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Potential Benefits of Implementing Building Information Modelling (BIM) in the Nigerian Construction Industry

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Abstract: Building Information Modelling (BIM) is an innovative technology that has transformed the way construction projects are delivered. It has helped to overcome the problems of cost and time overruns, poor quality, safety issues, dissatisfaction, and loss of profit, among others; associated with the traditional method of project delivery. Despite the enormous benefits of BIM, its adoption and implementation among construction companies in the construction industry of developing nations remained low. In order to drive and influence the wider implementation of BIM, this study assessed the perceived potential benefits of BIM in the Nigerian construction industry. The study adopted a survey approach in which well-structured questionnaires were used to gather data from construction professionals in Port Harcourt, Nigeria, using snowball sampling techniques. With 132 responses, the data gathered were analysed using frequencies, percentile, relative importance index (RII) and Kruskal-Wallis test. The study concluded the level of awareness of BIM is high while its adoption is low. Also, the potential benefits of BIM adoption that could encourage wider implementation in construction are; improve project quality, minimize errors and mistakes, better clash detection, reduced construction time, improve multi-party communication and collaboration, improve project documentation, improves efficiency and productivity, project cost reduction, and minimizes disputes and conflicts. The Government of Nigeria and other African countries should come up with a policy that would make BIM application in construction mandatory.

Keywords: BIM, BIM benefits, BIM implementation, BIM awareness, construction projects, Nigeria

1. Introduction

Globally, regardless of the level of development of a nation, the influence of the construction sector is robust and well-acknowledged on the growth and development of economies of nations. Onyeagam et al. (2019) described the construction sector as one of the dominant sectors that stimulate the provision of jobs and impact the activities of other sectors of the economy. Eze et al. (2019) see the construction industry as a sector that brings about economic growth, infrastructure acceleration, the apparent impact being a contribution to the GPD of nations, the creation of jobs, increased companies' revenue generation, housing and other infrastructure provisions. For Onyejeakor et al (2020), the construction sector is the mainstay and prime mover of economies of nations. Notwithstanding these vita and critical roles of the construction sector, construction projects are characterised by schedule overruns, budget overruns, poor quality, safety issues, claims and disputes and dissatisfaction of contract parties. Thus, projects poorly performed and delivered.

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The situation is blamed on the complexity of the construction project, operational inefficiency, level of uncertainty, poor productivity, absence of information reuse and management, poor collaborative working (Samimpay& Saghatforoush, 2020; Saka et al., 2020). In addition, the working practices of the construction sector are largely dependent on the traditional manual method of delivering projects. Hergunsel (2011) highlighted several solutions to improve the delivery and success of construction projects. Among these are the use of 3-D coding and modelling, integrated project delivery systems, among others. Similarly, de-Matos & Miranda (2018) suggested that the application of innovative technologies and processes in construction-related activities such as execution, projection, supervision; are essential to improve the use of resources and ensure better performance of projects. Building information modelling (BIM) stood out as an innovative method that aid effective collaborative working among project teams, and this have the effect of cost reduction, schedule improvement, improved quality delivery and safety performance, and better customer satisfaction and relationship (Azhar, 2011; Azhar et al., 2008; de-Matos & Miranda, 2018).

Building Information Modelling (BIM), according to (Rogers et al., 2015), is the breakthrough in technology that is essential to modernising construction work, which impacts positively on productivity and value addition to stakeholder groups. BIM is an integrated approach towards curbing construction industry ineffectiveness, and construction organisations must key into this innovative technology that is changing how project management is being carried out. For construction organisations to have a good standing within the industry, they must innovate to remain competitive and survive. This was pointed out by (Awodele et al., 2020) that the survival of construction organisations is reliant on effective competition. This can be achieved through the adoption of modern technologies. BIM application is mandatory in the UK and the impact has been unprecedented. The implementation level of BIM in the UK has increased from 13% from what it was in 2011 to 74% in 2018 (NBS, 2018). In South Korea, BIM is made compulsory for public projects whose budget is more than S$50; this is because of its benefits. In Brazil, BIM usage increased from 24% in 2013 to 73% in 2015 (Smart Market Report, 2015), in Japan, BIM usage increased from 27% in 2013 to 43% in 2015, and in the US, the usage of BIM was 79% in 2015 (Fitriani et al., 2019). BIM implementation experiences have grown in other countries such as; Denmark, Norway, Malaysia, Canada, Australia, and Singapore, among others (Saka et al., 2020).

