Journal of Engineering and Technology for Industrial Applications

ITEGAM-JETIA

Manaus, v.7 n.32, p. 44-49. Nov/Dec, 2021

DOI: https://doi.org/10.5935/jetia.v7i32.787

ISSN ONLINE: 2447-0228

RESEARCH ARTICLE OPEN ACCESS

BUILDING INFORMATION MODELING (BIM) AND QUANTITY SURVEYING CONSULTANCY SERVICES IN NIGERIA

Reuben A. Okereke[1], Nneka Mercyjane Ihekweme*[2] and Imoleayo A. Awodele[3]

[1] Department of Quantity Surveying, Imo State University, Owerri, Nigeria.
[2] Quantity Surveying Department, Federal University of Technology, Owerri, Imo State, Nigeria.
[3] Construction Management and Quantity Surveying Department, Durban University of Technology, South Africa.

[1] http://orcid.org/0000-0003-1337-8179, [2] http://orcid.org/0000-0002-1549-6307, [3] http://orcid.org/0000-0003-1602-7294

Email: raphica2013@gmail.com, *nnekamercyjane@gmail.com, a.imole@yahoo.com

ARTICLE INFO

Article History
Received: November 30th, 2021
Accepted: December 07th, 2021
Published: December 15th, 2021

Keywords:
Building Information Modeling,
Quantity Surveying,
Quantity Surveyor,
Construction.

ABSTRACT

In the growing Sustainable construction business, Building Information Modelling (BIM) represents a new paradigm. This new paradigm shift needs to be embraced by quantity surveyors to remail globally competitive. The construction industry has seen a many advances, including ecosystems, construction software, building information modeling (BIM) and augmented reality among others. As a result of these developments and evolutions, new tools, procedures, and software have been developed to help construction professionals be more productive. For potential integration into the life cycle of construction projects, BIM has advantage, which will enable it to become a reference point for construction projects and, as a result, it will be a vital instrument in project procurement in the future. As a result, major functions of Quantity Surveyors (QS) in BIM-based construction procurement would be significantly different from what they are now. There are concerns that BIM adoption could jeopardize the profession of Quantity Surveying. Understanding the possible expansions of QS positions in BIM-based project delivery is essential. Therefore, this study submits the review of role and responsibility of Quantity Surveyors in the adoption of BIM in Nigeria with a few to outlining the derivate benefits of its adoption.

I. INTRODUCTION

Surprisingly, the construction sector is ladened with traditional –based mode of operation that mainly relies on using of documents made by paper with huge fragmentation among stakeholders. [1, 2]. According to [3]. this type of conduct has forced the construction industry into inefficiency and a lack of willpower to use information communication technology. In the way projects are completed, construction industry is on the zenith of a major transformation. This move has the potential to dramatically improve construction process and the design. Sustainable design building and BIM are two major industry trends that are propelling these improvements [4]. Inefficiencies of Construction industry has the following drivers: issuing specifications and drawings at many stages from consultants to the contractor, stratified approach and inadequate design coordination. [5]. At planning and design stages, the most important decisions about a building's sustainable design can be made. More activity in the construction industry has centered on BIM and sustainable design ideas as the value of BIM has grown. [6] BIM is a vital component in minimizing industry waste, such as wasted energy, providing value to industry products, and reducing environmental damage [7]. High design performance facility and the practice of traditional design can be changed by combining BIM technology and sustainable design strategies as submitted by [8]. According to [9]. Building information technology has the technological capability of enhancing the efficiency and productivity of construction project problem in terms of project delivery. [10]. added that Building information modelling can optimize stakeholders' performance and platform for integrating

construction Industry, engineering and architectural that is fragmented.

Quantity surveyors, on the other hand, must be kept informed about the significant benefits that this BIM paradigm change will offer. As a result, QS must become familiar with BIM-based project delivery. This will pave the path for present Quantity Surveyors to get the skills and competencies they need to ride the next global wave of sustainable development and stay at the forefront of the business. If quantity surveyors want to remain competitive globally, they must be willing to embrace and adopt any construction industry innovation. According to [11]. the construction industry has witnessed a lot of improvement, including ecosystems, augmented reality, building information modeling (BIM) and construction software among others. As a result of these developments and evolutions, new tools, procedures, and software have been developed to help construction professionals be more productive. BIM has become one of the most popular construction technologies in the last decade [12]. According to [13]. BIM is a process for developing, managing, storing, exchanging, and sharing interoperable building information. This automation, which has been studied through the usage of BIM, has aided in cost estimation efficiency, among other things [14].

