implement energy-efficient lighting systems, such as solar-powered lights, to reduce energy consumption.
4. **Create Outdoor Learning Spaces:** Create outdoor learning spaces, such as gardens, greenhouses, and outdoor classrooms, to support experiential learning.

BEST PRACTICES

1. **Integrate Sustainability into Curriculum**: Integrate sustainability into the curriculum, using the landscape as a teaching tool.
2. **Monitor and Evaluate**: Monitor and evaluate the effectiveness of sustainable landscape design and practices.
3. **Collaborate with Community:** Collaborate with the community, including local organizations and stakeholders, to promote sustainability and environmental awareness.

EMPIRICAL REVIEW

Below are sustainable research questions and a review analysis on a survey within the general parameters of the research scope.

2.1.1. RESEARCH QUESTIONS

SECTION A

1. Age a 20-30 yrs b. 31-40 yrs c. 41-50 yrs d. 51- 60 yrs e. 61 years and above
2. Gender a. Male b. Female
3. Marital status a. Single b. Married c. Divorced d. Widow/ widower e. others (Specify)………………
4. Educational level a. Below First Degree b. First Degree (HND/ Bsc) c. Masters d. Doctorate e. Others (Specify)

5. Name of Firm ____________________

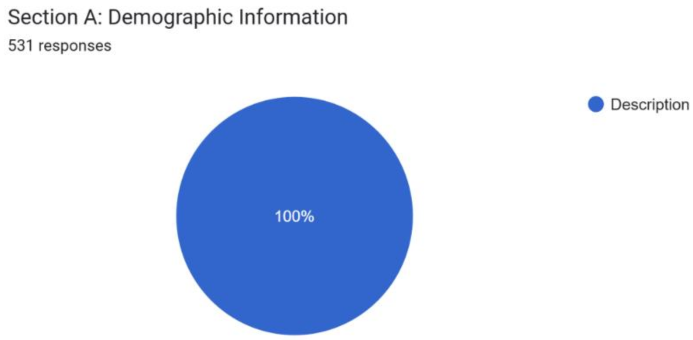
6. Type of Firm a. Sole proprietorship b. Partnership c. Limited Liability Company d. Corporation e. Public Sector Enterprise

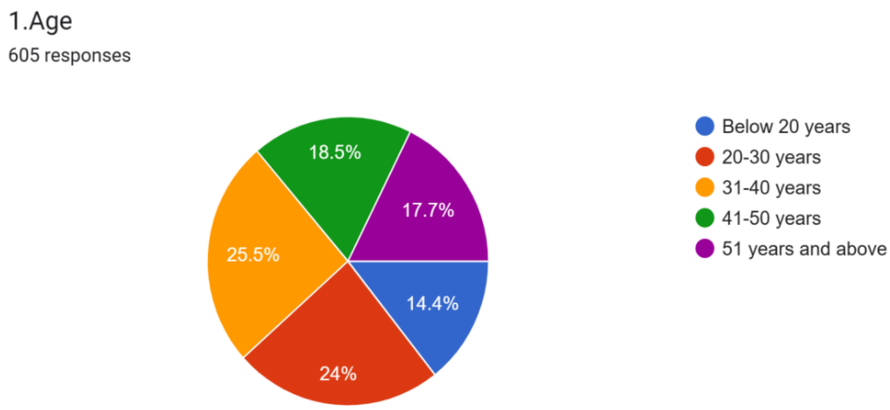
7. Duration (dealing with working drawing) a. 0-5 yrs b. 5-10 yrs c. 11-15 yrs d. 16-20 yrs e. 21 yrs and above

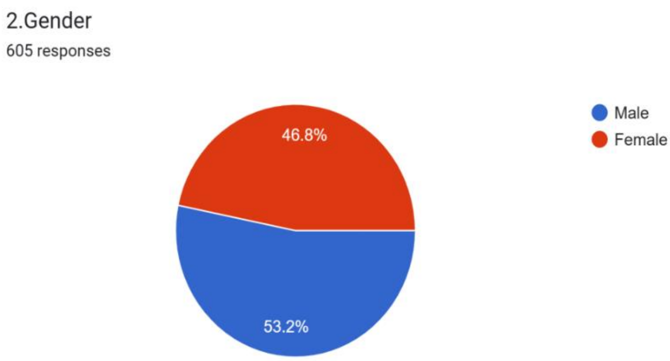
8. State of organization _____________________

