CITC GLOBAL
Construction in the 21st Century

The Fourteenth International Conference on Construction in the 21st Century (CITC-14)
Rio de Janeiro, Brazil | **September 2-5, 2024**

Impediments to the Implementation of Building Information Modelling for Project Planning

Opeoluwa Akinradewo[1], Clinton Aigbavboa[2], Samuel Adekunle[2], Andrew Ebekozien[2] and David Ebiloma[2]

[1]Department of Quantity Surveying and Construction Management, Faculty of Natural and Agricultural Sciences, University of the Free State, Bloemfontein, South Africa
[2]cidb Centre of Excellence, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa
opeakinradewo@gmail.com

Abstract
BIM is an information management system that has eliminated many pitfalls that have plagued the industry in countries that have adopted it. BIM is widely used as a pre-construction tool where a digital representation of the facility is defined by the information added by different professionals through BIM's interoperability functionality. BIM improves the quality output of projects through features such as clash detection, which significantly reduces the need for Requests for Information (RFIs) and reworks. To seek ways to improve project quality and customer satisfaction and restore the construction industry's global market share, an assessment of the impediments to BIM usage for project planning is needed, which is what this study focused on. A quantitative research methodology was employed to retrieve data for this study. Data were retrieved using a questionnaire survey distributed to professionals in the South African built environment. The data retrieved were analysed using descriptive analysis. The study revealed that the top three impediments to implementing Building Information Modelling for project planning in the South African construction industry are a lack of support from top management, a lack of awareness of BIM benefits and a lack of BIM education. The study concluded that the various impediments to BIM implementation for project planning could be attributed to stakeholders' lack of knowledge about BIM in the construction industry. The study recommended government intervention by enforcing BIM within the industry or introducing policies encouraging BIM adoption.

Keywords
Building Information Modelling, Construction Industry, Project Management, Project Planning.

1. Introduction

Building Information Modelling (BIM) is an intelligent process or approach utilised by the Architecture Engineering and Construction Industry (AEC) to simplify and improve sustainability in construction works (Migilinskas et al., 2013). It incorporates different models of the proposed project into one to adequately visualise the project and effectively promote the sustainability of the project. It does this by early detection of structural clashes, cost calculation and control, identification of risky construction methods, and monitoring construction progress (Hall et al., 2022). The acronym BIM can be expanded into three meanings: Building Information Model, Building Information Modelling, and Building Information Management, each referring to different stages in which BIM is implemented (Wang & Chien, 2014). The Building Information Modelling stage was selected and implemented for this research study during the project planning phase. Most of the benefits of BIM are reaped during the early project phases (Sakikhales & Stravoravdis, 2017).
Windapo (2017) submitted that the use of BIM within the construction industry in South Africa is lower compared to the rest of the world. Although the use of BIM in South Africa has been implemented on several projects ranging in size, the author also noted that the young generation is not educated on the matter. At the same time, the older professionals are unwilling to embrace the change. In addition to the lag in implementing BIM in South Africa,

Negussie (2018) reported that Africa has a general problem of always falling behind and being the last continent to adapt. This problem can be attributed to poor leadership and a mindset arrest of the majority (Negussie, 2018). Published research studies on implementing Building Information Modelling in project planning in South Africa are limited. To add to the existing body of literature, an assessment of the impediments to using BIM in project planning must be carried out. This study is set to fill this gap in the body of knowledge. Therefore, this study is focused on answering the question, "What are the impediments to the implementation of BIM for project planning in South Africa?". This is to unearth the perceived impediments by construction professionals.

2. Building Information Modelling in the Construction Industry

The construction industry constructs and maintains the infrastructure on which almost every other industry depends (Mokoena & Mathibe, 2019). In addition, it contributes to the Gross Domestic Product (GDP) of a nation. It increases the employment rate, making it critical to the socio-economy of a nation (Kikwasi & Escalante, 2018). Mokoena and Mathibe (2019) stated that the construction industry's contribution to economic growth and long-term national development is generally recognised. Wibowo (2009) affirmed that the construction industry's economic significance arises from benefiting several parties involved in the supply chain, which has a snowball effect that generally leads to national growth of the economy. The author stated that it is achieved through its backwards and forward linkages. Furthermore, Windapo and Cattell (2013) agreed with this notion by stating that the construction sector is a complex cluster of industries, including banks, material and equipment producers, and contracting organisations.

