UNIVERSITY OF ILORIN

THE TWO HUNDRED AND EIGHTY (281ST) INAUGURAL LECTURE

"VALUE PROPOSITION FOR ENHANCING COST MANAGEMENT OF SUBSERVIENT AND NEGLECTED ELEMENTS IN BUILDING"

By

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THURSDAY, 15TH MAY, 2025

This 281st Inaugural Lecture was delivered under the Chairmanship of:

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15th May, 2025

ISBN:

Published by:

The Library and Publications Committee, University of Ilorin, Ilorin, Nigeria

Printed by
Unilorin Press, Ilorin, Nigeria

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Great Students of the University of Ilorin,
My Lord Spiritual and Temporal,
Distinguished Ladies and Gentlemen.

Preamble

Mr. Vice-Chancellor, I seek refuge in the Almighty Allah against the devil, and begin this inaugural lecture in the Name of Allah, the Most Beneficent, and the Most Merciful. Allah is the first without any reference point of starting, and He will be the last without any point of termination from His existence. The creator of all the creatures, the everlasting fountain of wisdom and the Lord of the Universe. I am greatly indebted to the Vice-Chancellor and the University Administration for giving me this opportunity.

The privilege of delivering this inaugural lecture is both an honour and a responsibility. As the first from the Faculty of Environmental Sciences and the Department of Quantity

Surveying at the University of Ilorin to hold this distinction, I am deeply humbled. This lecture focuses on the overlooked cost elements in buildings, particularly in BS. It explores how value engineering, standard adoption and technology can redefine cost management in this critical segment of buildings.

Quantity Surveying and Quantification of Construction Work

Providing financial and contract management advice to clients on building projects began about 350 years ago, and Quantity Surveying has been an integral part of the construction industry in the United Kingdom (UK) for over 170 years (Cartlidge, 2023). In the seventeenth century, quantity surveying was frequently carried out as a part-time occupation by "measurers," typically architects, master craftsmen, or land surveyors. These measures would provide financial reconciliations of completed building works based on a measure–and–value approach, culminating in producing the final account. However, the surge in construction activity following the Great Fire of London prompted "measurers" to transition into professional roles.

The profession was first accorded legal recognition in Edinburgh in 1729 when members (sworn measurers) were required to provide proof of competence before being engaged by clients. The sworn measurers were the only surveyors whose measurements were recognised in legal proceedings, which led to the establishment of the first method of measurement in 1773, known as the "Edinburgh Mode of Measurement," for use by sworn measurers (Murray, 1997; Seeley 1997& RICS 1988). Following the aforementioned, the proliferation of other local measurement modes led to the publication of the first National Method of Measurement in Scotland in 1918, referred to as the "Scottish Mode of Measurement of Building Works."

The need to prepare pre-contract price forecasts emerged in 1830, and the inconsistencies in the method of measurement among practitioners prompted the creation of the first Standard Method of Measurement of Building Works in 1922 by the Royal Institution of Chartered Surveyors to ensure uniformity and accuracy in Bills of Quantities (BoQ). Although it is not compulsory for QS to adopt the recommendations in the standard method of measurement, however, “when an allegation of professional negligence is made against a surveyor, a court or tribunal may consider the contents of any relevant guidance notes published by RICS in determining whether the member acted with reasonable competence” (RICS, 2012).

Core Business of Quantity Surveyors

The primary duty of Quantity Surveyors (QS) is to ensure that clients’ resources on construction projects are managed as efficiently as possible to deliver maximum value for money, while meeting legal and quality standards (Cartlidge, 2023). However, the process employed by QS to prepare cost advice for clients consists of three phases: defining the brief and setting the budget; planning and controlling the design costs; and managing costs during the procurement and construction stages (Ashworth & Hogg, 2007; Ashworth *et al.*, 2013). Thesethreephases followthe Royal Institute of British ArchitectsPlanofWorks.

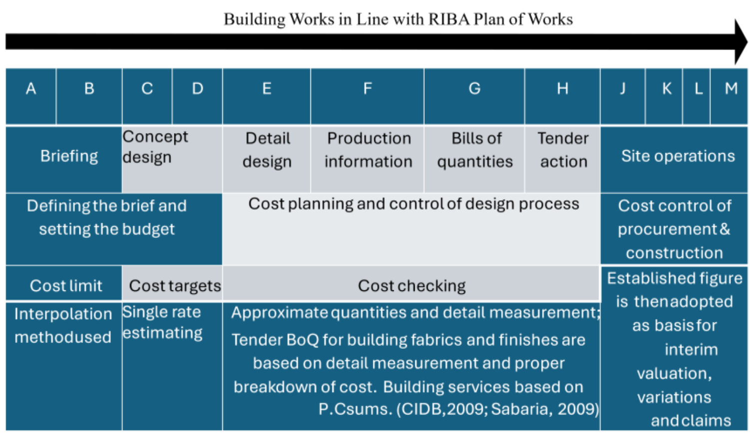

Figure 1: Cost Management Approaches by QS in Line with RIBA Plan of Works 2013

As illustrated in Figure 1, from the inception to the concept design stage of design development, it is common for QS to utilise single-purpose approximate estimating techniques to establish the initial budget for clients' requirements (Potts, 2008). As more design information becomes available, approximate quantities are measured to prepare estimates, andcost-checking exercises are conducted to improve the reliability of the initial budget estimates. Once the detailed design is finalised, quantities are extracted from the drawings, and the preparation of bills of quantities (BoQ) is undertaken in accordance with the Standard Method of Measurement (SMM).

The completed BoQ is then sent, along with other documents, for the contractor to price during the tender process. This establishes the foundation for post-contract cost control of on-site work to prepare interim valuations for contractors and suppliers, as well as claims and final accounts (Hore et al., 1997; Ashworth, 2004; Ashworth & Hogg, 2007;Ashworth *et al*., 2013). However, this approach is only employed for building fabrics and finishes by QS while Prime Cost (PC) Sums are allocated for BS works (such as lifts, heating systems, air-conditioning systems, and electricity supply systems) because they are not designed by the architect (Oforeh, 2008; Babalola & Adesanya, 2008; & McCaffrey, 2011).

Building Services

Building Services (BS) is a term that encompasses all mechanical and electrical service systems installed to provide the desired comfort levels in a building. The building envelope aids in achieving these comfort levels through the design and installation of BS. Thus, buildings must be designed with essential features that deliver the expected comfort level to occupants and meet environmental standards. These features include a balance of space temperature, lighting, humidity levels, efficient communication capabilities, convenient power supply, high-quality sanitation, and reliable system installations to protect both occupants and property.According to McCaffrey (2011), BS comprise all engineering systems associated with buildings, excluding civil and structural engineering works. Tao and Janis (2001) categorised BS into Mechanical Systems, Electrical Systems, and Building Operation Systems, as shown in Table 1.

Table 1: Building Services Components in Buildings

Mechanical Systems	**Electrical Systems**	**Building Operation Systems**
▪ Heating, ventilation and air conditioning ▪ Site utilities: water supply, sanitary disposal, gas supply, etc ▪ Plumbing: water distribution, water treatment, sanitary facilities ▪ Fire protection: water supply, stand pipe, fire and smoke detection, automatic sprinklers, etc ▪ Special systems	▪ Electrical power: normal, standby and emergency power supply and distribution ▪ Lighting: interior, exterior, and emergency ▪ Auxiliary: telephone, signal, data, audio/video sound, fire alarm, security systems, etc ▪ Special systems	▪ Vertical transportation systems: lift and escalators, elevators and material moving systems. ▪ Processing: production, kitchen equipment, ▪ Automation: environmental controls, management, etc ▪ Special systems

Source: Tao and Janis (2001)

In addition to the costs associated with BS components, accommodation space for these components is crucial. Space requirements for medium and large vertical and horizontal ducts might necessitate the creation of underground subways within a building, the utilisation of raised access floors, and sufficient accommodation for suspended ceilings, equipment, and appliances. All these factors carry cost implications, which could significantly increase the overall expense of the BS components.