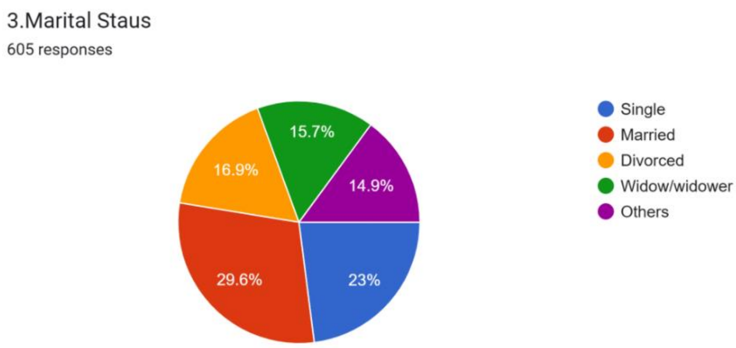
9. Country of Practice ______________________

10. Specialization a. Contractor b. Architect c. Engineer d.Project managers e. Others (specify)

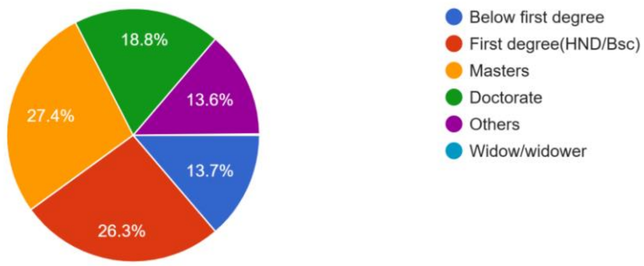




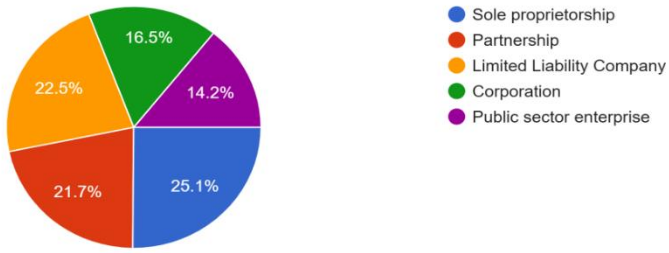




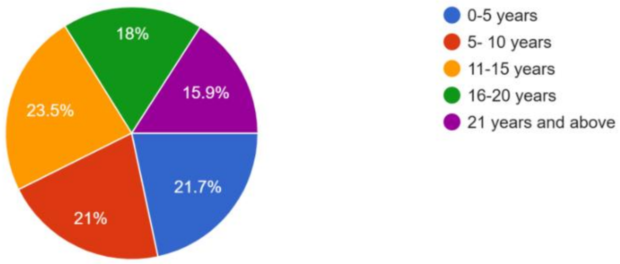
4.Educational level
605 responses



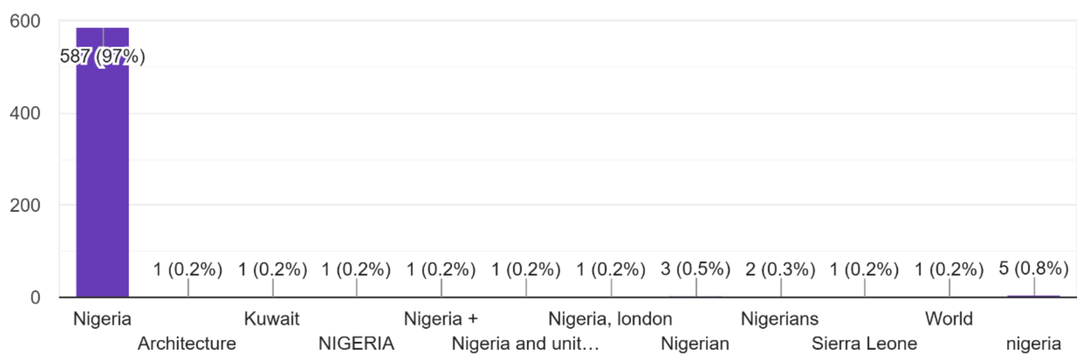
6.Type of firm
605 responses

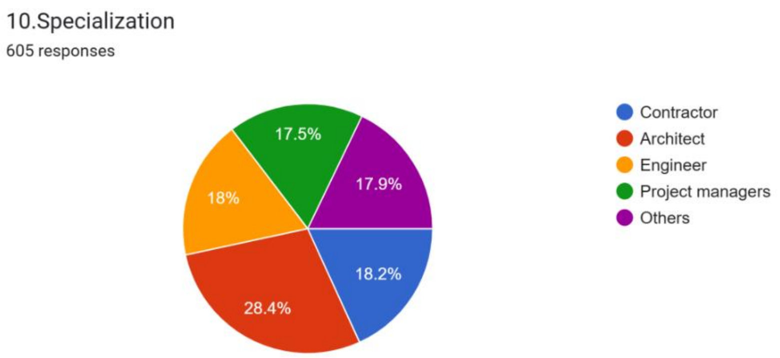


7.Duration(dealing with working drawing)
605 responses



9.Country of practice
605 responses





2.1.2.RESEARCH QUESTIONS SECTION B

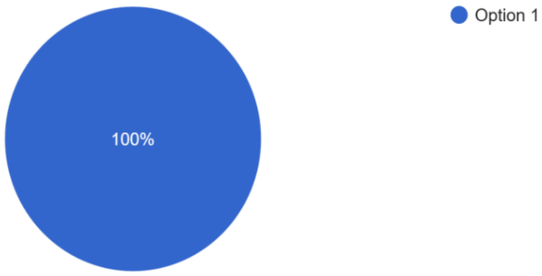
The following research questions illustrates the research questions asked and carried out through a survey with responses represented through pie charts and piecharts as related to the research scope.

a.	The working drawings accurately represent the properties of sustainable materials.
b.	Specifications for sustainable materials are clear and comprehensive in the drawings.
c.	I am satisfied with how sustainable materials are depicted in the working drawings.
d.	The representation of sustainable materials in working drawings meets industry standards.
e.	Working drawings provide adequate details for the implementation of sustainable materials.
12	**Clarity of Material Specifications**
a.	Specifications for sustainable materials are easy to understand in the working drawings.