According to Olanrewaju et al. (2021), the volatility associated with the construction industry in developing countries has given impetus to improve the nation's financial practices, noting that construction projects in these nations typically encounter several timing delays. The authors reiterate that the sector is dealing with a slew of productivity difficulties due to a lack of acceptance of emerging technologies or innovations such as but not limited to blockchain, Industry 4.0, the Internet of Things (IoT), and Building Information Modelling (BIM). As a result, emerging nations' building sector fails to meet government objectives for society and clients. Osunsanmi, Aigbavboa, and Oke (2018) stated that the banking, manufacturing, and retail sectors have embraced digitisation and information technology as a new strategy to ensure competitive advantage and efficiency, which has paid off. However, national regulators, sectors, and individual businesses are all moving at various rates and in different directions regarding digitisation. Whether it is players in the AEC value chain, technology providers, or governments, this unpredictability widens the gap between pioneers and latecomers (Gerbert, et al., 2016). According to Aghimien et al. (2018), digitalisation is more visible in the South African construction sector during the design and feasibility phases. The authors' research recommends that digital technology be used in other parts of construction other than feasibility and design due to the benefits of implementation. A Boston Consulting Group report affirmed this, stating that digitalisation will radically alter the game in AEC, increasing efficiency and quality along the value chain in construction (Gerbert et al., 2016). Hence, the South African construction industry can be the vanguard of implementing digital technology, starting with the SADC region. After all, technology is changing and developing at an unprecedented rate and pace worldwide. The contribution of new technology to economic growth may be appreciated only when and if it is broadly embraced and exploited (Takim, et al., 2013).

Seminal literature on project management in the construction industry, such as Bond et al. (2010), Demirkesen and Ozorhon (2017) and Chan & Chan (2004), stated that the AEC community are not accustomed to collaboration. Sakikhales & Stravoravdis (2017) noted that this is the case even in the early stages of a project. Architects, engineers, and contractors work individually during the project planning stage. Much double-handling takes place. Requests for Information (RFI), stagnation of work as drawings get finalised, and plant hires not being utilised all add to the cost of a project (Azmy, 2012). Most of these problems can be traced to the Design-Bid-Build project delivery method (Hardin & McCool, 2015). Governments of countries like the United Kingdom (Gledson, 2016) and the United Arab Emirates (Mehran, 2016) are reaping the benefits of BIM involved in its use in the early stages by creating and funding BIM governing bodies. This saw BIM moving away from being a visualisation and simulation software to being used as a design tool. However, seminal literature such as Elhendawi (2018), Smith (2014), Gledson (2016) alludes to the dangers of improper implementation. For instance, Windapo (2017) stated that improper implementation methods utilised in some projects undertaken in South Africa using BIM resulted in a higher cost than the original estimate. The author emphasised that professionals in the industry should acquire knowledge to implement BIM and its tools efficiently. Harriss (2018) pointed out a few problems with the adaptability of BIM in the South African construction industry. For instance, the high level of unemployment coupled with a surplus of unskilled labour has created a climate which seeks job creation above productivity. In corroboration, CIDB (2020) affirmed this stance by reinforcing that the industry has an oversupply of unskilled labour and a shortage of skilled labour. The report added that this impacts SMEs' profit margins.

2.1 Impediments of building information modelling implementation for project planning

Takim and Akintoye (2002) claimed that BIM implementation during the initiation phase from the project management phases, where important choices are taken, such as determining the project's objectives and planning its execution, has the greatest impact on the project's success. Since it is widely acknowledged that the sector must enhance its performance, the industry must provide better value for money while becoming more lucrative (Fairclough, 2002).

According to Lee and Borrmann (2020), policies are defined as written concepts or rules governing decision-making. Research institutes, educational institutions, and regulatory organisations are among the participants responsible for training practitioners, conducting research, disseminating benefits, and resolving disagreements amongst industry players. These players are specialist groups that do not produce building items (Wong et al., 2010). However, the South African government policy encourages construction firms to hire more workers to enhance the economy and relieve poverty while discouraging technological advancements (CIDB, 2007). Implementing BIM for project planning in the South African industry will alter the role of project managers. This is deduced from Kamyab (2018), who stated that the function of project managers in the architectural, engineering, and construction (AEC) sector has changed due to BIM. In principle, BIM promises project managers that it will improve communication and cooperation in the management of their projects, therefore boosting the AEC industry's efficiency and success rate, but BIM also comes with role alterations and a need to shift from linear project delivery methods (Sakikhales & Stravoravdis, 2017). In corroboration, Migilinskas, et al. (2013) state that drastic changes in work methods, personnel capabilities, relationships with clients and project implementation team participants, as well as contractual arrangements, are necessary