Subservient Nature of Building Services Installations

The installation of BS inherently depends on the building works, which results in a subservient role for BS. The services designer collaborates with the architect, the BS cost plan follows the primary building cost plan, and the main contractor supervises the BS trade subcontractor. Consequently, the services team must often adapt to these predetermined conditions, limiting opportunities for optimisation. Historically, BS were typically not included in building designs and constructions. For instance, in ancient civilisations such as Egypt and Rome, buildings were primarily designed for structural integrity and aesthetic appeal, with minimal consideration for BS. Heating, ventilation, and sanitation were often introduced as afterthoughts, leading to inefficient retrofitting and increased costs.

Mr. Vice-Chancellor, you will also recall that in days of old, clay pots elegantly balanced on villagers' heads were used to fetch water from meandering streams. Food for the household was prepared in a rustic kitchen setup featuring a three-stone fire pit, with a large pot suspended over the fire. The flame was provided by skilfully arranged firewood to complete the cooking process. For toilet purposes, secluded spots were usually chosen where foliage ensured privacy, and simple tools such as a hoe or trowel were employed to dig small pits for waste to return to nature. As night falls, only the soft glow of oiled lamps placed on wooden tables and a long-raised platform provides lighting. Community meetings are held in an open space surrounded by tall trees, where community members gather for discussions, and the sound of drums enhances the vibrant atmosphere as everyone shares their thoughts before making decisions.

However, in the modern day, the reliance on fetching water from streams has shifted to built-in plumbing systems. Modern buildings typically feature advanced water supply networks that provide reliable, clean drinking water through taps and bathrooms. Such systems reduce the physical labour associated with water collection while improving hygiene and accessibility. Traditional cooking over firewood has given way to modern kitchens with gas or electric stoves and ovens. Modern kitchen designs often include proper ventilation systems, enhancing comfort and reducing smoke-related health issues. Using bush toilets has evolved into formal sanitation systems with restrooms and sewage disposal.

Accordingly, contemporary buildings integrate plumbing solutions that ensure proper waste management, reducing health hazards and enhancing overall sanitationfinishes (**Amuda-Yusuf** & Mohamed, 2012). This shift contributes to better public health outcomes and environmental cleanliness. The reliance on oil lamps for light has transitioned to electric lighting in buildings. This change not only improves visibility but also enhances safety and security, allowing for extended productive hours and community activities after dark. The open spaces previously used for community gatherings have been reimagined as multipurpose rooms or auditoriums (for the University Community). These spaces often facilitate various activities, from meetings to cultural events, fostering community engagement in a more structured and accessible environment.

Consequently, the integration of BS was introduced late in the design process because architectural considerations prioritised aesthetics and spatial form over essential services, resulting in spatial constraints and operational inefficiencies. Even in the post-war era, despite significant advancements in BSsystems, architects and engineers continued to operate in silos, which further delayed the integration of BS.Typically, the BS designer begins work only after the architects have finalised the architectural drawings. This delay often prevents QS from obtaining adequate design information for accurate quantification and costing at the tender stage.

The reliance of BS installations on the structural framework emphasises their subservient role during construction. Although BS installations exist in nearly all building types, the UK construction industry—which has influenced Nigerian construction practices-did not formally recognise BS engineering as a distinct professional discipline until the establishment of the Chartered Institution of BS Engineers (CIBSE) in 1976 (Francis, Yik, Lai, Lee, & Chau, 2012).

BS are complex and reliant on completing other critical building elements, such as fabrics and finishes (**Amuda-Yusuf** & Mohamed, 2012). The complexity of BS projects necessitates a division of roles and responsibilities among the client, design team, specialist designers, contractors, and specialist subcontractors (Lam, Gibb, & Sher, 1997; Lam, 2006). These participants enter the BS project life cycle at different stages, each with distinct roles, responsibilities, risk management capabilities, and capacities for bearing risk, which may conflict. This situation leads to significant interface risks within the project team, materialising throughout the project's life cycle (**Amuda-Yusuf**, Adebiyi, Olowa, Oladapo & Olorunoje,2017a).

According to Hall and Greeno (2009), BS encompass specialised work that is discrete and inherently complex. Architects tend to concentrate on aesthetics, structural engineers on loads and stresses, QS on costs, services engineers on internal environmental factors, and services subcontractors on production methods (Barton, 1983;Gura, 1984). Consequently, most BS frequently fail to meet clients' requirements due to faults in the pre-design and design phases, defects in the installation stages, and malfunctions during testing and commissioning (Babalola, 2012). A case in hand is this auditorium e; the building services represent the least appealing aspect of the auditorium due to their subservient nature. Perhaps the design inadequately integrates them, and the quantity surveyors failed to plan their costs appropriately alongside the auditorium's fabrics and finishes. Consequently, BS components appear clumsily exposed as an afterthought in the available spaces.

Amuda-Yusuf, Adebiyi, Olowa, and Olorunoje (2017b) identified the absence of a distinct professional discipline for BS as a key risk factor affecting project performance in North-central, Nigeria. This delay in professional recognition has had lasting consequences, including: difficulty in clearly defining the required breadth and depth of technical knowledge and skills in BS; gaps in academic programs, limiting the comprehensive education of upcoming professionals in BS; insufficient professional development opportunities for graduates and junior practitioners to stay abreast of industry advancements; and a lack of integration between building fabrics, finishes, and the components of BS, resulting in design inefficiencies (Francis, Yik, Lai, Lee, & Chau, 2012).

Thus, the complex nature of BS has contributed to increased project costs, inefficient spatial allocation for services, and reduced system performance, as services are often forced to conform to predefined architectural layouts rather than being strategically integrated from the outset. The resulting challenges were identified as design-related problems and coordination problems as treated below**Amuda-Yusuf**, Adebiyi, Olowa, & Olorunoje (2017a):

Challenge I: Design Related Problems

Drawings serve as a principal method for conveying design information and clients' requirements for BS projects among project stakeholders. BS design activities can be undertaken by various types of organisations, including consultants who focus solely on systems design, manufacturers who design and produce, and installers who design and execute (Churcher, 2009). Essentially, the final design originates from a specialist designer, contractor, or manufacturer, who are often not involved in the design development stages.

In many instances, valuable ideas are withheld by specialist contractors (HVAC, IT, Security and Communications, Plumbing, and Fire Fighting)to secure a competitive advantage during the tender process (Buys & Mathew, 2005; Rawlinson & Dedman,2010), resulting in a lack of understanding of each other's problems (Michie, 1981) which makes it challenging for design consultants to optimise design solutions (Churcher, 2009). Furthermore, in most cases, these specialist engineers are not adequately represented in the conditions of engagement, forms of contract, and actual management of BS projects (Pavitt & Gibb, 2003).

Design-related problems and coordination issues are regarded as risks because the lesser the amount of information available at the early design stage of a construction project, the higher the level of risks and uncertainties (Odeyinka, Weatherup, Cunningham, McKane, & Larkin, 2010). Therefore, insufficient design information is a potential risk source that could hinder achieving the BS project objectives. The complex nature of BS makes risks unavoidable in their design, and determining the amount of risk deemed acceptable poses a challenge for the designer (Mok, Tummala, & Leung, 1997). According to Lam *et al*. (1997), all BS projects carry associated risks, and one of the designer's primary difficulties is managing and mitigating those risks. Risk management involves quantifying the outcomes of alternative decisions and ensuring that the decisions made today provide a satisfactory basis for future decisions (Marsh, 2003).

Challenge II: Coordination Issues

According to **Amuda-Yusuf**, Adebiyi, Olowa, & Olorunoje, (2017a), the likely areas of conflict arising from lack of coordination include: services conflicting with the structural frame; discrepancies in dimensions as stated on different drawings; improper reservation of holes; conflicts between two or more services; discrepancies between the actual equipment dimensions and those in the detailed design; differences in equipment location; improper sequencing of works; difficulties in identifying access points and services; challenges in supporting and fixing services; insufficient space for completing adjacent finishing works; and difficulties in inspection, commissioning, and maintenance.

