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Barriers to the Uptake of Technology in the Quantity Surveying Industry

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***Abstract*—**The usage of modern technology is widespread in industrialised nations. The issue still pertains to developing countries since they struggle to use technology in the building sector. The study aims to identify the barriers to technology usage in quantity surveying firms. Quantity Surveyors were interviewed via Microsoft teams due to the dispersed nature of the participants. However, where the interview was not possible, the interview guide was emailed to the participants to fill in. In all, 12 participants were interviewed out of the 25 participants contacted. The data received were analysed using the content analysis process. The study's findings demonstrate that quantity surveyors have access to a wide range of technology that significantly enhances their project activities. However, quantity surveying companies are hesitant to use technology for several reasons, including the cost and maintenance associated with it. Other obstacles include a lack of knowledge, poor market acceptance, legal obstacles, and budgetary constraints. Despite the advantages associated with modern technology applications, quantity surveying firms are not using them, which may ultimately affect their work output. Therefore, firms need to re-examine these obstacles, inhibiting their adoption of technology in the work process to enhance their production. The study reveals the main hindrances to technology usage, which may help firms institute measures to address them.

***Keywords*—**Technology usage barriers, technology implementation, technology acceptance, quantity surveying.

I. Introduction

EVEN though there is evidence that new technology promotes performance and competitive advantage, the construction industry is one of the last to adopt it [1]. Although technology advances quickly, the adoption of technology by the industry is sluggish, which further alters the roles of quantity surveyors and how they carry out their many responsibilities [2]. Internationally, the building industry has benefited the economy by boosting the GDP and lowering the nation's unemployment rate [3]. Zingoni [4] estimates that 1.3 million individuals in South Africa work in the construction industry. Technology helps the nation's economy thrive, but it also poses a threat to the construction sector since the availability of new technology will put nearly 5 million jobs in Australia at serious risk [5].

The construction sector is a dynamic industry that is changing due to technology. According to Olatunji et al. [6], the use of technology is eroding the traditional job of the quantity surveyor because the construction sector uses technologies like big data, artificial intelligence, and machine learning, as well as Building Information Modelling (BIM). Performance levels for quantity surveyors and construction professionals are also influenced by the information that is accessible. Construction designs previously done on paper with several flaws have been reduced thanks to the introduction of BIM, which has proven effective in the design stage [3]. It has been discovered that South African quantity surveyors are having trouble advancing their technique because of the high cost of the necessary gear and equipment [2].

Some quantity surveying firms are hesitant to adapt to new technology since it threatens the South African business. This is a challenge because technology affects the nature of quantity surveyors and demands new abilities [7]. Advantages such as creating environmentally friendly structures, improved communication, and removing cost overruns and delays as benefits of technology usage have been stated by researchers. Likewise, technology can increase the industry's overall performance, even though it may be expensive to buy the necessary equipment and develop essential skills [3]. This study intends to identify the barriers to technology adoption by quantity surveyors in the South African construction industry.

II. Literature Review

A. Benefits of Technology in the Quantity Surveying Industry

BIM gives accuracy and consistency of data; BIM includes multiple things, such as drawings dimensions, and is easily accessible [8]. Accuracy in the construction industry leads to other benefits such as collaboration, increasing sustainability, collaboration with other teams, and accuracy promotes safe environments [8]. Technology has also improved the sharing of data and obtaining information which has increased the accuracy of cost estimates in the quantity surveying industry. The accuracy of these estimates is reliable and has made design changes quicker by including the cost impact analysis [9]. The most significant advantage of BIM models is that they allow construction companies to estimate the project in more detail and accuracy, reducing time and costs. Estimating becomes more accurate using BIM models; however, the cooperation of the professional team is vital because performing quantity take-offs and cost estimating requires accurate information [10].

Technology like BIM can assist in generating building representation at any given time and stage. These presentations range from simple to complex photorealistic drawings of how the buildings will look [8]. The importance of visualisation in the construction industry is that clients can see their building/ property in a three-dimensional model before the property is

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erected [8]. This is beneficial because a flaw can be discovered early rather than when the building is being constructed [11]. Quantity surveyors also have a better understanding of the project while interacting with 3D models; this assists quantity surveyors in minimising the assumptions made about the design. Again, 3D visualisation is better than turning the pages to figure out what the building looks like [12].