The process is "a specified ordering of work tasks over time and location, with a beginning, an end, and clearly defined inputs and outputs: a framework for activity" (Davenport, 1992). People who purchase, design, construct, produce, utilise, manage, and maintain building facilities or structures are included. In the case of BIM, there seems to be a chronic lack of understanding of the use of BIM from the parties involved in the process. For example, a quantity surveyor might be aware of BIM but is unsure of his/her maturity level or that he/she will operate in the sixth dimension of BIM (Ahmed, 2018). Initial adoption hurdles were unavoidable, such as significant investment requirements and a lack of industry-wide demonstration of value (Gerbert et al., 2016). For example, in the United Kingdom, SMEs were unable to adopt BIM level 2 as mandated by the government, and as a result, they missed out on both public and private sector projects. According to reports, 40percent of SMEs fail out on 90percent of the public projects they bid on, and more than 50% of SMEs have seen a decline in their success rate when bidding for public construction projects in the previous five years (Awwad et al., 2020).

According to Mehran (2016), a lack of uniform BIM standards hinders progress in implementation. It is argued that a strategy has to be in place to standardise the BIM process and establish the procedures for its use (Azhar et al., 2012). Furthermore, Odubiyi et al. (2019) argued that proper BIM standards will allow for a clear comprehension and interpretation of correct data. Arensman and Ozbek (2012) cautioned about the legal ambiguity of BIM. Who owns the model? Who has modification rights? who has distribution rights? who is liable for modifications or errors? how to handle copyright protection? and how to safeguard digital intellectual property. According to Turka & Klincb (2017), several writers have noted these legal problems as impediments to adopting BIM technology. Hall et al. (2018) noted that BIM adoption provides advantages, but due to management fears, adoption has been slow. Many studies state that BIM adoption will save time during construction, increase productivity, and ease decision-making (Gledson, 2016; Latiffi et al., 2013). In corroboration, KPMG's annual study (KPMG 2015) stated that 75% of construction and engineering executives are not leveraging modern technology to oversee project estimation and performance.

Takim et al. (2013) suggest that the dynamic character of the industry, the interconnectedness of many contributing organisations, and a need for a high level of coordination encourage the need to shift to a collaborative nature. However, the lack of collaboration is worsened by clients with no incentive for collaboration with other contracted parties in defining the solution that will best meet expected results (Koskela & Howell, 2008) even though the client decides on the project delivery method (Murphy & Ledwith, 2006). According to Wortmann et al. (2016), there are no standard BIM protocols for cross-industry collaboration; South Africa falls behind developed countries in BIM adoption. In addition, the authors identified the encouragement of stakeholder collaboration as an impediment to implementing BIM in the South African construction industry. According to Awwad et al. (2020), the reasons for this sluggish acceptance include the unique aspects of construction, the complicated nature of the sector, the immaturity of ICT, budgetary constraints, and a lack of knowledge of BIM implementation.

2.

3. Research Methodology

The rationale of the current study is to contribute to the body of knowledge on the impediments of BIM implementation in the South African construction industry. To achieve this, the study adopted the quantitative research approach. A quantitative research method is useful in getting information from a sample of people and reporting on the questions posed by the researcher (Pallant, 2006). When conducting a quantitative research study, the numerical measurement of specific aspects of phenomena is imperative and should be precise. The study retrieved data through a structured questionnaire distributed to respondents, including architects, construction managers, engineers, project managers, and quantity surveyors in the Gauteng province, South Africa. A 5-point Likert scale questionnaire was developed using information obtained from reviewed literature, with the questionnaire survey divided into two sections. The first section extracted information about the respondents' demographics, in which three questions were asked. The second section focused on the identified latent variables to measure the impediment. The choice of Gauteng province was because it houses most of the professionals within the country who are adopting modern technologies for construction activities. 189 questionnaires were randomly distributed to professionals within the study area between September and November 2021, and 167 questionnaires were recovered, totalling an 83% response rate. All the questionnaires recovered were deemed suitable after being reviewed for completion. The data obtained from the questionnaire were evaluated using the Mean Item Score (MIS) and Standard Deviation (SD). Cronbach's alpha was adopted to determine the reliability coefficient of the data collection instrument. The adopted cutoff alpha for this study was 0.70, and the analysis result indicated 0.93, making all data retrieved reliable (Pallant, 2006).