To achieve an effective performance of quantity surveying services, firms of Quantity Surveying are established which provides structure of an organization. These services include final account preparation, cost control, variation assessment, cost planning and estimating, negotiating contacts among others. [15]. The way QS firms are structured in Nigeria is synonymous to fragmentation in that about twenty-five percent of the firms have between 8 to 15 staff, Sixty-percent have 1 to 7 staff, while small firms account for fifteen percent have staff strength more than 15 number [15]. The study conducted by [16], blamed the fragmentation witnessed in the firm of QS on construction sector weakness which has the tendency to deter performance improvements. Non -existent is the study that examined adoption of Building Information Modelling among quantity surveyors when discharging their duties in the Nigerian construction industry. Therefore, this study asked the following questions. (1) What benefit can QS firms derived from adopting BIM ?(2) What are the associated challenges towards it application? (3) How applicable is BIM to QS firms and finally What are the practices in use among the Nigerian QS firms?

I.1 BUILDING INFORMATION MODELING CONCEPT

The desire to generate correct construction details of a building planned in a complex form sparked the development of 3D modeling [17]. BIM was first introduced in the 1990s, and it has provided the construction sector with numerous benefits. BIM has progressed from a software to an integrated system. Information technology (IT) solution provider is BIM which is used for combining software applications and IT tools to design a building in a common platform without depending on the utilization of software [18]. The emergence of BIM has resulted in a significant shift in how operations are carried out in the sector. According to [19]. BIM saves qualitative data and quantitative data. As a result, BIM allows estimators to export to specialist costing platforms without having to perform significant additional computations on design quantification of elements. BIM primary concept is based on the necessity to create a platform that addresses 2D computer-aided design (CAD) technologies' shortcomings by assuring a collaborative platform that puts all building information into a single file that can be exchanged and used by all project stakeholders [20]. According to several studies, the notion of BIM lacks a clear definition. According to [21], because to its developing nature, the idea of BIM has no approved definition.

The collaborative effort of all the BIM characteristics discussed thus far, according to [22], is an evolution that can solve problem which allows designers to optimize designs easily with visualizations, analyses, and simulations resulting in higher-quality construction documentation. The building's major IT-based information system promotes and unifies all of the building's designs and functions. The introduction of BIM marks a watershed moment in the built environment, removing the hurdles that all professionals face. BIM provides a comprehensive perspective of a project, from beginning to completion, even before completion, allowing for the mitigation of any recognized risk.

I.2 OVERVIEW OF QUANTITY SURVEYING FIRM

Quantity surveyors are employed in all aspects of the built environment around the world [23]. Because of the industry-wide influence and effect on project baseline, customer happiness, operational dynamics, and management efficiency, among other things, a favorable atmosphere is critical for quantity-surveying firms in the adoption of Building Information modeling.Quantity surveying is a broad term that refers to a wide range of projects utilizing highly specialized technologies and novel approaches for operating and implementing them. This, combined with a misunderstanding of function of quantity surveyors in projects of engineering [23] has resulted in quantity surveyors being excluded from some of these engineering projects due to a misunderstanding of their capabilities. To manage and procure some of these projects successfully, the circumstance necessitates collaboration and the deployment of specific resources among different QS firms.

Meanwhile, the scope of work of quantity surveying organizations includes residential, commercial, industrial, recreational, agricultural, and retail projects, as well as infrastructure provision [23]. Quantity-surveying organizations provide a variety of vital services to clients based on the previously established scope of work (engagement wise). Some of these services include but not limited to risk management, preliminary cost advice, post contract management, contractor selection advice, feasibility studies, obtaining or negotiating tenders/bids offer, taxation and insurance, technical auditing, valuing construction works, document preparation, cost control and project control, Expert guidance, security management, and investment assessments are also important services supplied by QS firms, as are condition surveys, value management, due diligence studies, project management analysis and coordination engineering [24]. Contract audits asset management, lifecycle costing, property condition appraisals, scheduling and planning, property management, financial analysis, procurement management, facilities management, and engineering analysis, to mention a few of other services available.