BIM makes it easy for quantity surveyors to measure quantities of floor areas and material volumes. It is easy and quick to estimate costs, schedule materials and procurement processes because the data are readily available from the BIM at all times. This increases overall energy usage, productivity, and performance [8]. The quantity surveyor must look for any missing items before estimating quantities for the budget. BIM can provide any cost detail that can be helpful in the early stages of design [12]. Technology enables quantity surveyors to export quantities from spreadsheets to a BIM estimating model, and then pricing can begin. Quantity surveyors can define BIM measurements by using plug-ins to automatically produce all the required quantities for creating a cost estimate, which will easily map out the building's cost and components [13]. BIM quantification tools associated with CostX transfer information from one software to another. Cost estimation is essential to the construction project workflow [10]. BIM model design tools produce visual diagrams, making it easier for the quantity surveyor to make the building components and ensure that the components have been added to the cost estimate [13]. BIM models offer better data coordination because they integrate 3D and 2D drawings, which was difficult using paper drawings. This has also improved the communication between construction professionals to share vital information [9]. With all the available information, everyone is informed about the changes in the design and acknowledges the consequences. Coordinating documentation reduces errors and reworks [9]. Data Coordination in a project also improves collaboration between stakeholders, reducing the time needed for documentation and further producing beneficial project outcomes [14].

B. Challenges of Technology Adoption in the Quantity Surveying Industry

The construction industry is not always eager to learn, adapt and implement new methods in the construction industry [15]. New technologies such as BIM require a change in how the construction industry operates. Incorporating technology into the workspace involves time, money and also resources. Office spaces will have to integrate systems that need to be regularly updated, and the staff needs to be trained to use BIM technology. According to Gee [15], employers are hesitant to include BIM in contracts because of fear of limitations towards tenders which can impact the contract amount. Changes will have to be made to the contractual and legal aspects of collaborating technology in the quantity surveying professions [15]. The incorporation of BIM can cause the responsibilities of professionals a bit ambiguous because professional errors, omissions and mistakes cannot be quickly confirmed on who worked on specific activities [15]. Contract documents must be adjusted to ensure that risk is allocated to the correct person, especially with various stakeholders' contributions [15]. Marefat et al. [16] mention that BIM adopters have legal issues for the construction industry; legal considerations must cover topics such as ownership, responsibilities for inaccuracies, licensing problems and the lack of sharing information. BIM models are complicated because of the privity of contracts and third-party rights, which complicate these models. The development of a legal framework and contractual framework is needed for BIM projects [17].

Adopting technology in the quantity surveying industry requires construction firms to make significant investments to fund the available new technology [18]. Construction firms will also have to pay special attention to employers' training and skills, which is very costly [18]. Despite the cost implication, construction firms must prepare to employ skilled people. Again, construction firms need to consider the maintenance that comes with technology in the quantity surveying industry. Asian construction industry issues regarding the "wait-and-see" approach were identified as significant factors for reluctance in technology adoption. In 1997's, the impact of technology on performance was poorly understood, making it difficult for top management to invest continuously in technology [19]. Limited exposure in the quantity surveying profession is also one of the prime challenges in BIM adoption. Quantity surveyors advise on financial and contractual matters in the construction. They must enhance their skills, especially in technical visualisation [20]. In Nigeria, factors such as a lack of marketing strategy, sub-consultant status and the inability to accept and change the lack of investment in the necessary technology needed in the quantity surveying industry [21].