4. Findings and Discussion

According to the findings, most respondents work at a consultant firm, with the data indicating 48%. In contrast, contractors accounted for 28% of the population sample. Also, tertiary students and government employees comprise 12% of the total. The most common qualification among respondents was the BSc bachelor's degree (32%). In second place were the Honour's Degree (28%) and Diploma (28%). Fourth place was the master's degree (12%), and no Doctorate was recorded. An overwhelming majority of the respondents have worked for 0-3 years (60%); this indicates that the population sample is relatively inexperienced, followed by 4- 8 years of experience (28%), while 8% of the sample has 9-15 years of experience. Only 4% of the sample worked for more than 15 years. This indicates that the respondents possess above-average knowledge to provide tangible answers to the research question.

Table 1 captures the respondents' ranking of the factors affecting the impediments to the implementation of BIM. The highest-ranked impediment was lack of support from top management (MIS= 4.36, SD= 0.81), closely followed by a lack of awareness of BIM benefits in second rank (MIS= 4.2, SD= 0.913), while lack of BIM education was ranked third (MIS= 4.16, SD= 1.106). The last two ranked impediments are Lack of BIM standards (MIS= 3.52, SD= 1.447) and Project sizes too small for BIM (MIS= 3.52, SD= 1.447).

Table 1. Impediments to the implementation of Building Information Modelling for project planning.

Impediment	Mean Item Score	Std. Deviation	Rank
Lack of support from top management	4.36	.810	1
Lack of Awareness of BIM Benefits	4.20	.913	2
Lack of BIM education	4.16	1.106	3
Lack of BIM demand	4.12	1.092	4
Unwillingness to adapt to 4IR	4.08	1.187	5
Lack of Organisational restructuring required for BIM	4.04	1.136	6
Affordability	3.96	.978	7
Unfavourable Policies	3.92	1.256	8
Difficulties from the current environment	3.80	1.041	9
Lack of BIM-skilled Personnel	3.76	1.268	10
Fragmentation in the AEC industry	3.76	1.200	10
Security and Legal issues	3.64	1.221	12
SME's capability to adopt	3.60	1.041	13
No relevancy in the current construction climate	3.52	1.229	14

2.

Lack of BIM standards	3.52	1.447	15
Project sizes too small for BIM	3.28	1.308	16

The main impediment discovered in the study was the lack of top management support. This challenge is not unique to the context studied but has been widely recognised in various sectors and regions. According to KPMG's 2015 report, almost three-quarters of construction and engineering executives are not utilising current technology to manage project estimation and execution effectively. This indicates a significant gap in adopting advanced tools to enhance project efficiency and accuracy. Corroborating these findings, Enshassi et al. (2019) conducted a similar study and identified a lack of senior management support as a critical barrier. Their research highlighted additional factors, such as a lack of awareness of the benefits of Building Information Modelling (BIM) and inadequate BIM education. These factors contribute to the hesitance in adopting BIM technology, which is crucial for modern construction management. The current literature consistently supports these observations. For instance, Babatunde et al. (2020) found that a lack of senior management support, an absence of appropriate BIM guidelines, and a low level of BIM technical know-how and awareness were among the top six impediments to adopting BIM within the Nigerian construction industry. This study underscores the need for strategic leadership and comprehensive guidelines to facilitate BIM adoption. Awwad et al. (2020) examined the successful implementation of BIM Level 2 within the United Kingdom construction industry in a different geographical context. The author noted that while larger firms have successfully integrated BIM into their processes, Small and Medium-sized Enterprises (SMEs) were often left behind. This observation is significant because the composition of SMEs within the UK's construction industry is high, similar to the situation in many developing countries, including South Africa.

The prevalence of SMEs in South Africa's construction industry further reinforces the findings of this study. The lack of top management support and insufficient BIM education and awareness among SMEs presents a substantial barrier to the widespread adoption of BIM. Addressing these challenges requires targeted interventions aimed at improving managerial support, developing clear guidelines, and enhancing technical know-how through education and training programs tailored to the needs of SMEs.

5. Conclusions

The literature reviewed for this study revealed that fragmentation and management fears are among the recurring impediments to implementing BIM for project planning. Hence, many studies suggest a 'paradigm shift' is required to battle these impediments to utilise BIM fully.