According to Marsh (2003), no standard contract forms fully acknowledge the complex interrelationships necessary to successfully install BS in construction projects. The main shortcomings of these standard forms of contract concerning services include a lack of interconnectivity among the various contracted parties; absence of defined design responsibility; insufficient provisions for commissioning and/or testing; lack of provisions for the contractor’s design portion; inadequate provisions for detailed costing beyond capital cost; and lack of maintenance or system operation provisions (**Amuda-Yusuf**, Adebiyi, Olowa, & Olorunoje, 2017b). **Amuda-Yusuf**, Mohamed, Yusof, and Misnan (2014a) explained that this lack of standardisation, coupled with the dominance of imposed conditions set by the main contractor, creates a chain of liability that prohibits a direct contractual relationship between the client and subcontractor.

Amuda-Yusuf, Adebiyi, Olowa, and Olorunoje (2017a) highlighted that failures in coordinating BS design could impact installation time, costs, delays in other trades, cooperation among parties, and the standard of workmanship. Furthermore, design coordination problems not recognised during the design process may become apparent during installation (Churcher, 2009). For example, a clash between ductwork and a structural beam will require time for a design solution, which could involve revising calculations, updating drawings, obtaining approvals for the redesign, reordering materials, reinstalling the ductwork, and reprogramming.

However, during installations, addressing design coordination issues can incur additional costs, including those from drawing time, incidental items (retaining scaffolds for longer periods), and costs associated with variations (Michie, 1981). The time required to resolve coordination issues could lead to critical delays in trades or activities (Michie, 1981;Churcher, 2009). **Amuda-Yusuf** and Mohamed (2012) and **Amuda-Yusuf** and Mohamed (2014b) opined that the persistent delay in integrating BS has led to: increased project costs due to rework and last-minute modifications; sub-optimal routing of ductwork, plumbing, and electrical systems; and performance inefficiencies caused by forced adaptation of services to architectural layouts rather than strategic early-stage planning.

Neglect of Cost Management in Building Service

Mr. Vice-Chancellor, in Nigeria, there is a lack of evidence indicating that quantity surveyors (QS) are effectively demonstrating leadership in the cost management of building services (BS), in contrast to their management of building fabrics and finishes. Clients have expressed dissatisfaction with the cost management of BS (**Amuda-Yusuf**, Adebiyi, & Olowa, 2016). This study explored the extent of QS involvement in the cost management of BS in North-central, Nigeria. They revealed a surprising lack of a structured approach to establishing reliable budgets for BS, particularly concerning a balanced distribution of expenditure among various components.

The fundamental reason for this disconnect appears to be that quantity surveying education has evolved with a greater emphasis on building fabrics and finishes, often neglecting the associated technologies relevant to BS (**Amuda-Yusuf** & Mohamed, 2012). Meanwhile, the roles of QS in BS are expected to reflect the involvement, commitment, and expertise demonstrated in the cost management of building fabrics, finishes, and other construction products (**Amuda-Yusuf** & Mohamed, 2014).

Traditionally, QS overlooks BS's detailed cost management because the designs for these services are not always finalised by the time the tender documents are prepared. Consequently, the specialised nature of BS leads to the allocation of both provisional and prime cost sums (**Amuda-Yusuf** & Mohamed, 2012). This methodology renders it exceedingly difficult and risky for the QS to manage the costs associated with BS. The traditional approach of allowing prime cost sums based on historical cost data was effective in the past because the systems previously comprised familiar plants, equipment, and components arranged in tried-and-tested configurations to fit within the building fabric.

This approach will fail in modern buildings, as BS is integrated with ICT and essentially linked to building energy efficiency, reduction of carbon emissions, workplace productivity, health and wellbeing, planning, and sustainability (**Amuda-Yusuf**, Raheem, Adebiyi, & Abdulraheem, 2020; McCaffrey, 2011). These developments have pushed the cost of BS from the traditional 10–30 per cent of the total building cost to 70 per cent of the total cost of buildingsas illustrated in Figure 2.

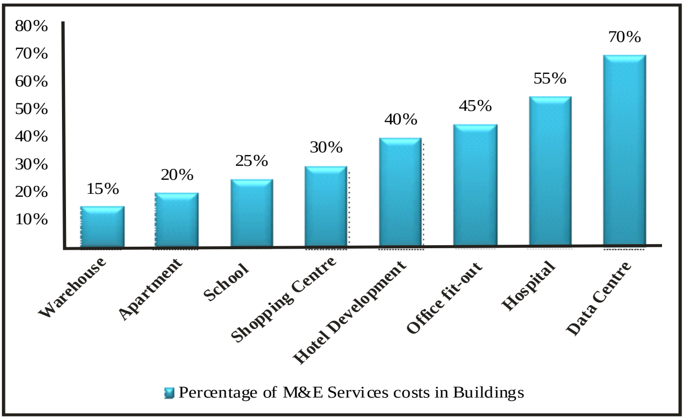

Figure 2: Building Services Costs in Buildings (**Amuda-Yusuf**, 2015)

Providing accurate cost advice is particularly challenging when there is insufficient design information, especially during the early stages of a project for BS. The lump sums established in the BoQs for BS are generally based on the total floor area of previous building projects, which involves a single-purpose deterministic estimate, alongside statistical and historical cost data, as well as the types and uses of the buildings. Such estimates and cost plans rarely originate from projects with BS that demonstrate similar performance and aesthetic standards, as this information may not be readily available from historical records (Swaffield & Pasquire, 2000).

Swaffield and Pasquire (1996) examined the method used to produce budget estimates for BS by assessing the ease of use and appropriateness of historical cost data for engineering services. They found that the current method of budget estimating for building structure and fabric is unsuitable for BS, and there is a need for a better understanding of the factors that influence the cost of BS. Similarly, Mok *et al*. (1997) studied early price estimation practices in Hong Kong and described the method employed by BS engineers as a single-figure deterministic estimate. They claim that this approach is illogical, cost-ineffective, and reactionary, therefore inadequate for BS projects.

Mok *et al*. (1997) proposed a risk management process as a logical and consistent approach to identifying and making suitable allowances for risk factors in the BS cost estimation process. However, the study did not provide information about specific practices or how the process could effectively manage BS costs in construction projects. James (1999) stated that a single price rate estimate can only be applied to determine the early costs of building fabrics and finishes; it is unsuitable for site works, special foundations, and BS. He further stated that the cost of BS is rarely consistent from one project to another and, therefore, requires separate attention when preparing the budget estimate.

In a seminal work by Nanayakara and Fitzsimmons (1999), they developed a cost benchmark for BS in the United Kingdom. They examined various methods used to forecast the contract price of BS. They noted that historical and statistical cost information generally used for BS cost estimates lacks quality and consistency, as costs are typically averages for similar installations derived from projects with different attributes. In another study, Buys and Mathews (2005) investigated the capital cost of HVAC systems in South Africa. They found that cost per floor area or cost per unit capacity factors are used to predict the cost of HVAC components. They argued that the method is not sufficiently accurate due to a lack of consideration for the differences between concept designs, buildings, climates, and specifications. They observed that each subsystem of HVAC (design techniques, building layout, and reticulation route) contributed significantly to the installed cost, and none of them can be disregarded.

Babalola and Adesanya (2008) examined the factors influencing the preparation of cost estimates for electrical services in Nigeria. The authors identified four key factors impacting this process. These are estimators' competence, project technicality, economic requirements, and contract conditions. They further described estimators' competence to encompass the completeness of pre-contract design, design complexity, estimators' knowledge and expertise, project size, scope, installation scale, quality of information, and estimating methodologies employed. Design-related problems and coordination issues are regarded as risks because the lesser the amount of information available at the early design stage of a construction project, the higher the level of risks and uncertainties (Odeyinka, Weatherup, Cunningham, McKane, & Larkin, 2010).

Amuda-Yusuf, Adebiyi, Olowa,and Olorunoje (2017b) evaluated and ranked the risk factors based on their impacts on cost and time performance in BS projects and found that, high foreign material content, poorly prepared tender documents, late involvement of BS engineers, non-involvement of specialist designers, changes in government policy, poor specification, and inadequate coordination of design input (Table 2) are the most important risk factors affecting cost and time performance of BS project.