II. LITERATURE REVIEW

II.1 QUANTITY SURVEYORS KEY ROLE IN THE CONSTRUCTION INDUSTRY

In the construction business, quantity surveyors are everywhere [25]. The quantity surveyor's role, according to a report published by [26], is "to ensure that the construction industry's resources are used to the best advantage of society by providing financial management for projects and a cost consultancy service

to the client and designer throughout the construction process." The typical QS performs various responsibilities, as we stated before in the introduction section. A Quantity Surveyor's main responsibilities include financial control, cost management, and contractual administration of a project from start to finish. Table 1 QS's Roles in Cost Management in Construction Projects.

Table 1: QS's Roles in Cost Management in Construction Projects.

No.	Pre-Contract Stage	Pre-Contract Stage
1	ProbableCost Estimate	Valuation and Payment
2	Procurement Advice	Preparation of Final Account
3	Cost Planning	ContractualDisputes Settlement
4	Preparationof Quantities	Construction Cost Control
5	Bill of Quantities Preparation	Risk Analysis
6	Bidding Process	Insurance Valuations

Source: Adapted from [27].

From the start of a project until the completion of a structure, quantity surveying is an important aspect of the construction process. It's a job that requires a high level of expertise as well as carefully developed deployment abilities. It necessitates precise design interpretation and numerical representation of component quantities. It's traditionally been a manual procedure, which is prone to errors and takes a long time. However, automating the process BIM, time issues can be eradicated and errors addressed.

Preliminary Cost Estimating: Early in the design process, a BIM model may provide a relatively accurate cost estimate and measurement, as well as cost implications of additions and revisions, thus saving money and time and avoiding project overruns. This method allows designers to view the cost implications of their changes in real time, which can help reduce unnecessary overruns of the budget caused by project changes. If the BIM model is shared with the contractor, the time for detail estimates can be drastically reduced, and precision can be much improved [28].

Procurement Advice: [17] posits that considerable work early in the design process is required to build up the model and develop and analyze various design ideas in order to maximize the potential of BIM. To make this possible, fees and payment schedules may need to be adjusted. Similarly, for virtual prototyping exercises to be useful, the contractor must be involved. To fulfill this potential, a procurement method that allows involving contractor early is required. Furthermore, the usage of BIM models, which combine the work of architects, engineers in various forms, contractors, subcontractors, and suppliers, raises additional legal concerns.

5D Cost Planning: Cost planning services that provide cost certainty by providing realistic and precise cost estimates from concept to completion and at any point during the development process [29]. Cost planning has the objectives of ensuring that the client receives value for money spent based on the predetermined amount, reducing the time required to produce a successful design, to make the design process more efficient, and to ensure that all work emanating from the client's brief to the design team is contained in the cost planning process. Particularly, allocating cost targets to each element of the building to arrive at a contract sum is what cost planning seeks to achieve. It is also helps in providing basis for cost control as according to [30] in that abandoned work is prevented from the design work. As a result, BIM gives quantity surveyors the ability to undertake cost planning automatically across all building elements.

Cost Estimating: Automated quantity generation gives you a faster, more precise way to analyze data and give better advise. This allows for real-time option modeling and scenario testing in order to examine ways to enhance cost, efficiency, performance, and building design [31]. Early in the design process and throughout the project lifespan, quantity take-offs generated in a BIM model can quickly be used to derive cost estimates by project teams to assist in making an informed decision and communicate cost information about alternatives to the clients. Estimating cost databases are combined with BIM model which is has better efficiency and risk of omissions and errors are greatly decreased. Quantity take-off time is reduced so that estimators can have more time to concentrate on other valuable responsibilities such as factoring risk, selecting construction assembly and pricing. [32].