Lack of interoperability in the construction industry significantly impacts technology adoption in the industry [22]. This slows down the implementation of BIM. According to Agyekum et al. [20], interoperability is the ability to exchange data between project team members using soft waves and information communication technology. In summary, interoperability is communicating among project team members using information technology systems [22]. Mayouf et al. [23] also stated that the lack of interoperability is the leading cause of delayed implementation in the construction industry. However, the specialised software's affordability and ability to keep users updated with new technology are also a limitation in the industry [24]. Babatunde and Ekundayo [25] state that implementing BIM has many challenges, especially with integrating BIM into the school curriculum; this problem is not only in Nigeria but in many developing countries. Progress has been made in developed counties such as the United States of America, United Kingdom, Australia, Singapore and New Zealand to incorporate BIM into undergraduate curriculums. Nigeria has constraints that inhibit using modern ICT infrastructure in the construction industry, such as inadequate power supply, expensive hardware and software, the fear of virus attacks, and low order from firms [25]. These are among the many constraints that have been observed. At the same time, Musa et al. [26] state that the lack of ICT facilities, power supply and education systems, and

training centres limit the uptake of BIM tools in the construction industry. Education and training are vital to quantity surveyors' ICT education and gradual professional development [27]. ICT adoption is an integral part of the success of BIM adoption, just as seen internationally. There is a need to fill the gap in construction education by the relevant stakeholders in universities that offer Quantity Surveying programmes in Nigeria [27]. Implementing BIM is seen as a new effort but not relatively seen in academia [25].

The lack of resources also causes the lack of BIM implementation in higher institutions, absent government authorities, poor connectivity issues, availability of qualified staff, the need to update the BIM software constantly, and lack of accreditation and regulations to guide BIM implementation in higher institutions [25]. The lack of collaboration between industry experts and higher instructions is also a challenge that Nigeria is experiencing. BIM is difficult for people without IT skills, further creating resistance to change and making it difficult to introduce to the universities' curriculums. Babatunde and Ekundayo [25] argue that BIM implementation requires new teaching methods, materials and textbooks that are BIM-orientated resources for students. Sabongi [28] states that there is no time to establish a new curriculum in universities, and insufficient funding and the unwillingness to evolve the universities' curriculum are the most significant barriers to implementing BIM in Nigerian universities. According to Babatunde and Ekundayo [25], it is a challenge to educate lecturers because of the rapid technological change; there are also significant disagreements and arguments over the concept of BIM, whether it is a software tool or a mythological process. BIM requires new teaching methods, and the modelling process involves knowledge from construction experts that are not readily available [25]. The involvement of BIM in universities requires a shift in the culture of universities which requires funding, experts and resources; thus, implementing BIM will require drastic changes in universities. Infrastructure and IT facilities in most countries make it challenging for staff to go through training and collaborate with construction experts to enhance their skills. Lecturers in universities are still reluctant to use the BIM software that students must be taught [25].

III. Research Methodology

The research method adopted for this study is the qualitative approach. This approach was chosen because we can conclude the generalised theories provided in the interviews. The qualitative approach is appropriate for small sample sizes. Although this might be a disadvantage because the conclusions can only be based on small sample size, the reliability of the results would not be in question [17]. A target population is a group of individuals the researcher plans to conclude [29]. Data were collected from quantity surveyors all over South Africa registered under ASAQS and SACQSP, as well as those registered elsewhere. These quantity surveyors were searched through multiple companies and by a word of reference from other professionals. The type of sampling used in this research is convenience sampling. This type of sampling chooses the available participants at that specific time; however, everyone could be selected from a particular population [30]. In all, 25 quantity surveyors were contacted for an interview, of which 12 participated.

Data were collected using an interview guide made of semi-structured open-ended questions. Participants were interviewed via a Microsoft team link, which was emailed to the participants at an agreed time. The interviews lasted for about 30 to 40 minutes per participant. However, in some situations, the participants requested for the interview questions to be emailed due to their unavailability for online interviews. Thus, the interview guide was emailed to five participants, who completed it and emailed it back. We followed up with these five participants during the data analysis for clarification where necessary. Saturation was reached after the 9th participant. Content analysis was used to analyse the information from interviews. Content analysis determines the appearance of certain words, themes and concepts in the information gathered. It aims to organise and make sense of the information gathered to draw realistic conclusions [31]. Qualitative content analysis is shown in words, including themes, making it simple to interpret the data [31]. The participants' demographics are shown in Table I.