Table 2: Risk Factors with a High Probability of Occurrence

Risk Factor	**Risk Probability**	**F-Stat**	**P-Value**
High foreign materials content	5.67	1.646	.533
Poorly prepared tender document	5.54	1.023	.367
Late involvement of the BS engineers.	5.49	1.445	.245
Non-involvement of specialist designers	5.49	2.128	.149
Government policy change	5.30	.584	.562
Poor specification	5.75	2.883	.065
Poor coordination of design inputs	5.29	1.174	.421

Amuda-Yusuf, Adebiyi, Olowa, and Olorunoje (2017b)

Amuda-Yusuf, *et al* (2017b) furthercategorised the risk factors into five main components: pre-contract risks, post-contract risks, client-related risks, procurement risks, and external risks. They argued that classifying the risk factors can highlight significant issues that demand the attention of project participants. This classification will enable the client and contractor to acknowledge the high-risk areas within BS projects and allocate responsibility for those risks to the party or parties best able to control them. The distinctive nature of BS projects poses challenges for cost consultants in establishing a reliable budget in a standardised format, compounded by the lack of uniformity in practice (**Amuda-Yusuf** & Mohamed, 2014). **Amuda-Yusuf** and Mohamed (2012) argued that the consequences of these varying practices include substandard tenders, discrepancies between bills of quantities and drawings, insufficient pricing information, challenges in agreeing on variations, disputes, delayed project delivery, and cost overruns. Therefore, the following propositions are put forward to enhance cost management of BS:

1. Value Engineering methodologies to meet clients' requirements in BS projects (**Amuda-Yusuf**, 2009; **Amuda-Yusuf**, Adebiyi, & Oyewumi, 2015; **Amuda–Yusuf,** Sanni, & Olowa, 2015).
2. A standard-based pricing mechanism (**Amuda-Yusuf** & Mohamed, 2014; **Amuda-Yusuf**, 2012; **Amuda-Yusuf**, Muhamed, & Remeli, 2013; **Amuda-Yusuf**, Mohamed, Yusof, & Misnan,2014a; **Amuda-Yusuf** & Mohamed, 2014b; **Amuda-Yusuf** & Mohamed, 2015).
3. The integration of the rules in measurement standards in BIM (**Amuda-Yusuf**, Adebiyi, & Idris, 2016; **Amuda-Yusuf**, 2018; **Amuda-Yusuf**, Salami, & Adebiyi, (2015); **Amuda-Yusuf**, Adebiyi, Olowa, &Oladapo, 2017).

Value Proposition for Effective Cost Management of BS

Value Engineering (VE) is a structured approach to defining value for a client in achieving perceived objectives. It addresses the overall project goals, questions the project's necessity, and seeks to clarify the clients' priorities in attaining them (Hayden & Pasloe, 1996). **Amuda-Yusuf** (2009) examined the challenges and benefits of applying VE concepts in processing clients' requirements for BS projects. Case study document reviews and interviews with selected industry practitioners in theUK regarding industry practices were carried out. Findings from the study are illustrated in Figure 3.

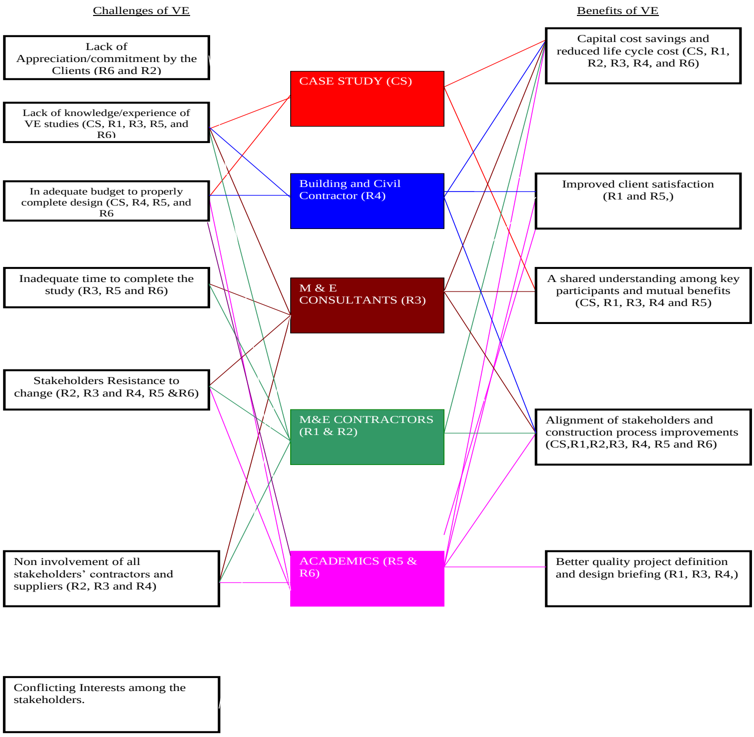

Figure 3: Value Engineering Adoption for Building S*ervices* (**Amuda-Yusuf** (2009)

The study recommended that industry stakeholders educate clients about the significance of VE studies and their associated benefits. Such actions will ensure that the time allocated for the study is planned and budgeted appropriately. Moreover, a collaborative working relationship should be established as early as possible to foster trust among project participants. Such an arrangement will encourage the sharing of successful VE experiences, which can help overcome barriers to implementation. In another study, **Amuda-Yusuf**, Sanni, and Olowa (2015) argued that VE is not well appreciated, and no structured approach is taken for procuring BS through VE.

Practitioners believe that implementing VE could result in substantial savings in capital and life cycle costs for buildings, alignment of stakeholders' objectives, enhancements in the construction process, improved client satisfaction, and a shared understanding among key participants. A model for implementation was created based on the Royal Institute of British Architects Plan of Works, shown in Figure 4, highlighting the need to involve everyone in the BS supply chain when the building design is about 5% complete to use value engineering principles in developing the client's business case and to keep using these principles until the design is finished.

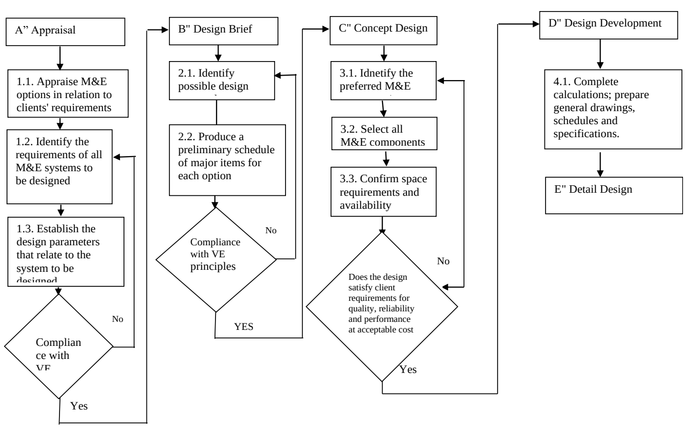

Figure 4: Value Engineering Implementation Model
Amuda-Yusuf, Sanni, and Olowa (2015)

It was also discovered that VE could be included in the planning of BS and the choice of components to solve design and coordination problems before and after the BS procurement process. Similarly, **Amuda-Yusuf**, and Adebiyi (2015) opined that the primary obstacles to adopting VE for BS include a lack of understanding of VE among client organisations, insufficient service requests, and inadequate study time. Furthermore, **Amuda-Yusuf** and Adebiyi (2015) pointed out that the functional logic diagram (see Figure 5) in the value engineering process could be adopted to analyse the quality of BS in a way that QS could comprehend. That this would bridge the gap between QS' knowledge and BS technology, enabling a more detailed analysis of BS costs, facilitating the collection of more relevant historical cost information, and allowing QS to make better use of BS cost information.