Preparing Bills of Quantities: With its 4D modeling capabilities, BIM is now capable of automating many classic QS functions. Quantity measurements from construction plans can be computerized using a BIM system. This will make it easier for quantity surveyors to have design documentation in electronic format that include exact numbers and specified materials. A BOQ can be generated automatically with the help of a properly equipped Building Information Model. After that, the BOQ is used to create reports in the required format. This can be done at any point in the QS dispatch process, including tendering, construction control, and estimating [33].

Bidding Process: Due to the transparency and accessibility of project information and documentation, competitive tendering and bidding with BIM models can eliminate the hazardous gap that occurs between project members [34] Traditional tender processes can be used for procurement at the bidding stage. The BIM produced far higher quality construction information and a more accurate bill-of-quantities than traditional working drawings. In addition, the BIM can provide instruction in quantity extraction and measurement to aspiring constructors. Bidders can identify and remedy model problems throughout the tender process, resulting in more accurate bids. The bidders were able to completely comprehend the structure and the risks connected with it, lowering the tender return costs [35].

Cost Control: In real-time, cost and quantity progress can be monitored, controlled with precision and transparency, thanks to the development of 3D building information modeling (BIM) integrated with quantity information management. Discrepancies, cost overruns, and other issues are identified early, allowing efforts to be taken to correct them or at the very least mitigate the repercussions. The main difficulty is that quantity and cost information is tracked as-it-occurs, and as-built quantity surveying is performed in tandem with site progress. As the foundation for cost management, schedule management, procurement, logistics, and resourcing, project can derive many benefits from accurate quantity control. The better the precision and priority given to it, the better the results: a more well-managed project [36].

II.2 NEED OF A QUANTITY SURVEYOR TO GET ACCUSTOM TO BIM BASED PROJECT DELIEVRY

Overbudgeting, conflict, rework, poor communication, standing time, material waste, and delays are all common problems in the construction sector today. With the current global economic troubles adding to the pressures, the need to address and resolve these issues has never been higher. Optimizing the efficiency and correctness of building design information interchange with the

goal of providing significant assurance in construction project delivery could be key to addressing such widespread and internationally recognized issues. As a result, intelligent BIM may provide a remedy to the aforementioned flaws [37].

Furthermore, owners are frequently confronted with cost overruns or unforeseen charges, forcing them to either "value engineer or Quantity Surveyor" the project above budget or terminate it. Contingencies are added to estimates by service providers and clients or put aside a budget to deal with construction uncertainties to avert the risk of overruns and incorrect estimates [38]. Unreliable estimates put owners at risk and unduly inflate the total cost of the project. A lot of factors influence the accuracy of cost estimates, including changing market conditions, the period between estimate and execution, design revisions, and quality difficulties [39]. The fact that BIM is accurate and computable makes it a more dependable source for owners to execute estimating and measurement of quantity, as well as providing quick design revisions feedback on cost. Because the capacity to impact cost is greatest early in the process, at the conceptual and preliminary stages, this is critical [40]. Quantity surveyors also blame poor estimates on communication failures among project parties, lack of time, poor documentation, between quantity surveyor and the client [41].

According to several researchers, the following are the grounds for BIM adoption in the Quantity Surveying profession [42].

• 30% of projects do not meet original programme or budget
• 92% of clients said that designer's drawings are typically not sufficient for construction
• 37% of materials used in construction become waste
• 10% of the cost of a project is typically due to change orders
• 38% of carbon emissions are from buildings not cars

This leads to the notion that because BIM decreases the number of resources required for a construction project and so saves money, professional fees should be reduced [43].BIM is currently only used in the late stages of design and engineering or the early stages of building. BIM will have a greater impact on cost if it is used earlier in the design process. The goal of using BIM-based cost estimate methodologies is to improve overall cost reliability [40].BIM is being deemed highly significant to the future development of construction information technology and to the construction industry, based on current academic research, professional development, and industrial market [44].Furthermore, BIM has developed as a cutting-edge method of project management. BIM improves project team cooperation, resulting in increased profitability, lower costs, better time management, and better customer/client relationships [45]. As a result, there should be a requirement for QS to become familiar with BIM-based project delivery.