Nevertheless, BIM diffusion in the construction industry and adoption and implementation by construction organisations is still slow and not as envisaged (Ayinla & Adamu, 2018). Even though the government of some developed countries have made appreciable efforts in the area of BIM incentives, they are still facing some challenges like the developing countries in BIM adoption. These changes in BIM adoption is also being experienced in Nigeria, as it is still an emerging country. The construction projects in Nigeria, like other developing countries, is marred by myriads of challenges such as time overruns, cost overruns, project delays, project abandonments, corruptions, disputes and generating wastes (Bello & Saka, 2017; Saka et al., 2019). Thus, the adoption and implementation of BIM would have tremendous value and relevance in the Nigerian construction industry in implementing construction projects. BIM technology diffusion is slow and the implementation level is poor as a result of the presence of some barriers such as lack of government support, lack of awareness, high cost of implementation and lack of implementation guidelines/strategies (Saka & Chan, 2019; Olugboyega & Aina, 2016; Abubakar et al., 2014).

While there are many studies on BIM that have emanated from developed countries, the same cannot be said about Nigeria, a developing country. Studies on BIM in Nigeria have been centered on the drivers and barriers to BIM (Amuda-Yusuf et al., 2015; Onungwa et al., 2017; Usman & Ashiru, 2019; Hamma-Adama & Kouider, 2019; Saka et al., 2020; Maina, 2018). BIM benefits are an area that has been neglected in literature by researchers, especially in the Nigerian context. This has not been given full attention, and this could be pointed to slow uptake and low adoption of BIM in Nigeria. Exposing contractors and other stakeholders to BIM benefits could help drive and propel the adoption level of BIM in the industry (Ibrahim et al., 2019). Knowing the benefits of an innovative practice could trigger the demand and supply, leading to creating a market (Eze et al., 2021). Makabate et al. (2020) advocated for more studies in the areas of BIM benefits to encourage more practices and use of BIM in the Architecture, Engineering and construction industries. It is based on this knowledge that this study assesses the potential benefits of BIM in the construction industry of Nigeria. This study covers the assessment of the potential benefits of BIM adoption in the construction industry of Nigeria, intending to enhance its implementation. The study is limited to the sampling of construction professionals (Architects, Builders, Engineers, and Quantity Surveyors) involved in the delivery of both private and public developmental projects in Port Harcourt, River State, Nigeria.

The outcomes of this study will improve the knowledge of BIM, and subsequently facilitate and drive BIM implementation and overcome the limiting barriers to their full-scale adoption for better productivity and performance of construction projects. A comprehensive grasp of the benefits of BIM by players in the construction sector will aid in overcoming the impediment that influences BIM adoption decisions in construction. This study will also be useful in ensuring the materialisation of BIM adoption in a short time in African and other developing countries of the world where its adoption is low.

2. Review of Literature

2.1 BIM Diffusion and Adoption in Nigeria and Other Developing Countries

BIM is a digital model comprising different information of a building system (Fitriani et al., 2019). According to Masood et al. (2014), Building Information Modeling (BIM) means "the development and implementation of a computer-generated model to integrate the planning, design, construction and operation of a facility". BIM is a documentation process that consists of information on the design, planning, construction, facility management and operation phases of a project (Kumar & Mukherjee, 2009). BIM represent an all-inclusive process that involves documentation that is beneficial to the operational visualisation of construction organisations, especially as it has to do with the estimation, scheduling, design coordination and resources management in construction projects.