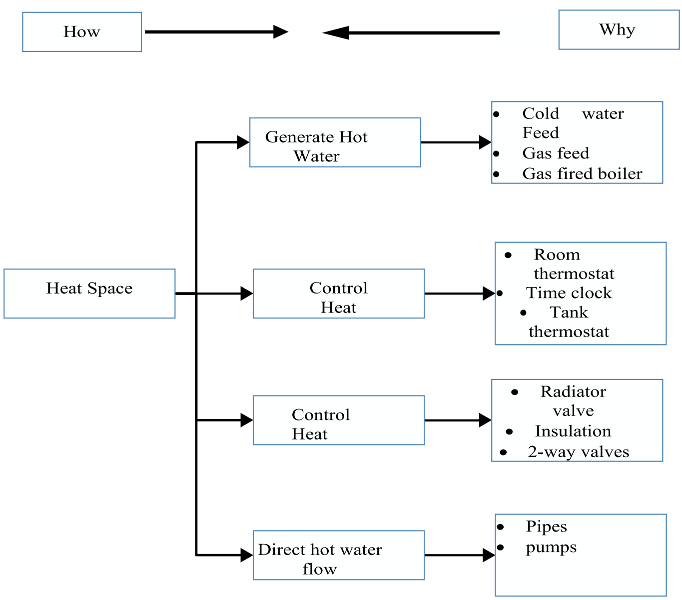

Figure 5: A Function Logic Diagram of BS Heat Installation
Source: Marsh (2003)

Adopting Standardised Measurement Methods

Amuda-Yusuf, Adebiyi, and Olowa (2016) argued that the pre-contract cost management roles performed by QS are limited to using single-purpose approximate estimating methods, statistical methods, and historical cost information to advise clients on the cost of BS project. In the post-contract phase, QS prepare interim valuations, assess variations, manage claims, and prepare final accounts based on bills of quantities prepared by Services Engineers. QS failed to address the gap in effectively managing the costs of BS projects, making it challenging to provide cost advice for comparative design solutions and alternative BS components and installations.

The study recommended collaboration between QS and service engineers from the inception of BS project to enable them to acquire a deeper knowledge and comprehensive understanding of the technology involved in BS components.

Amuda-Yusuf and Mohamed (2014) opined that the most widely used estimating method for BS during the design phasewas the superficial area method, followed by the unit method and approximate quantities. Standard-based detailed measurement was the least utilised method. Practitioners believed that adopting the Standard-based Pricing Mechanism (SBPM) could enhance the quality of BS price forecasts; ensure active post-contract cost monitoring and control; promote collaborative working relationships; improve efficient whole life cycle cost management; enhance risk management; and facilitate an efficient tendering process.

Mr. Vice-Chancellor, **Amuda-Yusuf**, Muhamed, and Remeli (2013) explored the hindrances to the adopting a uniform pricing mechanism (UPM) for BS in the Malaysian construction industry, focusing on the perspectives of QS, mechanical engineers, and electrical engineers. Ten significant factors were recognised as barriers to implementing UPM for BS. The seven most critical obstructive factors, ranked in order of significance, are: difficulty in interpreting the existing measurement standards by design consultants; late involvement of BS design consultants; insufficient skills by QS in BS technology; services drawings are often not ready for billing at the tender stage;absence of a generally accepted measurement standards for BS; resistance from certain service engineers towards QS' involvement in cost management of BS; and incorporation of specialist contractors’ design aspects into BS projects.

The study argued that the quality of information available during the early stages of a project is inadequate to enable the application of detailed measurement rules. In addition, services drawings are frequently incomplete due to the late engagement of BS consultants, and specialist designers are usually not involved until a contract has been awarded. **Amuda-Yusuf**, Mohamed, Yusof, and Misnan (2012) proposed a framework for enhancing cost management of BS, addressing issues such as the lack of coordination and technical skills among practitioners. The study revealed that different consultants employ varying methods, without reference to measurement standards. This variability complicates tender evaluation, increases costs for contractors, and leads to disputes and delays.

Accordingly, **Amuda-Yusuf** and Mohamed (2015) investigated the necessity of developing measurement standard for BS suitable for the Malaysian construction industry. Findings from the study revealed that the physical state of BS components is the most significant factor, followed by the dimensions of the components and their shape. **Amuda-Yusuf** (2015) designed a six-step implementation framework to guide industry practitioners in developing a Building Services Measurement Standard (BSMS) that reflects the preferences of industry experts while accommodating evolving industry requirements. The six stages are:

1. **Understand Current Industry Practices:** This involves examining existing practices in cost management of BS to identify issues and areas for improvement.
2. **Identify Stakeholders and Resources Required:** This stage focuses on identifying the key stakeholders involved in BSMS development and securing the necessary resources, including funding and expertise. Key stakeholders include professional bodies (BQSM, RISM, ISM, MBAM, CIDB, and JKR), government departments, contractors, manufacturers, and academia.

3. **Determine Features of BSMS:** This involves capturing the views of all relevant stakeholders to determine the desired features of the BSMS, including its structure, item descriptors, and units of measurement.
4. **Align BSMS with Classification and Coding:** This stage focuses on aligning the BSMS with established classification and coding systems to ensure consistency and facilitate data exchange.
5. **Produce Draft of BSMS:** This involves developing a draft of the BSMS based on the information gathered in the previous stages. The draft BSMS is then tested on pilot projects to assess its effectiveness and identify areas for improvement.
6. **Implement BSMS:** This final stage involves implementing the BSMS in the industry through education, training, and promotion.

To be acceptable however, the BS measurement standard must reflect the preferences of local practitioners and be adaptable to emerging industry requirements (**Amuda-Yusuf**, Mohamed, Yusof, & Misnan, 2014a). The purposes of this standpoint are twofold. The specialist nature of BS dictates that design responsibilities are shared among clients, design consultants, specialist designers, and sometimes contractors (**Amuda-Yusuf** & Mohamed, 2014b). The service engineers have argued that not all items of BS contained in existing measurement standards can be measured, as this may lead to unnecessarily lengthy bills of quantities (**Amuda-Yusuf** & Mohamed, 2012).

Further more,**Amuda-Yusuf**and Mohamed (2015) pointed out that the measurement standards for BS may need to adopt a more inclusive approach to the measurement process, similar to the Civil Engineering Standard Method of Measurement (CESMM), to reduce the number of items that require measurement. It is critical that the development of the BSMS involves a combination of knowledge and expertise from BS engineers, QS, specialist designers, and contractors to ascertain the significant cost attributes of BS to be measured. Secondly, **Amuda-Yusuf** and Mohamed (2015) stated that BIM represents a shift from traditional two-dimensional design practices to three-dimensional design solutions, four-dimensional schedule modelling, and five-dimensional (5D) cost management.

Their study revealed that the 5D BIM may necessitate filtering the rules of measurement into the BIM model to facilitate the automation of quantity extraction and estimating processes by cost consultants and estimators, in accordance with traditional QS practices. To address these needs, BSMS may need to be based on local classification systems, which would support local practitioners' preferences and establish a foundation for collaboration between QS and cost consultants in the BIM model (**Amuda-Yusuf**, 2018).

Integration of Building Information Modelling in Measurement Standards

Mr. Vice Chancellor, BIM is transforming the traditional methods (such as manual quantity extration and estimating) used within the construction industry. It is clear that different disciplines possess varying interests in BIM. For example, architects are keen to leverage BIM's potential to enhance their 3D design capabilities (RIBA, 2012). BS engineers seek efficient methods for calculating energy consumption. Structural engineers aim to achieve greater integration between analysis and design (Arayici *et al*., 2012). In addition, it is vital for QS to establish a foundation for automated take-off and estimating within the BIM model (RICS, 2014). This is important because automated quantity take–off is easily conducted in BIM, but not in line with traditional measurement rules, due to a lack of alignment between conventional SMMs and the BIM model (**Amuda-Yusuf**, Adebiyi, & Idris, 2016).

Amuda-Yusuf, Adebiyi, Olowa, *et.al.*, (2015) examined the barriers to 5D BIM adoption by QS in Nigeria. The study identified the five most important barriers affecting the BIM by QS as: lack of collaborative initiatives from industry stakeholders; issues with communication and data sharing among firms; insufficient government support; andabsence of a clear roadmap for BIM implementation.

The BIM model is incompatible with traditional take-off and estimating software tools, and there is a non-alignment of the current roles of the Building and Engineering Standard Method of Measurement **Amuda-Yusuf**, Mohamed and Olowa (2013). The authorsconsidered that 5D BIM has the potential to enhance communication efficiency and the interpretative ability of QS. However, for these benefits to be realised, it is essential for construction industry stakeholders to formulate strategies for developing and implementing an information exchange system that can support collaboration(**Amuda-Yusuf**, Olowa, & Sidiq, 2015).