b.	There is sufficient information about sustainable materials in the working drawings.
c.	The clarity of material specifications for sustainable products is satisfactory.
d.	Working drawings clearly indicate the environmental benefits of specified materials.

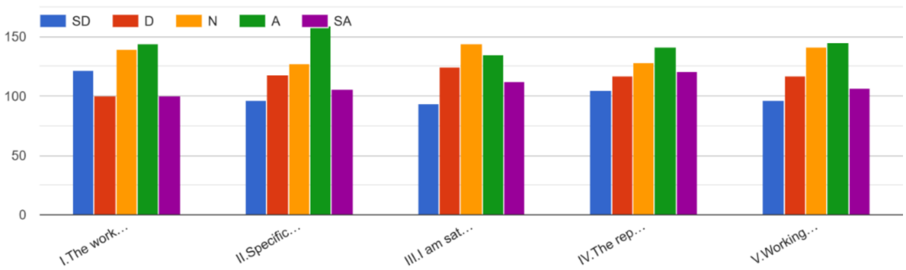
e.	The material descriptions in working drawings are precise and complete.
13	**Types of Smart Technologies**
a.	Specifications for smart technologies are clearly outlined in working drawings.
b.	I find the representation of smart technologies in working drawings to be comprehensive.
c.	The integration of smart technology specifications is well-handled in working drawings.
d.	Working drawings adequately address the functionality of smart technologies.
e.	Specifications for smart technologies are easily understandable in working drawings.
14	**Changes in Specification Formats**
a.	The format of specifications for smart buildings has adapted well to new technologies.
b.	Working drawings reflect the changes in specification formats for smart technologies effectively.
c.	The evolution of specification formats meets the needs of modern smart buildings.
d.	Specification formats in working drawings have improved with the introduction of smart technologies.
e	Changes in Specification formats are clearly documented in working drawings.