While both developed and developing nations are still being confronted with one challenge or the other; the developed countries are ahead due to the efforts of some governments and institutions in those countries (Olawumi & Chan, 2019). Thus, BIM diffusion is yet to reach the target envisage (Ayinla & Adamu, 2018). The lack of government support and awareness, lack of guidelines or strategies for implementation and the high cost of implementation were identified as the cause of the slower rate of diffusion of BIM in developing nations (Lam et al., 2017; Sexton & Aouad, 2006; Jayasena & Weddikkara, 2013; Saka & Chan, 2019).

In the Middle East, the adoption rate of BIM is low at 30% (Yang & Chou, 2018), and it is relatively low in Africa, according to the report of Gerges et al. (2017). In Kenya, Nasila & Cloete (2018) reported that the Kenyan construction industry is still lagging in the application of BIM, and it has led to poor information management and coordination among project stakeholders. Othman et al. (2020) reported that in Malaysia, the implementation of BIM is low as only 13% of 268 participants from private and public organisations adopt BIM. This situation was blamed on poor awareness, slow adoption and lack of clear policies guideline. Regarding the level of awareness, Al-Ashmori et al. (2020) found that in Malaysia, BIM awareness is low. In the Indonesian construction sector, it was reported that despite the boom in construction, the implementation of BIM is low, especially among local contractors (Fitrianimet al., 2019; Telaga, 2018).

In Nigerian and other African countries, only a few studies reported on BIM adoption and implementation (Saka & Chan, 2019 Olawumi & Chan, 2019). The Nigerian construction industry, like most developing countries, is regarded as a 'BIM infant industry' (Jayasena & Weddikkara, 2013). This is despite the Nigerian construction sector being the largest in West Africa (Saka & Chan, 2019; Danwata, 2017). In Nigerian, Hamma-Adama and Kouider (2018) found that the adoption of BIM is low while the awareness level is reasonable.

The adoption of BIM has remained a challenging task due to the significant level of change management required and the overcoming individual resistance and being comfortable with the existing traditional methods. As a result of the inherent difficulty in implementing BIM, Gu & London (2010) reported that the mainstream construction organisations and projects are yet to enjoy the full benefits of BIM.

2.2 Benefits of BIM Adoption in Construction

BIM adoption comes with a lot of benefits that span project design, planning, construction through operation and maintenance. BIM benefits were categorised by Latiffi et al. (2013) into budget-related, schedule related, design aspects, communication-related and documentation. The essential underlying concerns of BIM adoption benefits are majorly due to project speed, clients, the system of innovation, competition, efficiencies and cost versus time (Ismail et al., 2015). The study of Ibrahim et al. (2019) indicate that at the design phase, the most important benefits of BIM are; concepts become clearer and project conceptualization easier, earlier and more accurate visualizations of a design to the owner, support decision making regarding the design, improve design quality, design and installation services coordination improved, improve design effectiveness, save design time and cost, enhance and improve planning process, enhance the accuracy of existing documentation, risk reduction, and increase attention to the selection of the components of construction at early stages. At the construction phase, the most important benefits of BIM adoption are; clash detection, the improvement in constructability, error reducer, rework and waste for better sustainability for construction, the improvement in understanding the sequence of construction activities and duration, the improvement in synchronization of design and construction planning, the enhancement of productivity through time and cost-saving, the enhancement of contractors ability to make informed decisions, by estimation, coordination and scheduling the construction process, reducing whole project's life cycle cost the improvement in visualization of construction details, and dispute resolution. In addition, at the operation and maintenance phase, the major benefits of BIM according to (Ibrahim et al., 2019) are; The information on a building life cycle can be shared more easily, The improvement in collaboration, The enhancement of environmental sustainability, Reducing the risk of losing project information, and The enhancement of the control of the whole life costs.