TABLE I
Participants' Demographics

Demographic information		Number of respondents	Percentage
Firm's location	Northern Cape	1	8%
	Kwa-Zulu Natal	1	8%
	Mpumalanga	1	8%
	Free State	3	25%
	Gauteng	6	50%
	Total	12	100%
Gender	Male	6	50%
	Female	6	50%
	Total	12	100%
Experience	0 - 4 years	8	67%
	5 - 8 years	2	17%
	Over 8 years	2	17%
	Total	12	100%
Quantity Surveying Industry	Building and Construction	5	42%
	Consulting	4	33%
	Civil Engineering	2	17%
	Mining Sector	1	8%
	Total	12	100%
Professional registration	Registered	7	58%
	Not Registered	5	42%
	Total	12	100%
Qualifications	Honours degree	8	67%
	Bachelor degree	4	33%
	Total	12	100%

Most participants (50%) are from Gauteng, whilst the gender is equally divided (50%) respectively. Most participants (67%) have been in the construction industry for 4 years, indicating that they finished their education not long ago. Thus, they may be very familiar with the technologies available in the industry. Again 58% of the participants are professionally registered, while 67% have an honours degree.

IV. Findings

A. The Specific Technology Available to the Quantity Surveyor

The technology available to quantity surveyors, according to Table II, are WinQS and DimensionX, with a percentage of 20%, respectively. Excel and MS projects were the most common technology, with a percentage of 17% and 13%, respectively. Technology such as BIM and ArchiCAD is not common among quantity surveyors, with a percentage of 8%. The technology that had the lowest percentage was Revit and Take-off, with 2%; this technology is not common among quantity surveyors. Drone usage was not mentioned fewer (3%) among the participants, indicating its familiarity to the participants.

TABLE II
TECHNOLOGIES AVAILABLE TO QUANTITY SURVEYORS

Question	Technologies	Frequency	Percentage
What technology are available to quantity surveyors?	WinQS	12	20%
	DimensionX	12	20%
	BIM	5	8%
	Excel	10	17%
	MS Project	8	13%
	Revit	1	2%
	Candy	4	7%
	ArchiCAD and other CAD products	5	8%
	Drones	2	3%
	Take-off	1	2%
	Total	60	100%

B. Barriers to Technology Usage

The question aimed to get participants' opinions on the challenges that hinder technology adoption by the quantity surveying industry. The majority of participants (32%) stated that the cost of the equipment is the challenge that hinders technology adoption. This was followed by maintenance issues (23%) associated with the ownership of this modern equipment. Again 19% of them stated that lack of knowledge by most professionals is a challenge in embracing modern technology in work execution. Likewise, lack of market acceptance and legal issues associated with technology use hinder technology adoption. Lastly, 6% mentioned that budgetary constraints by various firms also prevent them from acquiring modern tools to execute their work. The responses of the participant are shown in Table III.

TABLE III
BARRIERS TO TECHNOLOGY USAGE

Interview question	Responses	Frequency	Percentage
In your opinion, what are some challenges hindering technology adoption by quantity surveyors in the South African construction industry?	Cost involved	10	32%
	Maintenance issues	7	23%
	Lack of knowledge	6	19%
	Poor market acceptance	4	13%
	Legal obstacles	2	6%
	Budgetary constraints	2	6%
	Total	31	100%

V. Discussions

A. The Barriers to Technology that Quantity Surveyors Experience

According to the results, the participants mainly mentioned several factors as barriers to adopting technology by quantity surveying professionals in the construction industry, as indicated in Table III. The participants state that small companies have difficulty implementing technology because of the finances required for technology. Acquisition of modern technology is considered expensive hence they find it challenging to use them for work execution, although they are aware of the advantages involved. This assertion was also identified in past studies Xu et al. [18] determined that quantity surveying firms must invest considerably in acquiring modern equipment. However, due to inadequate finances, most firms find it challenging to acquire these tools for their workers to enhance their work output. Training people to use these modern tools was also considered time-consuming and expensive, limiting their adoption. The participants also raised the maintenance cost for this modern equipment. Post-acquisition maintenance is challenging since repairing damaged equipment is considered expensive. Even the artisans to repair it are often hard to find, leaving the equipment unused for several months [18]. For instance, as interviewee 3 states;

> "Small companies in South Africa have difficulty adopting technology because most of this software requires payment every month and small firms find that very costly".