II.3 CHALLENGES OF BIM

Many design firms are not ready to practice the on real time projects, which is a huge obstacle. As a result, they frequently form a BIM group and assign BIM specialists to work alongside with project teams. As a consequence, the project will have a BIM model, but the project team will have minimal or no experience with it. Worse yet, this method will almost always increase project costs, as the BIM teams' efforts will incur additional fees and may not result in significant cost savings [46, 47] point out the following issues with BIM**:**

• Because BIM systems generate large, complicated files, scaling and managing a fully loaded central BIM project database becomes a substantial difficulty.
• Data Sharing in BIM takes the form of drawing files. Instead of sharing intelligent objects from the model, users are reverting to documents exchange (views of a building model is created as drawing files).
• The requirement for more complex data management at the level of building objects. To help tackling the challenges like real-time, object versioning, object-level locking and multiuser access that arise when multi-disciplinary design teams try to adopt a unified BIM, server technology for Model was therefore created.
• When employing a single detailed BIM to depict a number of the various design schemes under consideration, there is a conflict in the work process. While parametrically defined architectural items can be readily reproduced using selected dimensions and features, maintaining numerous BIM models for different design options is prohibitive.
• Only one BIM system can be used by the entire project team. For design and analysis, each organization often has its own set of preferred and trusted software packages. Rather than relying on a single building model, project team members typically rely on a variety of purpose-built models on any given building project amongst different businesses and through lifecycle phases of the project.

II.4 COMPUTER SYSTEMES AND SOFTWARE

Despite the various limitations of software supporting traditional methods for generating building products in terms of collaborative capabilities, most experts choose such systems because the traditional approach to software implementation' makes the systems user-friendly. They also provide a gradual transition to automated systems, with most systems presenting data in traditional paper formats such as paper for taking-off [48].However, while current methods appear to be working well, they have a significant impact on the quantity surveyor's ability to accomplish his duties during the design stage of a building project [48].Cost estimates are prone to mistakes since they are typically based on limited information and created in a short period of time [49]. Creating a three-dimensional (3D) model of client's proposal is the first step in an environment of BIM that is perfect, followed by resource requests that is automatically generated, calculation of cost or cost estimations, bills of quantities and a list of specifications for product, [50]. This necessitates extracting all measurements and information about components of building from

The 3D model, then merging it with databases including Information and other costs unit [51].

II.5 RESPONSIBILITIES AND SERVICE ARE BEING ADJUSTED

Traditionally, after the proposed project's design has gotten to a stage where it can virtually be frozen, the Quantity Surveyor begins to produce documentation relating to procurement and bills of quantities. Estimating during the design phase is typically notional and based on limited project knowledge, hence Quantity Surveyors are increasingly active in the design review process later on [48].Bills of quantities automation eliminates errors and misunderstandings while also evolving in tandem with design modifications [52].It alleviates some of the monotony and expedites the process [53].This frees up time for data interpretation, analysis, and arrangement into a consistent, understandable, and logical format, as well as shifting the traditional responsibility of

designing to a cost, to costing a design [48].'Value for money,' requirement is satisfied by designing to a cost and hence fulfills one of the quantity surveyor's most important roles [54]. However, in order to avoid data re-entry inaccuracies and assure model consistency, an individual must control the data exchanged between consultants.

II.6 EXPENSES AND TRAINING

The creation of new technology and the application of new tools and processes are frequently accompanied by a slew of expenses and a lack of technological skill and knowledge. The shift from existing methodologies to next-generation BIM technologies will not be without its difficulties. Training seminars, workshops, programs, and tutorials software may typically overcome a lack of knowledge and expertise relating to complicated processes and software [55].

II.7 QUANTITY SURVEYOR PREREQUISITE

In order to implement BIM with substantial consequences, project teams will need new abilities, and fee scales will need to be changed to reflect professional duties [56]. The distinguishing abilities or skills of a Quantity Surveyor, according to [26]. Are related with value and measurement, which provide the basis for proper cost controlling, analyzing, management of a construction project in the context of predicting, planning, and accounting.