Newton and Chileshe (2012) state that BIM helps to improve design, Chen & Baddeley (2015) highlighted the benefits of BIM to include better clash detection, better coordination, better synchronization, better projects sequencing, enable the project team to access and interrogate information of the project. The most important advantages of BIM in the construction industry of Jordan according to the report of Matarneh & Hamed (2017) are; reduce rework during construction, maximizing productivity, reduce conflict/changes, clash detection, enhance communication & collaboration, improve visualization, improve project documentation, faster & more effective method, improve quality, and enhance design review. BIM improve the reliability of anticipated field conditions, enable visualisation of the built environment, give room for more off-site materials prefabrication (Rajedran and Clarke, 2011). Li et al. (2014) through a case study that compared five projects in Asia, found that BIM allows for design flexibility, improves the precision of drawings, improves safety and productivity, allows for clash detection, facilitate equipment and asset maintenance and management, and provides a digital model that can be utilized throughout the building life cycle.

Ullah et al., (2019) grouped the benefits of BIM into three phases which are pre-construction, construction and post-construction. At the preconstruction phase, BIM enables a more accurate and speedy estimation of cost, leads to sustainable design (Khosrowshahi, 2017), improvement in energy efficiency, improved concept and feasibility, and resolve clash issues in designs through visualisation of a model (Eastman et al., 2011; Latiffi et al., 2016). BIM at the construction phase helps to improve resources planning and sequencing (Kjartansdottir et al., 2017), allows for effective management of project resources procurement and storage (Eastman et al., 2011), aids the fabrication of building components offsite (Enshassi et al., 2018), allows for effective and efficient utilisation of site (Deshpande and Whitman, 2014), and improve health and safety performance of projects through reduction of congestion on-site (Khosrowshahi, 2017). The most important post-construction benefits of BIM according to (Kjartansdottir et al., 2017; Husain et al., 2014; Enshassi et al., 2018) are; makes scheduling of maintenance work easy, better access to information during maintenance, the management of assets is improved with faster and more accurate information, ad improves decision making at the operation and maintenance of a facility. BIM has the potential to increase construction projects quality, efficiency and productivity. This is based on its capability to reduce mistakes and errors, mismatches, provision of accurate and updated information, and improve building illustration and accessibility (Eastman et al., 2011).

In Malaysia, Al-Ashmori et al. (2020) found that the most important benefits of BIM adoption are; increase productivity and efficiency, assess time and cost associated with design changes, eliminating clashes in design, improving multi-party communication and maintaining synchronize communication, integrating construction scheduling & planning, identify time-based clashes and monitor and track progress during construction. Wong et al. (2020) state that BIM has a more significant positive impact on productivity and this can be useful in encouraging SMEs to transition from the traditional construction approach to the adoption of a more viable approach involving the use of BIM. BIM support and improves the services rendered by professionals in the built environment (Olatunji et al., 2021). The most frequently reported benefit of BIM in literature is cost reduction and control through the life cycle of the projects (Makabate et al., 2020; Bryde et al., 2013).

According to Samimpay & Saghatforoush (2020), BIM is among the latest innovations in construction that has improved the speed of problem resolution. It was further stated that when applied by construction professionals, it has the capability to minimise design errors and mistakes, improve cost and time performance of projects, design improvement, increase project coordination and stakeholders cooperation, and improve construction integration. All these determine and influence the constructability of a project (Samimpay & Saghatforoush, 2020). BIM has the potential to save cost, minimise design clash, enable quality and informed decision making, improve the performance of projects, and better collaborate (Farnsworth et al., 2014). The adoption of BIM-based tools enables an Architect or engineer to incorporate novel approaches that could minimise risks and hazards on construction project sites (Fargnoli & Lombardi, 2020). Risks management involves every stakeholder and BIM facilitate data exchange and better communication and collaboration among stakeholders.