The findings revealed that the top three impediments to implementing Building Information Modelling for project planning are a lack of support from top management, a lack of awareness of BIM benefits and a lack of BIM education. Therefore, it can be deduced that this research objective was met. BIM usage in South Africa is currently low, suggesting that it is primarily used on an ad-hoc basis. Hence, there is a need for a study of this nature to assist with understanding the impediments faced by professionals who have successfully implemented BIM for project planning. South Africa can be the vanguard of BIM since it is reported that BIM is still in its infancy across the continent.

As the world enters the fourth industrial revolution (4IR), tools such as BIM will be an integral part of construction. There is a thin line between pioneers and latecomers. The side that the South African construction industry will find itself on in the coming years depends on the reaction rate of the government (the industry's biggest client), prominent companies, and educational institutions. Hence, this study recommends investing in RandD for BIM specifically focused on South Africa, as identified in the research gap. Government intervention is needed, either through enforcing BIM usage within the industry or introducing policies that create a conducive environment for BIM adoption. The study was limited to AEC professionals within the South African construction sector. For future studies, attention can be focused on comparing the opinions of professionals across various regions.

References

Aghimien, D., Aigbavboa, C., Oke, A. and Koloko, N. (2018). Digitalisation in the construction industry: Construction professionals perspective. In *Proceedings of the Fourth Australasia and South-East Asia Structural Engineering and Construction Conference, Brisbane, Australia,* 3-5.

Ahmed, S. (2018). Barriers to Implementation of Building Information Modeling (BIM) to the Construction Industry: A Review. *Journal of Civil Engineering and Construction, 7*(2), 107-113.

Arensman, D. B. and Ozbek, M. E. (2012). Building information modeling and potential legal issues. *International Journal of Construction Education and Research, 8*(2), 146-156.

2.

Awwad, K., Shibani, A. and Ghostin, M. (2020). Exploring the critical success factors influencing BIM level 2 implementation in the UK construction industry: the case of SMEs. *International Journal of Construction Management*(https://doi.org/10.1080/15623599.2020.1744213).

Azhar, S., Khalfan, M. and Maqsood, T. (2012). Building information modelling (BIM): now and beyond. *The Australasian Journal of Construction Economics and Building, 12*(4), 15-28.

Azmy, N. (2012). The role of team effectiveness in construction project teams and. Iowa: Iowa State University.

Babatunde, S., Udeaja, C. and Adekunle, A. (2020). *Core.* Retrieved 11 3, 2021, from https://core.ac.uk/download/pdf/334458427.pdf

Bond, P., Dor, G. and Ruiters, G. (2010). *IDRC.* Retrieved 09 04, 2021, from https://idl-bnc-idrc.dspacedirect.org/handle/10625/48391

Chan, A. and Chan, A. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal, 11*(2), 203-221.

CIDB. (2007). *Construction Procurement: The procurement of professional services* . Pretoria: Construction Industry Development Board.

Davenport, T. (1992). *Process Innovation: Reengineering Work through Information Technology.*

Demirkesen, S. and Ozorhon, B. (2017). Impact of Integration Management On Construction Project Management Performance. *International Jpurnal of Project Management, 35*(8), 1639-1654.

Enshassi, M., Al Hallaq, K. and Tayeh, B. (2019). Limitation Factors of Building Information Modeling (BIM) Implementation. *The Open Construction and Building Technology Journal, 13*(1).

Elhendawi, A. (2018). Methodology for BIM implementation in KSA in AEC industry.

Fairclough, J. (2002). Rethinking construction innovation and research-a review of the government’s RandD policies and practices. *National Academies Report.*

Gerbert, P., Castagrino, S., Rothballer, C. R. and Filitz, R. (2016). *The Transformative Power of Building Information Modelling.* BCG .

Gledson, B. (2016). Exploring the Consequences of 4D BIM Innovation Adoption. Manchester: *Association of Researchers in Construction Management.*

Hall, A. T., Durdyev, S., Koc, K., Ekmekcioglu, O. and Tupenaite, L. (2022). Multi-criteria analysis of barriers to building information modeling (BIM) adoption for SMEs in New Zealand construction industry. *Engineering, Construction and Architectural Management*, (ahead-of-print).

Hardin, B. and McCool, D. (2015). *BIM and construction management: proven tools, methodsand workflows*. John Wiley and Sons.

Harris, V. (2018). BIM - It’s your move. Capetown: Oracle.