V. CONCLUSIONS

To a traditionally oriented Quantity Surveyors and allied professional, Building Information Modeling will pose a great challenge in the aspect of services they rendered. [48] as cited by [57].BIM came to bear as a development that aimed at integrating economics value addition and working systems to delivery of project. Delivering good-quality results, by eliminating drudgery and monotony from a variety of tasks, BIM offers this benefit [53].Continue reliance on the preparation of bills of quantities by Quantity surveyors as their major source of revenue, will soon be put to an end and dramatically be reduced as a result process automation [48].Quantity Surveyors' capability and ability in terms of contractual and financial decision as regards construction development has made them to redefine their role [53]. Quantity surveyors who can overcome these obstacles will have a bright career in this rapidly changing business. As a result, they must concentrate on improving the learning experience with BIM techniques and collaboration technology updating industry techniques and methods and developing QS specific skills such as quantification, data scheduling, visualization (3d viewing), and pricing, as well as multi-disciplinary work-based projects. To fully comprehend the QS's future function, a thorough examination of what precise information will be made accessible to him via BIM at various stages of the project, as well as what information the QS must give at each level, is essential. This has been determined to be the best course of action for the current research.

VI. AUTHOR'S CONTRIBUTION

Conceptualization: Dr. Reuben A. OKEREKE and Nneka M. IHEKWEME.
Methodology: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Investigation: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Discussion of results: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Writing – Original Draft: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Writing – Review and Editing: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Resources: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Supervision: Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.
Approval of the final text Dr. Reuben A. OKEREKE, Nneka M. IHEKWEME and Imoleayo A. AWODELE.

VII. REFERENCES

[1] Davidson, R.D. (2013), "A study of the deployment and impact of building information modeling software in the construction industry", unpublished MSc thesis, School of Civil Engineering, Faculty of Engineering, Leeds University, Leeds.

[2] Ganiyu, A.Y. (2016), "BIM interoperability and information standardisation", paper presented at a 3-Day Workshop/Annual General Meeting of the Nigerian Institute of Quantity Surveyors, Port-Harcourt, November 8–12.

[3] Hosseini, M.R., Azari, E., Tivendale, L. and Chileshi, N. (2015), "Barriers to adoption of BIM in Iran: preliminary results", 6th International Conference on Engineering, Project, and Production Management, Gold Coast, pp. 384-394.

[4] Johnson, B., & Gunderson, D. (2009). Educating Students concerning Recent Trends in AEC: A Survey of .International Proceedings of the 46th Annual Conference. Mississippi: Associated Schools of Construction

[5] Olorunkiya, J.O. (2016), "BIM evolution: are we ready? Or where are we on the adoption curve?", Paper presented at a 3 – Day Workshop/Annual General Meeting of the Nigerian Institute of Quantity Surveyors, Port-Harcourt, November 8–12.

[6] Smith, S. (2007). Using BIM for sustainable design.

[7] Wong, K., & Fan, Q. (2013). Building Information Modelling (BIM) for Sustainable Building Design. *Facilities*, *31*(4). doi:10.1108/02632771311299412

[8] Gleeson, J. (2008). *Computer-aided green design*. Retrieved from http://www.architectureweek.com/0330/tools_1-2.html

[9] Rogers, J. and Chong, H. (2015), "Adoption of building information modelling technology (BIM): perspectives from Malaysian engineering consulting services firms", Engineering, Construction and Architectural Management, Vol. 22 No. 4, pp. 424-445.

[10] Kovacic, I., Vasilescu, D., Filzmoser, M., Suppin, R. and Oberwinter, L. (2015), "BIM in teaching – lessons learned from exploratory study", Organization, Technology and Management in Construction (An International Journal), Vol. 7 No. 3, pp. 1358-1366, doi: 10.5592/otmcj.2015.3.3 Research paper.

[11] Babatunde, S.O., Perera, S., Ekundayo, D.,and Adeleke, T.O., (2020) An investigation into BIM-based detailed cost estimating and drivers to the adoption of BIM in quantity surveying practices; Journal of Financial Management of Property and Construction Vol. 25 No. 1, pp. 61-81.

[12] Kulasekara, G., Jayasena, H.S. and Ranadewa, K.A.T.O. (2015), "Comparative effectiveness of quantity surveying in a building information modeling implementation", Second World Construction Symposium2013: Socio-Economic Sustainability in Construction, Colombo, pp.101-107.