Some participants also raised legal issues. Some participants stated that using modern equipment such as drones for area view requires approval, and this approval process is challenging, thus demotivating their usage. Marefat et al. [16] identified that BIM usage has legal complications for the construction industry, including issues such as ownership, responsibilities for inaccuracies and licensing problems. Again, interviewees mentioned that most people in the quantity industry lack knowledge in using this modern technology, and the time for training is often not enticing. People prefer using what they are familiar with to prevent mistakes in project estimates and other work activities. Gee [15] also identified legal barriers, lack of awareness, lack of BIM incorporation in universities, and lack of interoperability. As interviewees 6 & 12 proclaim, respectively:

> "I think the approval that is needed, for example, using a drone for the aerial survey, is part of the problem. The approval process takes time."

> "The software is very expensive and finally, the industry as a whole needs to buy into the newly available resources which has not happened across the board due to the fact that there are still many people who stuck by the old ways of doing things".

Also, the participants stated that the lack of acceptance by the quantity surveying market and budgetary constraints were barriers to modern technology usage. It is believed that professionals in the industry do not see the need for these technologies since they are familiar with the traditional tools,

which they believe are more reliable. Making mistakes as a quantity surveyor can severely affect the client's project. Thus, to be sure of what they are doing, they prefer using tools they are familiar with rather than trying new tools and equipment for task execution. Again, most participants noted that they need more capital to invest in these modern tools because clients need to pay them on time; thus, they could not invest in modern technology for their work. Often their fees are negotiated and discounted to secure contracts, limiting the financial resources available for investment. For instance, interviewee 4 notes;

> "I prefer to use the software I am familiar with. It may be old-fashioned, but I know I can rely on it rather than using the modern software I am unfamiliar with."

According to Eadie et al. [19], many professionals do not understand the impacts of technology on performance enhancement, making it difficult for top management to invest in technology continuously. Agyekum et al. [20] advised quantity surveyors to improve their skills in tools such as technical visualisation to enhance the accuracy of their work. Likewise, issues such as a lack of marketing strategy and the inability to accept change have resulted in the absence of investment in the necessary technology needed in the quantity surveying industry [21].

B. The Implication of the Findings

The findings indicate various hindrances to adopting technology usage by professionals in the quantity surveying industry. These issues are preventing them from experiencing the benefits associated with technology usage. These may ultimately affect productivity and efficiency in task execution. According to Wu et al. [13], the BIM application makes pricing easier as it provides a detailed breakdown of quantities, even though it has no industry standard between the model and cost estimating. Again, BIM technology also improves the communication between construction professionals to share vital information, thereby reducing miscommunication which often leads to mistakes and omissions [17]. Despite these advantages, quantity surveyors in South Africa are not using this modern technology. These may result in mistakes and time waste in work execution which will affect the client adversely. There must be an improved education at the institutions where these professionals acquire knowledge to increase the awareness of the need to use these tools in their work. These will assist professional firms in setting aside funds to invest in modern technology. The quantity surveying professional bodies must also increase the awareness levels of modern tools among their members. Perhaps, knowledge of critical modern equipment should be part of the requirement for professional registration to enforce current technology knowledge among quantity surveying professionals.

VI. Conclusion and Recommendations

Technology adoption in the construction industry is growing worldwide and enhancing work efficiency. However, players in developing economies' construction industry often lag in technology adoption. This study, therefore, sought to identify the reason behind the lack of technology adoption by quantity surveyors since they play a crucial role in the construction industry. The study found that the main obstacles to integrating technology are financial, lack of awareness, legal impediments, and slow market adoption. Companies must recognise the technological drivers and barriers and educate quantity surveyors about the technologies they may not be familiar with, which may significantly increase their productivity. Businesses should start small or with less expensive technology and software. Businesses must begin with what they can afford and progressively upgrade to more expensive software. Before installing software, companies should research the cost. The software requires upkeep and ongoing expenses, which can be prohibitive for small businesses. The program may become a liability without yielding the maximum profit. Professional bodies must educate members on adopting modern tools to execute their work. The study is limited to the quantity surveyors operating in the South African construction industry. Future studies can adopt a quantitative approach to increase the sample size.