Thirty-two (32) benefits of BIM were selected from the literature and summarised in table 1 below.

Table 1- Summary of selected BIM benefits

S/N	benefits of BIM	Sources
1	Improve design	Newton & Chileshe (2012); Li et al. (2014); Samimpay & Saghatforoush (2020); Ibrahim et al. (2019)
2	Better clash detection	Chen & Baddeley (2015); Li et al. (2014); Ibrahim et al. (2019); Latiffi et al., 2016); Ullah et al. (2019); Eastman et al. (2011); Al-Ashmori et al. (2020); Matarneh & Hamed (2017); Samimpay & Saghatforoush (2020); Farnsworth et al. (2014)
3	Better coordination	Samimpay & Saghatforoush (2020); Ibrahim et al. (2019); Chen& Baddeley (2015); Al-Ashmori et al. (2020); Farnsworth et al. (2014)
4	Reduce rework in construction	Ibrahim et al. (2019); Matarneh and Hamed (2017)
5	Better synchronization	Chen & Baddeley (2015); Ibrahim et al. (2019); Al-Ashmori et al. (2020
6	Better projects sequencing	Chen & Baddeley (2015)
7	Give room for more off-site	Rajedran & Clarke (2011); Enshassi et al. (2018)

	materials/components prefabrication	
8	Enable visualization of the built environment	Rajedran & Clarke (2011); Matarneh & Hamed (2017)
9	improves health and safety	Li et al. (2014); Ibrahim et al. (2019); Khosrowshahi (2017); Fargnoli & Lombardi (2020)
10	Allow for flexibility and sustainable design	Li et al. (2014);Ibrahim et al. (2019); Matarneh & Hamed (2017);Khosrowshahi (2017); Ullah et al., (2019)
11	Facilitate equipment and asset maintenance and management	Li et al. (2014);Ibrahim et al. (2019); Kjartansdottir et al. (2017); Enshassi et al., 2018
12	Provides a digital model that can be utilized throughout the building life cycle.	Li et al. (2014); Makabate et al., (2020); Bryde et al. (2013)
13	More accurate and speedy estimation of project cost and time	Khosrowshahi (2017); Ibrahim et al. (2019); Ullah et al., (2019); Al-Ashmori et al. (2020);
14	Improvement in energy efficiency	Eastman et al. (2011); Ullah et al. (2019)
15	Improve resources planning and sequencing	(Kjartansdottir et al. (2017); Al-Ashmori et al. (2020)
16	Effective management of project resources procurement and storage	Eastman et al. (2011),Ibrahim et al. (2019)
17	Improve efficiency and productivity	Li et al. (2014); Eastman et al. (2011); Ibrahim et al. (2019); Al-Ashmori et al. (2020); Wong et al. (2020); Matarneh and Hamed (2017)
18	Allow for effective and efficient utilisation of site	Deshpande & Whitman (2014)
19	Improves decision making at the operation and maintenance of a facility.	Enshassi et al. (2018); Ibrahim et al. (2019); Farnsworth et al. (2014)
20	Access to information is fast and reliable	Kjartansdottir et al. (2017); Husain et al. (2014)
21	Provision of accurate and updated information	Eastman et al. (2011);Ibrahim et al. (2019)
22	Improve multi-party communication and collaboration	Al-Ashmori et al. (2020); Matarneh & Hamed (2017); Samimpay & Saghatforoush (2020)
23	Monitor and track progress during construction	Al-Ashmori et al. (2020); Ibrahim et al. (2019)
24	Improve services delivery	Olatunji et al. (2021); Ibrahim et al. (2019)
25	Project cost reduction	Samimpay & Saghatforoush (2020); Ibrahim et al. (2019); Makabate et al. (2020); Bryde et al. (2013); Matarneh & Hamed (2017); Kalfa (2018); Farnsworth et al. (2014)
26	Reduced construction time	Matarneh & Hamed (2017);Ibrahim et al. (2019); Samimpay & Saghatforoush (2020); Kalfa (2018)
27	Improve quality	Matarneh & Hamed (2017);Samimpay & Saghatforoush (2020); Ibrahim et al. (2019); Yin et al. (2019); Farnsworth et al. (2014)
28	Improve project documentation	Matarneh & Hamed (2017);Ibrahim et al. (2019)
29	Minimises disputes and conflicts	Matarneh & Hamed (2017);Samimpay & Saghatforoush (2020);
30	Minimise errors and mistakes	Eadie et al. (2013); Ibrahim et al. (2019); Latiffi et al. (2013); Samimpay & Saghatforoush (2020)
31	Constructability improvement	Samimpay & Saghatforoush (2020);Ibrahim et al. (2019); Mohandes & Omrany (2013); Rokooei (2015); Diaz (2016); Eadie et al. (2013),
32	Improving team building skills	Rokooei (2015); Ibrahim et al. (2019); Mohandes & Omrany (2013)