[13] Yan, H. and Damian, P. (2008), "Benefits and barriers of building information modeling", in 12th International Conference on Computing in Civil and Building Engineering, 16th-18th October, 2008, Beijing, China.

[14] Alufohai , A. (2012). Adoption of building information modeling and nigeria's quest for project cost management. Nigerian institute of quantity surveyors, 1(1), 6-10.

[15] Olatunji, S.O., Olawumi, T.O and Aje, I.O.,(2017) Rethinking Partnering among Quantity-Surveying Firms in Nigeria. J. Constr. Eng. Manage., 2017, 143(11), pp. 1-12

[16] Egan, J. (1998). "Rethinking construction." ⟨https://goo.gl/L4JSYL⟩ (Aug.23, 2016).

[17] Boon, J. (2009). Preparing for the BIM revolution. *13th Pacific Association of Quantity Surveyors Congress (PAQS 2009)* (pp. 33-40). Malaysia: The Institution of surveyors Malaysia (ISM).

[18] Jayasena, H.S. and Weddikkara, C. (2012), "Building information modeling for Sri Lankan construction industry", Paper presented at the World Construction Conference, Global Challenges in Construction Industry, 28-30 June, Colombo, pp. 196-201.

[19] Olatunji, O. and Sher, W. (2015), "Estimating in geometric 3D CAD", Journal of Financial Management of Property and Construction, Vol. 20 No. 1, pp. 24-49.

[20] Abdullahi, M. and Ibrahim, Y.M. (2016), "Building information modeling", paper presented at 3-Day Workshop/Annual General Meeting of the Nigerian Institute of Quantity Surveyors, available at: http://niqs.org.ng/wp-content/uploads/2016/ (accessed 20 August).

[21] Royal Institution of Chartered Surveyors (2012), Building Information Modeling Survey Report, available at: www.scan2bim.info/files/rics_2011_BIM_Survey_Report.pdf (assessed 16 December 2018).

[22] Jaradat, S. and Sexton, M. (2016), "BIM articulation in different-sized architectural firms", in Chan, P.W. and Neilson, C.J. (Eds), Proceedings of the 32nd Annual ARCOM Conference, Vol. 1, 5-7 September, Association of Researchers in ConstructionManagement, Manchester, pp.63-72.

[23] Olawumi, T. O., and Ayegun, O. A. (2016). "Are quantity surveyors competent to value for civil engineering works? Evaluating QSs' competencies and militating factors." J. Educ. Pract., 7(16), 1–16.

[24] Olawumi, T. O., Akinrata, E. B., and Arijeloye, B. T. (2016). "Value management—Creating functional value for construction project: An exploratory study." World Sci. News, 54, 40–59.

[25] Poon, J. (2003). Professional ethics for surveyors and construction project performance: what we need to know. *Proceedings of Construction and Building Research (COBRA) Conference* (pp. 124-132). UK: Royal Institution of Chattered Surveyors (RICS) Foundation.

[26] RICS . (1971). *The future role of Quantity Surveyors*. London: Royal Institution of Chartered Surveyors.

[27] Willis, C. J., Ashworth, A., & Willis, J. A. (1994). *Practice and Procedure for the QuantitySurveyor* (10th ed.). Oxford: Blackwell Science.

[28] Colleen, K. (2009). *Preliminary Cost Estimation*. Retrieved from BIM Project Execution Planning Guide: http://bimex.wikispaces.com/Preliminary+Cost+Estimation.

[29] Mitchell Brandtman. (2013). *5D Cost Planning.* Retrieved from 5D Quantity surveyors & construction expert opinion: www.mitbrand.com/.../5D_Cost_Planning_MitchellBrandtman_19-04-20.

[30] Hua, G. B. (2010). Designing Green to a Whole-Life Cost Plan Through Adopting Standard. Singapoor.

[31] Shaw, B. (2010). *Knowledge Centre*. Retrieved from The Fifth Dimension of Building Information Modelling (5D BIM).

[32] Autodesk;. (2013). *BIM workshop*. Retrieved from bim-design-process: http://bimcurriculum.autodesk.com/unit/unit-2-%E2%80%93-bim-design-process

[33] BIM Outsourcing. (2013). *BIM & Quantity Surveying*. Retrieved from BIM Outsourcing: http://www.bimoutsourcing.com/bim-quantity-surveying.php

[34] Graham, M. W. (2010). *Managing construction projects.* USA: John Wiley & Sons.