References

[1] A. Olatunji, "Risk Associated with the Use of Software's for Quantity Surveying Practices in South West Nigeria", 2012, Durban University of Technology.

[2] T. Haupt and N. Sanjivi, "The threat of technology to the way quantity surveying is practised in KwaZulu-Natal", In: *10th Built Environment Conference*, Port Elizabeth, 2016, pp.26-30.

[3] T. Osunsanmi, C. Aigbavboa and A. Oke, "Construction 4.0: The future of Construction Industry in South Africa", *International Journal of Civil and Environmental Engineering*, Vol. 12(3), 2018, pp.150-153. DOI: 10.5281/zenodo.1315923

[4] T. Zingoni, "Deconstructing South Africa's construction industry performance - The Mail & Guardian", 2020. (online) The Mail & Guardian. Available at: https://mg.co.za/opinion/2020-10-19-deconstructing-south-africas-construction-industry-performance/ (Accessed 27 August 2021).

[5] M. Loosemore, "The Impact of Technology on Employment in Construction – Architecture, Construction, Engineering, Property", 2016. (online) Sourceable.net. Available at: https://sourceable.net/impact-technology-employment-construction/ (Accessed 22 August 2021).

[6] O. Olatunji, J. Lee, H. Chong, and A. Akanmu, "Building information modelling (BIM) penetration in quantity surveying (QS) practice", *Built Environment Project and Asset Management*, Vol. 11(5), 2021, pp.888-902. DOI: 10.1108/BEPAM-08-2020-0140

[7] B. Thompson and A. Waller, "*Report for Royal Institution for Chartered Surveyors"*, (ebook) London: Royal Institution of Chartered Surveyors, 2017, pp.6-9. Available at: https://www.rics.org/globalassets/rics-website/media/knowledge/research/insights/impact-of-emerging-technologies-on-the-surveying-profession-rics.pdf (Accessed 18 October 2021).

[8] G. Kekana, C. Aigbavboa and W. Thwala, "Understanding Building Information Modelling in the South Africa construction industry", In: *OTMC2015 Conference*. (online) Johannesburg: University of Johannesburg, 2015, pp.2-4. Available at: https://core.ac.uk/download/pdf/54199032.pdf (Accessed 18 October 2021).

[9] N. Ismail, R. Drogemuller, S. Beazley and R. Owen, A Review of BIM Capabilities for Quantity Surveying Practice. *MATEC Web of Conferences*, Vol. 66(4), 2016, pp.1-6. DOI: 10.1051/matecconf/20166 IBCC 2016 600042

[10] A. Sattineni and R. Bradford, "Estimating with BIM: a survey of us construction companies", *The International Association for Automation and Robotics in Construction*, Vol. 1, 2011, pp.564-569. DOI: 10.22260/ISARC2011/0103

[11] J. Wao and I. Flood, "The role of quantity surveyors in the international construction arena", *International Journal of Construction Management*, Vol. 16(2), 2016, pp.126-137. DOI: 10.1080/15623599.2016.1142251