SECTION B :KINDLY TICK AS APPROPRIATE,SD=STRONGLY DISAGREE,D=DISAGREE,N=NEUTRAL,A=AGREE,SA=STRONGLY AGREE

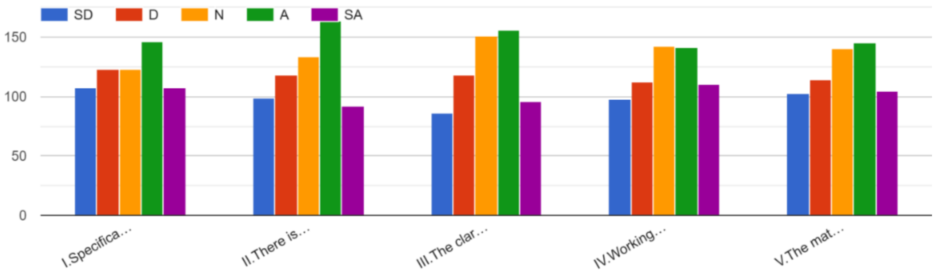
515 responses



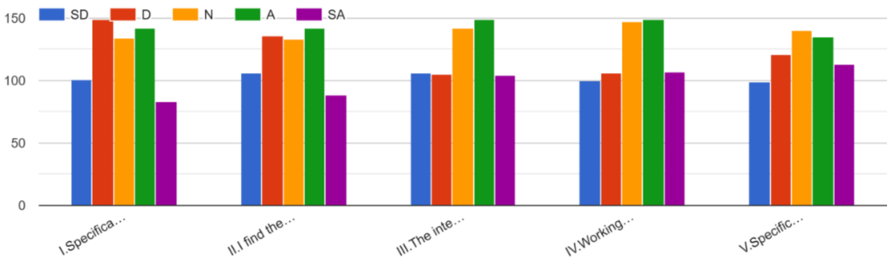
11.Types of Sustainable Materials

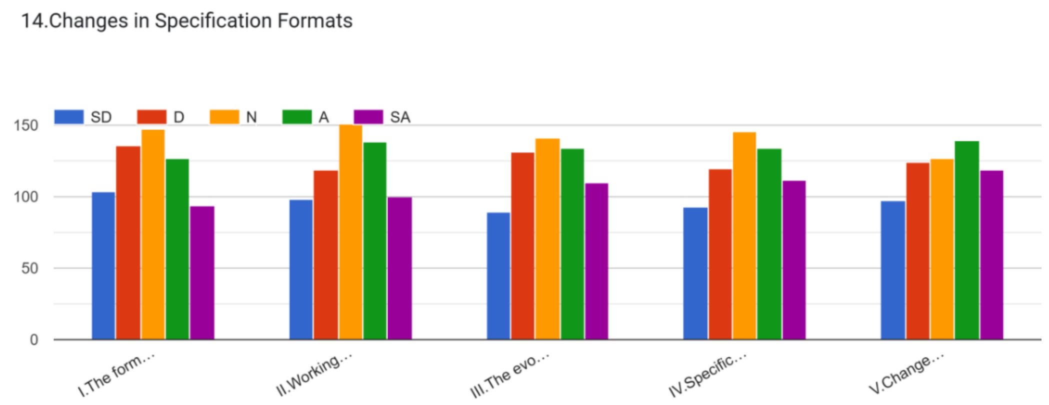


12.Clarity of Material Specifications



13.Types of Smart Technologies





RECOMMENDATIONS

- Sustainable smart buildings may enhance tenant comfort and productivity while lowering energy use and their negative effects on the environment.
- Building performance and sustainability may be maximized by advanced technologies like AI, IoT, and BIM.
- Green roofs and living walls are examples of sustainable materials and technologies that may enhance air quality and offer ecosystem services.
- Strong security measures are required to mitigate the cybersecurity threats related to sustainable smart buildings.
- The potential of sustainable smart buildings in many climates and circumstances requires more investigation.
- Broad adoption can be facilitated by creating standardized frameworks and norms for the design and operation of sustainable smart buildings.
- Urban settings can be made more robust, sustainable, and efficient by integrating smart city infrastructure with sustainable smart buildings.
- By embracing sustainable smart building technologies and practices, we can create a more sustainable, resilient, and environmentally conscious built environment for future generations.
- Use energy-efficient doors and windows: Specify doors and windows with high insulation values and low air leakage.
- Include building envelope optimization: To cut down on energy use, optimize building envelope design.
- Make use of environmentally friendly ceiling materials: Choose products that have minimal effects on the environment.
- Put indoor air quality monitoring into practice: Keep an eye on indoor air quality to guarantee a healthy atmosphere.
- Make use of energy-efficient cooling systems: Choose high-seer-rated energy-efficient cooling systems.
- Use data analytics to enhance building efficiency and energy use by using smart building analytics.
- Install energy-efficient heating systems: Choose high AFUE-rated energy-efficient heating systems.
- Incorporate daylight harvesting: Plan buildings to optimize natural daylight and minimize the need for artificial lighting; use energy-efficient appliances and equipment: Make sure that energy-efficient insulation is installed properly to maximize energy efficiency; and use sustainable insulation installation.