Similarly, **Amuda-Yusuf**, Mohamed, Ibrahim, and Olowa (2013) examined the necessity for measurement standards in Nigeria to align with the local information classification system, thereby promoting consistency with other domestic product information and naming conventions. Findings from the study revealed that different countries have adopted varied classification approaches, which are based on country-specific classification systems to develop local measurement standards, consequently facilitating electronic information coordination among project participants. Adopting the classification systems in measurement standards from other countries may not fulfil the requirements of local industry practices (**Amuda-Yusuf**, Adebiyi, & Idris, 2016).

Amuda-Yusuf, Adebiyi, and Olowa (2017) investigated the perceptions of Nigerian construction industry professionals' regarding the barriers to BIM adoption. Class means difference among the professional groups (Architects, QS, Engineers, and Builders) was used to pinpoint barriers to BIM adoption, and a discriminant analysis was performed to establish the disagreement among the respondents. Findings from the study revealed that the various groups have equal mean discriminant function scores on 16 barrier factors to BIM adoption, indicating a consensus among the groups regarding these factors. However, five items exhibited the most significant predictive power in differentiating the professional groups based on perceived barriers to BIM adoption. In order of magnitude, the five factors are: clients' low level of awareness, lack of funding, poor power supply, legal uncertainty, and lack of transparency. The barrier factors identified in this study will assist industry stakeholders in formulating appropriate strategies to overcome them to ensure successful BIM implementation.

Amuda-Yusuf, Adebiyi, and Muhammad (2018) examined the level of awareness and adoption of BIM among professionals in the Nigerian construction industry. Findings from the study revealed that the traditional Design-Bid-Build approach remains the most common method. Significant differences exist in the level of BIM utilisation among the professional groups for various projects. More than half of the respondents (excluding engineers) reported that they had not participated in a project that utilised BIM. Only 13% of architects indicated past experience with BIM projects, while 32% of QS, 44.4% of builders, and 61% of engineers have taken part in BIM projects. The study also found that the size of an organisation influences the transmission of information and knowledge. The study indicated that although BIM is gaining traction, its adoption within the Nigerian construction industry remains in its early stages.

In another study, **Amuda-Yusuf** (2018) examined the critical success factors (CSFs) for BIM implementation in Nigeria. Benchmark metrics were developed to rank the success factors. The top five success factors for BIM implementation, in order of importance, are: standard platforms for integration and communication; cost of development; education and training; standardisation (product and process); and a clear definition and understanding of users' requirements. Factor analysis was further employed to group the 28 CSFs into five components, using the rotated component matrix method, namely: industry stakeholders' commitment and knowledge of BIM; capacity building for technology adoption; organisational support; collaborative synergy among industry professionals; and cultural orientation.

The rankings of the CSFs provide the basis for refining the most significant factors that industry stakeholders should focus on for the successful implementation of BIM. Additionally, the underlying relationships among the success factors identified in this study will assist industry stakeholders in determining the best strategy to adopt for implementing BIM at the industry level. The findings emphasised the importance of standardisation, cost management, education, and collaboration among industry professionals.

Integrating Sustainable Enhancement Features in Measurement Standards

The Vice-Chancellor Sir,as the built environment continues to evolve, embracing sustainability within cost management is no longer optional but imperative. **Amuda-Yusuf** (2015) recommended integrating sustainable enhancement features into measurement standards. This is premised on the notion that, the current standard method of measurement does not adequately address sustainability-driven enhancements features, such as energy-efficient HVAC systems, renewable energy integration, and advanced water management solutions. **Amuda-Yusuf** , Mohamed, Yusof, and Misnan (2013) reviewed the role of QS in managing cost of green buildings. The major barriers to effective cost control of green buildings were identified as: lack of a clear green design goal; midstream attempts to incorporate green; decentralised management of the green building process; lack of experience with green buildings; and insufficient time and funding.

Amuda-Yusuf *et.al.,* (2020) also investigated awareness factors contributing to adoption of sustainability concepts during construction in Nigeria. Findings from the study indicated a variation in the level of awareness regarding sustainability concepts based on the type of organisation. Professionals from client organisations demonstrated the highest mean score (3.8) in terms of awareness of sustainability concepts, followed by those from academia (3.6), consulting (3.0), and contracting (2.2). **Amuda-Yusuf** *et.al.,* (2022) examined the critical success factors (CSFs) for the adoption of Green Building Technologies (GBT) within the Nigerian construction industry.

Findings from the study revealed thatthe five most important success factors for GBT adoption as social awareness of GBT benefits; availability of suitable natural environment conditions; availability of a stable economic environment; market demand and competitive advantage; and the technical background of team members. **Amuda-Yusuf** *et.al.,* (2020) identified the most important barriers to GBT adoption as lack of institutions to formulate policies and set guidelines , lack of information about green products and low awareness of sustainability issues, human resource and client knowledge, a lack of knowledge about GBT, and the high costs of green products.

My Major Research Contributions

Cost Management and Procurement of BS

Mr. Vice-Chancellor, during and after my Ph.D. programme, and as part of the requirements for the award of the Ph.D. degree at Universiti Teknologi Malaysia, I was able to publish some articles in reputable journal outlets focusing on cost management of BS. The government of Malaysia, through the Ministry of Higher Education, partly sponsored my Ph.D. in this field. I am pleased to inform you that part of the study's outcomes was implemented in the publication of the Third Edition of Standard Method of Measurement (SMM3) in Malaysia. On October 21, 2024, the Construction Industry Development Board in Malaysia officially launched the Standard. According to my supervisor, unlike the previous editions of measurement standards, SMM3 was developed based on the collective efforts of industry professionals, integrates sustainable enhancement features, and is compatible with BIM. These are key recommendations from my Ph.D. work.

BIM and Information Management

My research on BIM provides actionable insights for both practitioners and policymakers. For practitioners, the findings offer a roadmap for streamlining BIM implementation processes, enhancing team collaboration, and improving information exchange. For policymakers, the work underscores the need for supportive regulations, funding, and the establishment of national standards to encourage widespread BIM adoption. My research emphasises that developing a national classification system aligned with international standards is essential for enabling effective electronic information exchange, promoting better collaboration, and streamlining project delivery in Nigeria.

Book Publication

As the lead author, our *Book on Measurement of Building Works* in line with the 4th edition of Building and Engineering Standard Method of Measurement was published by AFKAR Printing & Publishing Company Limited in December, 2024. Measurement of building works is a fundamental aspect of quantity surveying that holds significant importance for students, practicing, and upcoming QSin Nigeria.Mastering the book ensures cost-efficiency, project success, and career growth. The book bridges theoretical knowledge and practical application, making it indispensable in the construction industry.

Professional Contributions

I have served as the Secretary, Professional Development and Library for the Nigerian Institute of Quantity Surveyors (NIQS) from 2017 to 2021. From 2019 to 2021, I organised a train-the-trainer workshop in Abuja on cost management for BS with the approval of the National Executive Council, under the then President of the NIQS, QS Muhammad Abba Tor, FNIQS, RQS. The workshop training on cost management for BS was conducted concurrently in the six geopolitical zones of the country and later stepped down by the State Chapters of the NIQS in 25 states of the federation, including the Federal Capital Territory. I have also served as the Chairman of the Nigerian Institute of Quantity Surveyors, Kwara State Chapter between 2019 to 2021.

Contributions to the University

At the university, I have served on several committees at the department, faculty, and university levels: I was twice the Acting Head of the Quantity Surveying Department (2016-2018 & 2022-2024), served as Acting Dean of the Faculty from 2018 to 2020, and I am currently the Dean of the Faculty of Environmental Sciences; in my role as Dean, I still teach a minimum of 7 courses per semester with Postgraduate supervisions. I have represented the faculty at the Business Committee of the Senate and served as Level Adviser at various times. I have served as a member of e-learning committee (2016). I am currently a member of the Technical Advisory Committee to the University Management and a member of the Investigative Committee on GGMAX Poultry Farm.