[35] American Institute of Architect [AIA]. (2008). *Gehry Technologies.* Retrieved from One island east: http://www.gehrytechnologies.com/services/projects/one-island-east.

[36] Gren, T. (2008, July). *Construction Data*. Retrieved from Quantity and Cost control: http://constructiondata.wordpress.com/2008/07/07/quantityandcostcontrol/

[37] Hooper, M. (2012). *BIM anatomy: an investigation into implementation prerequisites.* Sweden: Lund University.

[38] Touran, A. (2003). Calculation of contingency in construction projects. *IEEE transactions on engineering management, 50*(2), 135–140.

[39] Jackson, S. (2002). Project cost overruns and risk management. *Proceedings of the 18th Annual ARCOM Conference.* Glasgow.

[40] Eastman, C., Teicholz, P., Sacks, R. and Liston, K. (2008), BIM Handbook: A Guide to Building Informa on Modeling for Owners, Managers Designers, Engineers, and Contractors, John Wiley & Sons, Hoboken, NJ.

[41] Akintoye, A., & Fitzgerald, E. (2000). A survey of current cost Estimating practices in UK. *Construction Management & Economics, 18*(2), 161–172.

[42] Thomas, K. (2010). *Innovation and Growth Team Report.* UK: Northumbria university.

[43] Gee, M. (2010). *The influence of building information modeling on the quantity surveying profession.* South Africa: Built environment and information technology.

[44] Azhar, S., & Brown, J. (2009). BIM for sustainability analyses. *International Journal of Construction Education and Res earch, 5*(4), 276-292.

[45] Azhar, S., Brown, W., & Sattineni, A. (2010). A case study of building performance analyses using building information modeling. *27th International Symposium on Automation and Robotics in Construction* (pp. 1- 10). Alabama: ISARC.

[46] Wang, X. (2012). The New BIM Player – China. *Journal of Building Information Modeling*, 27-28.

[47] Howell, I., & Batcheler, B. (2004). *Building information modeling two years later huge potential, some success and several limitations.* Retrieved from Newforma: http://www.laiserin.com/features/bim/newforma_bim.pdf

[48] Matipa, W. (2008). *Total cost management at the design stage using a building.* Ireland: National University of Ireland.

[49] Aibinu, A., & Pasco, T. (2008). The accuracy of pre-tender building cost estimates in Australia. *Construction Management and Economics, 26*(12), 433-466.

[50] Popov, V., Juocevicius, V., Migilinskas, D., & Mialauskas, S. (2009). Application of building information modelling and construction process simulation ensuring virtual project development concept in 5D environment. *Automation in Construction, 19.*

[51] Bazjanac, V. (2010). *Model based cost and energy performance estimation during schematic design.* California:Lawrence Berkeley National Laboratory.

[52] Ashcraft, H. (2007). Building Information Modelling – A Framework for Collaboration,. *Construction Lawyer, 28*(3).

[53] Ashworth, A., & Hogg, K. (2007). *Willis's Practice and Procedure for the Quantity Surveyor* (12 ed.). Oxford London: Blackwell Science.

[54] Petric, J., & Maver, T. (2003). Sustainability: real and/or virtual? Automation in Construction. *Automation in Construction, 12*(6), 641-648.

[55] Rundell, R. (2010). *Implementing BIM Part 3: Staff training, 1-2-3 Revit.* Retrieved from Cadalyst: http://www.cadalyst.com/aec/implementing-bim-part-3-staff-training-2920

[56] Olatunji, O., & Sher, W. (2010). *Legal implications of BIM: Model ownership and other matters arising.* New Castle: School of Architecture and Built Environment.

[57] Nagalingam, G., Jayasena, H.S. and Ranadewa, K.A.T.O. (2013), "Building information modelling and future quantity surveyor's practice in Sri Lankan construction industry", The Second World Construction Symposium 2013: Socio-Economic Sustainability in Construction, 14-15 June, Colombo, pp. 81-92.