3. Research Methodology

The purpose of this study was to assess the potential benefits of BIM adoption in the construction industry. This study adopted a survey questionnaire to achieve its aim. The well-structured questionnaire designed using information obtained from a detailed literature review was administered to construction professionals (Architects, Builders, Engineers, and Quantity Surveyors) involved in the delivery of both private and public developmental projects in Port Harcourt, River State, Nigeria. The sampled professionals are those engaged by contractors, consultants and public sector organisation involved in construction-related developments. River state has Port Harcourt as its capital and it is one of the states in Nigerian that is endowed with oil and gas and other natural resources. These attract investors, developers, professionals and tradespeople to the state. In addition, the state government is implementing many building and infrastructure projects that have led to the influx of people from all works of life (Onyejeakor et al., 2020; Eze et al., 2020). The construction professionals constitute the larger proportion of the experts employed by construction-based organisations, and the category of workers play a critical role in ensuring the diffusion and implementation of innovative practices in the construction industry (Eze et al., 2020; Eze et al.2021).

The adoption of the questionnaire is premised on the understanding that is easy to use and it can cover a larger audience at a relatively shorter duration, and it is a common social research instrument (Tan, 2011; Blaxter et al., 2001). The questionnaire used gathered data on the respondents' background details, level of awareness and implementation of BIM, and the potential benefits of BIM in construction. The questionnaire was design based on a 5-point Likert scale in which 1 is the lowest scale and 5 is the highest scale. The 5-point Likert scale is common among construction management and BIM based studies such as Ibrahim et al. (2019), Eadie et al., (2013) and Masood et al. (2014). The criteria for participating in the survey are; i) participants must have spent (or have) at least five years experiences in construction project delivery, ii) must still be employed at the time of being sampled, iii)must be knowledgeable on innovative ICT tool and technologies used in construction, iv), practice in construction organisations or projects within the study area. These criteria were meant to ensure that the data obtained were unbiased and of good quality. To ensure that only qualified participants took part in the survey, these criteria were consciously stated in the questionnaire.

The snowball sampling techniques were adopted in administering the questionnaire by the researchers and with the help of trained research assistants. This sampling approach was adopted as it was impracticable to get the sample size of professionals who met the study criteria from any organisations database within the study area. Snowball sampling techniques rely on referral (Heckathorn, 2011), and it can increase the response rate of a study significantly (Atkinson and Flint, 2001). A total of 132 responses were received and were deemed satisfactory for analysis as they were sufficient compared to previous studies which adopted similar sampling techniques.

The gathered data were analysed using frequencies, percentiles, relative importance index (RII) and Kruskal–Wallis H test. The RII ranked the Potential benefits of BIM adoption in construction while the Kruskal–Wallis H test was used to determine if a significant difference existed in the perception of the various category of professional participants. The reliability index of the research instrument was ascertained using Cronbach's alpha test. The alpha value of 0.927 was obtained for the 32 selected benefits of BIM adoption (see table 2), and this indicates that the instrument is highly reliable. The data obtained are of good quality and unbiased. The methodological flow chart is shown in figure 1 below.