Mr. Vice-Chancellor, I have been the principal consultant on the cost management of the construction of the Faculty of Environmental Sciences buildings since 2016; under my leadership, about 60% of the consultancy fee paid by the university was used to equip a 20-seater capacity computer laboratory for the Quantity Surveying Department. Other departments often use the facilities in the laboratory for accreditation purposes. This effort has significantly improved the teaching of computer applications for quantity surveying to students in the department. The updated cost for completion of architecture and urban and regional planning departments as well as the lecture theatre has been submitted to the university based on request. I hope to continue leading the cost management roleon the projects, once they are finally approved.I have also served as an external examiner at Ahmadu Bello University, Samaru, Zaria; Obafemi Awolowo University, Ile-Ife; Federal University of Technology, Akure; and Federal University of Technology, Minna.

Conclusion

Mr. Vice-Chancellor, my research contributions aim to address the practical challenges in building projects, emphasising the need for technology adoption and sustainability. These insights have been achieved using robust methodological processes, leading to empirical conclusions that provide a foundation for improvements in the construction industry. I am confident that my ongoing research will continue to yield significant insights and lead to practical advancements in the built environment.

The recommendations to be presented here are not exhaustive but rather provide a roadmap for transformative change in the construction industry. By integrating interdisciplinary knowledge, promoting evidence-based practices, and fostering collaboration, the industry can achieve a new paradigm of efficiency, sustainability, and value creation. It is essential for theorists, practitioners, and policymakers to work together to achieve this transformation, as their collective efforts are critical to realising a better future for the built environment and the communities it serves.

Recommendations

Theory and Practice

1. **Integration of Interdisciplinary Knowledge:** Theories that integrate knowledge from engineering, architecture, quantity surveying, information technology, and management are needed. This necessitates a systems-thinking approach to understanding the complex interplay of factors influencing project outcomes. Such a holistic perspective can inform more robust project planning and delivery models.
2. **Embrace BIMwith a Strategic Approach:** The adoption of BIM represents a technological upgrade and a strategic shift in project management. Practitioners should move beyond viewing BIM merely as a software tool and embrace it as a collaboration and information management framework. This includes investing in training and capacity building, establishing clear protocols for data sharing and interoperability, and integrating BIM throughout all phases of project delivery.
3. **Adopt Standard-based Pricing Mechanisms for BS:** Practitioners should implement Standard-Based Pricing Mechanisms (SBPM), which depend on detailed Bills of Quantities (BoQ) prepared according to a Standard Method of Measurement (SMM). This approach will enable more accurate cost estimates, provide a basis for variation valuation, and facilitate improved cost control and monitoring.
4. **Integrate Value Engineering into Project Planning and Design:** VE is not merely a cost-cutting tool but a methodology for enhancing project value by focusing on functionality and life-cycle costs. Practitioners should incorporate VE into the design process, engage relevant stakeholders, and systematically analyse project functions to identify areas for improvement. This will

ensure that projects achieve their performance objectives at the lowest possible cost while considering the project’s sustainability.

5. **Promote Sustainable Practices:** The construction industry should increasingly embrace environmental consciousness. Practitioners should advocate for sustainable practices by adopting green materials, optimising energy and water usage, and implementing waste management plans. This also entails considering the entire life cycle of construction projects, including design, construction, operation, and deconstruction. This will include, for instance, utilising materials with low embodied energy and designing for adaptability and reuse.

Policymakers

6. **Develop and Enforce National Standards for BIM Adoption:** The lack of national standards is a significant barrier to BIM adoption. Policymakers should establish and enforce clear, nationally applicable standards for BIM implementation, including information classification systems that align with international standards. This will necessitate collaboration with industry stakeholders and experts to ensure that the standards are relevant and practical. A common standard will also improve the effectiveness of information exchange.

7. **Support the Development of a Local Measurement Standard for BS:** The lack of a standardised measurement for BS is a critical issue. Policymakers should initiate and back the creation of a local measurement standard for BS that reflects the country's specific practices, materials, and regulatory requirements. This standard should be formulated with input from practitioners and adhere to international best practices.

8. **Promote Education and Training in Sustainable Construction Practices:** The construction workforce must be educated and trained in sustainable construction principles. Policymakers should advocate for educational programmes, vocational training, and continuous professional development courses that emphasise sustainability in construction. This will ensure that professionals possess the skills and knowledge to adopt sustainable practices in their projects. They should also ensure that sustainable development is included in university curricula.

9. **Establish a Robust Regulatory Framework for the Construction Industry:** The construction industry requires a strong and well-defined regulatory framework to ensure transparency, accountability, and ethical practices. Given the sector's pivotal role in economic growth and infrastructure development, the creation of a ***Construction Industry Development Board*** **(CIDB)** is essential. This body would serve as a cornerstone for industry regulation, overseeing standards, quality control, fair pricing, environmental sustainability, safety compliance, and equitable procurement processes. By institutionalising the CIDB, policymakers can provide much-needed stability and professionalism in the sector. To maximize its effectiveness, the Board must operate independently, free from excessive political interference, ensuring impartial enforcement and long-term industry development.

10. **Invest in Research and Development (R&D) with a focus on implementation:** Innovation within the construction industry relies on sustained R&D efforts, yet research must be translated into real-world applications to drive progress. Policymakers and industry leaders should provide dedicated, easily accessible grants and incentives for R&D initiatives that

enhance construction technologies, sustainable materials, and efficient processes. Funding should be substantial enough to support comprehensive research, from experimentation to pilot testing. It is essential to establish partnerships between academia, construction firms, and government agencies to ensure that research findings are tested, refined, and deployed in actual projects. R&D should not merely terminate in publications but should lead to smarter, greener, and more efficient construction practices that benefit both the economy and society.

Acknowledgements

I thank the Vice-Chancellor, Professor W.O. Egbewole, SAN, for the opportunity given to hold this lecture.I wish to appreciate Professor A. A. Fawole (DVC, Management Services and my Family Physician, Professor Mojirade T. Bakare-Odunola (DVC, Academic), Professor M. Etudaiye (DVC, Research, Technology and Innovation), Mr. M.A. Alfanla (The Registrar and Secretary to Council), Professor K.T. Omopupa (The University Librarian),Mr. A.Lawal (The Bursar) and other management staff of this University for this honour.

I thank my late father, Alhaji Amuda-Yusuf Adebayo Adagba. May Almighty Allah continue to have compassion on his soul. To my mother, Alhaja Sinatu Amuda, a virtuous woman of immense strength and grace: your commitment to ensuring we receive a sound education is deeply appreciated. May Almighty Allah continue to strengthen you in health, wisdom, and in His worship. I thank the only brother to my father, late Emmanuel Ajomale (Baba-wolewole) for the childhood discipline instill in us. May God almighty continue to rest your soul. My profound appreciation extends to the late Oseni Taiwo Amuda, and all my late stepbrothers; may Allah continue to grant your souls eternal peace. I also express my gratitude to Alh. Abdullahi Durosinmi Amuda-Yusuf, the Olori-Ebi of the Amuda family, and Mr. Saliu Ajekiigbe Amuda-Yusuf. I sincerely appreciate the love and unwavering support I have always received since childhood.

I appreciate Professor A.O. Omotesho, the immediate past DVC (Academic), for his mentorship and guidance. Emeritus Professor M. A. Akanji, your gentle and simple approach to mentorship is well appreciated. The Chief Imam, Professor Nasir Abdulsalaam, and all members of the University of Ilorin Muslim Community are well appreciated. I humbly express my sincere appreciation to the Pioneer Dean,Professor N.B. Tanimowo, other past Deans, especially Professor A.I. Bako, Dr. Ayo Babalola, Dr. N.A. Bello and staff of the faculty especially, Dr. Maimuna O. Abdulraheem, Dr. Taibat R. Adebiyi. I extend my gratitude to all heads of departments and the Sub-Dean of the Faculty, Dr. S.B. Oladimeji, a colleague like a brother, thank you for your support.

I appreciate all my teachers. I thank my Ph.D. supervisor, Professor Mahdia Sarajul Fikri Muhammad, from the Universiti Teknologi Malaysia (UTM). It is a privilege to be supervised by such a pragmatic academic with immense intellectual prowess and commitment to perfection. I also appreciate the entire team of the Innovative Construction Research Cluster (ICON) at UTM for their support during my Ph.D. programme.