- Use smart thermostats: Install smart thermostats to optimize heating and cooling systems.
- Implement energy-efficient water treatment: Specify energy-efficient water treatment systems.

- Use sustainable construction methods: Specify sustainable construction methods, such as modular construction.
- Incorporate building performance monitoring: Monitor building performance to identify areas for improvement.
- Use energy-efficient HVAC controls: Specify energy-efficient HVAC controls to optimize system performance.
- Implement sustainable maintenance practices: Implement sustainable maintenance practices to reduce waste and energy consumption.
- Use sustainable materials in new construction: Specify sustainable materials in new construction projects.
- Continuously monitor and improve building performance: Regularly monitor and improve building performance to ensure optimal energy efficiency and sustainability

CONCLUSION

By combining ultra-low energy principles, smart technology, and green design, sustainable smart buildings are transforming the construction sector. These structures have several advantages, such as lower energy use, increased environmental sustainability, and better occupant comfort and productivity.

REFRENCES

1. Afolabi, A. O., et al. (2020). Assessment of the Literature on the Performance of Construction Projects in Nigeria. Journal of Construction Engineering and Management, 146(1), 04019115.
2. Oladapo, A. A. (2019). Critical Success Factors for Construction Projects: A Case Study of Nigeria. Journal of Construction in Developing Countries, 24(1), 43-61.
3. Ameh, O. J., et al. (2018). Challenges and Prospects of the Nigerian Construction Industry. Journal of Construction Engineering and Management, 144(3), 04018015.
4. Nigeria Construction Industry Report 2025. (2024).
5. Nigeria Construction Industry Report 2024. (2023). Retrieved
6. Ogunlana, S. O. (2017). Construction Management in Nigeria: Principles and Practice. Lagos: University of Lagos Press.
7. Akindoyeni, A. O. (2019). Construction Industry in Nigeria: Trends, Challenges, and Opportunities. Abuja: Nigerian Institute of Building.
8. International Conference on Construction in Developing Countries (2020). Proceedings of the 11th ICCIDC. Abuja, Nigeria.
9. The Comprehensive Guide to Construction in Nigeria. (2024).
10. Civil Engineering in Nigeria: Trends, Challenges, and Opportunities. (2023)
11. Specification: A key tool for efficient Facility Management in Lagos mega city (2024).
12. Ensuring Quality Control In construction (2024)