[12] R. Stanley and D. Thurnell, "The benefits of, and barriers to, implementation of 5D BIM for quantity surveying in New Zealand", *Construction Economics and Building*, Vol. 14(1), 2014, pp.105-117.
[13] S. Wu, G. Wood, K. Ginige and S. Jong, "A technical review of BIM based cost estimating in uk quantity surveying practice, standards and tools", *Journal of Information Technology in Construction*, Vol. 19, 2014, pg. 534 - 563
[14] D. Bryde, M. Broquetas and J. Volm, "The project benefits of Building Information Modelling (BIM)", *International Journal of Project Management*, Vol. 31(7), 2013, pp.971-980. DOI: 10.1016/j.ijproman.2012.12.001
[15] C. Gee, "The influence of building information modelling on the quantity surveying profession", Honours. 2010, University of Pretoria.
[16] A. Marefat, H. Toosi and H. R. Mahmoudi, "A BIM approach for construction safety: applications, barriers and solutions", *Engineering, Construction and Architectural Management*, Vol. 26(9), 2018, pp.1855-1877. DOI: 10.1108/ECAM-01-2017-0011
[17] Y. Lingam, "Influence of technologies like BIM, SAP and other tools for enhancement of quality and productivity of the organisation based on lean manufacturing techniques", *International Journal of Advance Research, Ideas and Innovations in Technology*, Vol. 4(4), 2018, p.133.
[18] Y. Xu, Y. Zhou, P. Sekula and L. Ding, "Machine learning in construction: From shallow to deep learning", *Developments in the Built Environment*, Vol. 6, 2021, p.1. DOI: 10.1016/j.dibe.2021.100045
[19] R. Eadie, H. Odeyinka, M. Browne and M. Yohanis, "An analysis of the drivers for adopting building information modelling", *Journal of Information Technology in Construction*, Vol. 13, 2013, pp.340-345.
[20] K. Agyekum, J. Ayarkwa and A. Acheampong, "Incorporating information technology in Quantity Surveying practice in Ghana: Challenges and Benefits", *International Journal of Engineering*, Vol. 13(4), 2015, pp.49-52
[21] D. Kadiri and E. Ayodele, Constraints to Quantity Surveying Awareness in Nigeria. *Civil and Environmental Research*, Vol. 3(11), 2013, pp.6-8.
[22] A. Aibinu, "Building Information Modelling Implementation in Practice: Lessons learned from a housing project in the Netherlands", In: *International Conference on Structural Engineering and Construction Management*. Melbourne: Kandy, 2015, pp.1-5.
[23] M. Mayouf, M. Gerges and S. Cox, "5D BIM: an investigation into the integration of quantity surveyors within the BIM process", *Journal of Engineering, Design and Technology*, Vol. 17(3), 2019, pp.537-553. DOI: 10.1108/JEDT-05-2018-0080
[24] O. Akinshipe, C. Aigbavboa, A. Oke, and M. Sekati, "Transforming Quantity Surveying Firms in South Africa Through Digitalisation", International Conference on Applied Human Factors and Ergonomics, Vol. 267, 2021, PP.256-259. DOI: http://dx.doi.org/10.1007/978-3-030-80876-1_33
[25] S. Babatunde, D. Ekundayo, O. Babalola and J. Jimoh, "Analysis of the drivers and benefits of BIM incorporation into quantity surveying profession", *Journal of Engineering, Design and Technology*, Vol. 16(5), 2018, pp.750-766. DOI: 10.1108/JEDT-04-2018-0058
[26] N. Musa, T. Oyebisi and M. Babalola, "A study of the impact of information and communications technology (ICT) on the quality of quantity surveying services in Nigeria", *Electronic Journal of Information Systems in Developing Countries*, Vol. 42(1), 2010, pp. 1-9. DOI: 10.1002/j.1681-4835.2010.tb00303.x
[27] J.O. Dada and N.A. Musa, "Key factors affecting the competence of quantity surveyors: evidence from construction industry stakeholders in Nigeria", *Journal of Engineering, Design and Technology*, Vol. 14(3), 2016, pp. 461-474. DOI: 10.1108/JEDT-09-2014-0060
[28] F.J. Sabongi, "The integration of BIM in the undergraduate curriculum: an analysis of undergraduate courses", Proceedings of the 45th Annual Conference of ASC, Gainesville, FL. 2009.
[29] P. Bhandari, "*How to create a research design*" 2021, (online) Available at: https://www.scribbr.com/methodology/research-design/ (Accessed 26 October 2021).
[30] N. Sanjivi, The impact of technological innovation on the role of the quantity surveyor in industry. Thesis (Masters'). Durban: University of KwaZulu-Natal, 2017.
[31] M. Bengtsson, "How to plan and perform a qualitative study using content analysis", *Nursing Plus Open*, Vol. 2(4), 2016, pp.8-14. DOI: 10.1016/j.npls.2016.01.001