I remain forever grateful to Mrs. Juliana Aduke Alabi, my guardian, during my secondary school days. Mrs. Alabi was an exceptional mother to everyone. Your hard work, generosity, and values remain a beacon that has shaped my journey in life. I extend a special tribute to your late husband, Elder S.O. Alabi; may his soul continue to rest in peace. My warm appreciation goes to Segun Alabi, Olawale Alabi, Taiwo, Dr. Kehinde, and Adekunle Alabi; the memories of our upbringing linger.

Mr. Vice-Chancellor, I would like to sincerely express my appreciation to the distinguished Senator Sule Simeon Ajibola (Boda Sule), a brother, a mentor and seasoned quantity surveyor from whom I drew the inspiration to pursue a career in quantity surveying. Thank you for your generous sponsorship of my M.Sc. degree in quantity surveying at the University of Salford. You remain a beacon of inspiration and a lasting pillar in my narrative of success. I must pay homage to Professor Ahmed Ibrahim Doko (DVC, Administration) of Ahmadu Bello University. Words cannot adequately capture the depth of my gratitude for your immense and transformative impact on my life. I wish to express my profound thanks to my esteemed mentors: Professor Deji Rufus Ogunsemi (former DVC Academic) of the Federal University of Technology, Akure; Professor Henry Odeyinka of Obafemi Awolowo University, Ile-Ife; and Professor Olubola Babalola (DVC, Academic) of Obafemi Awolowo University, Ile-Ife. I sought your mentorship, and all of you provided the necessary guidance. Your encouragement and visionary insight have reshaped my academic career.

My sincere appreciation goes to QS Toyin Abdulrahman Jimoh, a brother from another parent, the Director of the Physical Planning Unit, University of Ilorin. Your encouragement after I completed my Ph.D. aided my decision to join the university. I sincerely appreciate Prof. S. A. Kuranga, who facilitated my appointment. I am eternally grateful to Professor A. A. Ambali for considering me worthy of joining the university; I appreciate Professor Sulyman Age Abdulkareem for appointing me as the Acting Dean of the Faculty of Environmental Sciences in 2018. I am deeply grateful to Mr. Abdulrasheed Dauda Gidado Ajetunmobi, a kind-hearted brother with the milk of kindness; I hold you in high regard.

I appreciate the Faculty Inaugural Lecture Review Board, headed by Dr. T.O.O. Olowa and Dr. S.A. Olaniyan, Dr. Taibat R. Adebiyi. Thank you for your dedication to ensuring quality manuscripts for this lecture. I thank the Chairman of the Faculty Inaugural Committee, Dr. Taibat R. Adebiyi; Dr. S.A. Adeogun, Dr. Aishat T. Abubakar-Kamar and other members. I appreciate the solidarity of other members of the Quantity Surveying Department and the faculty at large. The Nigerian Institute of Quantity Surveyors is highly appreciated particularly the Kwara State Chapter.

Mr. Vice-Chancellor, I must pay homage to the pioneer Faculty Officer, Mrs. Kafilat T. Afolayan, the current Deputy Registrar (Senate), and other Faculty Officers:Mrs. Elizabeth Nnaji, Mrs. Rasheedat Adeta-Babamale, Mrs. Azeezat Q. Ibraheem, the current Deputy Registrar (Vice-Chancellor's Office), Mr. I. Abdulsalaam, Mr. S. Dagbo and Mr. O.J. Olaleye. I appreciate all non-teaching staff of the faculty.

I am profoundly grateful to the Chairman, Library and Publications Committee, for his meticulous efforts in facilitating the delivery of this lecture. I would also like to acknowledge Professor A.A. Adeoye, the Director of the Academic Planning Unit, who has been a special mentor to the entire Faculty of Environmental Sciences. Professor L.T. Ajibade, your unwavering support for the faculty, is immensely appreciated.

In the spiritual realm, I wish to express my sincere appreciation for the support received from the following religious associations: Ikerin-Opin Muslim Community, Ansarul Islam Society of Nigeria, Rahmatul Adabiyyah Muslim Association of Nigeria, and Ali Tantama Al-Kankawi Foundation. I would like to extend special thanks to my spiritual father, Sheikh Al-Imam AbdulRasak Ambali Aduagba, as well as to all the members of RAMAN Worldwide; I am truly grateful for your prayers and the support you have provided to my family. I also appreciate Sheikh Al-Imam Mustapha Musa Kamaldeen and all members of the Ad Dalilul Islamiy group. I appreciate Sheikh Abdulsalam Sadudeen Ajisefini and the entire Ekiti League of Imams. I thank Sheikh Al-Imam Lukman Isalekoto and Shuaib Aliyu Tantama Al-Kankawi. May Almighty Allah bless you all.

In the traditional circle, I wish to express my heartfelt appreciation to the Chairman of the Ekiti Local Government Traditional Council, His Royal Majesty Oba Saliu Abdulkareem Adasofegbe Arowobeku I, as well as to all the other royal fathers within the Ekiti Local Government Area, especially His Royal Highness Oba Joseph Adeniyi Ayodele, Ilufemiloye I, the Alaaye of Iaaye, Ikerin-Opin, and His Royal Highness, Oba Michael Kayode Owolabi, the Alara of Isare-Opin. My sincere appreciation also goes to the Chairman of Ikerin-Opin Development Association, Elder Francis Adebayo and the entire citizen of Ikerin-Opin especial Egbe Ifesowapo Ikerin-Opin.

I extend my heartfelt gratitude to my in-laws from the Baraje dynasty and Ile-Amodemaja of Okelele Ilorin, particularly to my late father-in-law, Alhaji Jimoh Baraje; Alhaja Adisat Maronike Jimoh; Mr. Abdulyekeen Sulyman Amode; Dr. Sherifat Alege; and Alhaja Saratallahi Adebayo. I am also thankful to my in-laws from the Oyewumi family in Offa, especially my father-in-law, Mr. Oyewumi Oyewale Yusuf (Walex), Mrs. Ranti Kuburat Oyewumi, Alhaji Abdulraheem Jide Oyewumi, and Alhaji Rauf Adegoke.

Vice-Chancellor Sir, permit me to appreciate the following individuals, who have played important roles in my career progression: first among them is Prince Tunde Ajibola, Professor Lanre Attanda (CEO National Horticultural Research Institute, Ibadan), Professor Lanre Sulyman, QS Tasiu Mustapha (MD, Afribased Projects Ltd), Alh. Dr. Muideen Olaniyi Azeez-Salako (ODU President), Prince Biodun Adebiyi and the entire Ojokure family, Arc. Abdulfatai Olatinwo, Engr. Oyinlola Muhammed, Hon. Ganiyu Gabriel Abolarin, Dr. Shuiab Abiodun Taiwo, Nurse Rahmotallahi Amosa, Dr. Kudirat Ahmed (Pingbin-pingbin), Hammed Ibrahim Okoki, Engr. Kamilu Bello, and Pastor Mathew Ayanlola Ayodele. I appreciate my siblings: Mrs. Rebecca Oluwayemisi Dada, Folashade Dosunmu, Arc. Sakariya Amuda, Medinat, Sherifat, and Rahmat. I appreciate you all with your families. My children, Maryam Eniola, Abubakar Kolawole, Aisha Oluwabukola, Balkis Abidemi, Rahmatallah Abike, and Nimotallahi Ajoke, thank you for your love, support, and patience.

I am truly grateful to my wives, Amuda Maimunat Okandeji Ayodele (Lekoo); this inaugural lecture holds even greater significance, as it coincides with your birth month, a joyful testament to your enduring influence and the shared milestones of family and scholarship. Thank you for supporting me in marrying your co-wife; and Amuda Aminat Oyedamola, for your enduring love, sacrifices, and unwavering support, which have been the foundation of this achievement. May Almighty Allah reward you abundantly for your support and love. Allahuma Amin.

To those whose names have not been mentioned, please know that your contributions to my journey are profoundly significant, and I am eternally grateful. To everyone who has attended this lecture, I am sincerely thankful; may the good Lord guide you to your destinations safely.

Wa'akhiru Dahwana, Anil amdul-Lilaahi, Robbil Aalameen!!!

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