Kamyab, N. (2018). *Digital commons.* Retrieved 10 1, 2021, from https://digitalcommons.harrisburgu.edu/

Kikwasi, G. J. and Escalante, C. (2018). *Wider.* Retrieved 07 29, 2021, from https://www.wider.unu.edu/publication/role-construction-sector-and-key-bottlenecks-supply-response-tanzania

KPMG. (2015). *Climbing the curve 2015 Global construction Project owner’s survey.* Online.

Koskela, L. and Howell, G. (2008). The Underlying Theory of Project Management Is Obsolete. *IEEE Engineering Management Review, 36*(2), 22-34.

Latiffi, A., Mohd, S., Kasim, N. and Fathi, M. (2013). BIM Application in Malaysian Construction Industry. *International Journal of Construction Engineering and Management, 2*(4A), 1-6.

Lee, G. and Borrmann, A. (2020). BIM policy and management. *Construction Management and Economics , 38*(5), 413-419.

Mehran. (2016). Exploring the Adoption of BIM in the UAE Construction Industry for AEC Firms. *Procedia Engineering, 145*, 1110-1118.

Migilinskas, D., Popovb, V., V, J. and Ustinovichius, L. (2013). The Benefits, Obstacles and Problems of Practical Bim Implementation. *Procedia Engineering, 57*, 767-774.

Mokoena, N. and Mathibe, P. (2019). *Challenges in African Construction Markets: A Study Across Eastern and Southern African Countries.* African Competition Forum.

Murphy, A. and Ledwith, A. (2006). Project management tools and techniques in high-tech SMEs in Ireland. Limerick: University of Limerick .

Negussie, S. (2018). Why Africa Remains Underdeveloped Despite its Potential? Which Theory can Help Africa to Develop? . *Open Access Biostatistics and Bioinformatics, 1*(2).

Odubiyi, T., Aigbavboa, C., Thwala, W. and Netshidane, N. (2019). Strategies for Building Information Modelling Adoption in the South African Construction Industry. Canada.

Olanrewaju, O., Kineber, A., Chileshe, N. and Edwards, D. (2021). Modelling the Impact of Building Information Modelling (BIM) Implementation Drivers and Awareness on Project Lifecycle. *Sustainability, 13*.

2.

Osunsanmi, T., Aigbavboa, C. and Oke, A. (2018). Construction 4.0: The Future of the Construction. *International Journal of Civil and Environmental Engineering, 12*(3).

Sakikhales, M. and Stravoravdis, S. (2017). Using Agile Project Management and BIM. In M. Dastbaz, C. Gorseand A. Moncaster (Eds.), *Building Information Modelling, Building Performance, Design and Smart Construction* (pp. 65-79). Great Britain: Springer.

Smith, P. (2014). BIM Implementation - Global Strategies. *Procedia Engineering*, 482-492.

Takim, R. and Akintoye, A. (2002). Performance indicators for successful construction project performance. In *18th Annual ARCOM Conference* 2(4), 45-61.

Takim, R., Harris, M. and Nawawi, A. (2013). Building Information Modeling (BIM): A new paradigm for quality of life within Architectural, Engineering and Construction (AEC) industry. *Procedia - Social and Behavioral Sciences*, *101*(8), 23-32.

Turka, Z. and Klincb, R. (2017). Potentials of Blockchain Technology for Construction Management. *Procedia Engineering, 196*, 638 – 645.

Wang, C. and Chien, O. (2014). *The Use of BIM in Project Planning and Scheduling in the Australian Construction Industry*. Kunming.

Wibowo, A. (2009). The Contribution of the Construction Industry to the Economy of Indonesia: A Systemic Approach. Semarang: Diponegoro University.

Windapo, A. O. (2017). The Impact of Building Information Modelling on Quantity Surveying Practice and Project Performance. *Integrated Building Information Modelling*, 1-240.

Windapo, A. O. and Cattell, K. (2013). The South African construction industry: Perceptions of key challenges facing its performance, development and growth. *Journal of construction in developing countries*, *18*(2), 65.

Wong, K., Wong, K. and Nadeem, A. (2010). Attributes of Building Information Modelling Implementations in Various Countries. *Architectural Engineering and Design Management*, *6*(4), 288-302.

Wortmann, A., Root, D. and Venkatachalam, S. (2016). Building Information Modelling (BIM) Standards And Specifications Around The World And Its Applicability To The South African AEC Sector: A Critical Review.