Table 2 - Reliability test

			N	%
Cases	**Case Processing Summary**	Valid	132	100
		Excluded[a]	0	0.00
		Total	132	100
	Reliability Statistics	Cronbach's Alpha	0.972	
		N of Items	32	

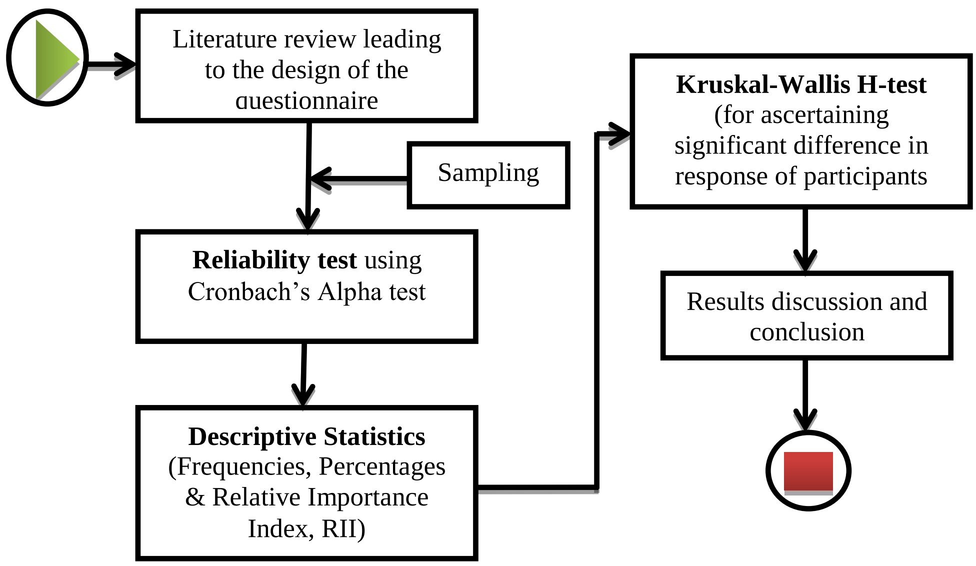

Fig. 1 - Methodological flow chart

4. Results and Discussion

4.1 Respondents Background Information

The analysis of the background information of the respondents shows that 44.70% work with contracting organisations, 32.58% work with consulting organisations and 22.73% work with organisations own by the government. The professional make-up of the participants showed that Architects are (15.15%), builders (12.88%), Engineers (40.155), and Quantity surveyors (31.82%). Their years of experience shows that those who have spent 5-10 years in the industry are (25.76%), 11-15years are (41.67%), 21.21% had spent 16-20years, and those who have spent over 20 years are 11.36%. The educational qualification of the participants indicates that HND holders are (12.12%), PGD (6.82%), BSc/B.Tech (52.27%), M.Sc/M.Tech (27.27%), and PhD holders are 1.52%. Furthermore, the professional qualification of the respondents indicates that the majority of them are fellow and corporate members of their professional bodies.

The details of the respondents show that they are academically and professionally qualified with the requite years of experience to give information that will aid the subject of this study.

Table 2 - Background information of participants

Category	Classification	Frequency	Per cent
Respondents Organization	Contracting	59	44.70
	Consulting	43	32.58
	Public organization	30	22.73
	Total	**132**	**100.00**
Profession of respondents	Architects	20	15.15
	Builders	17	12.88
	Engineers	53	40.15
	Quantity Surveyors	42	31.82
	Total	**132**	**100.00**
Years of experience	5 - 10years	34	25.76
	11-15 years	55	41.67
	16-20 years	28	21.21
	Above 20	15	11.36
	Total	**132**	**100.00**
Academic Qualification	HND	16	12.12
	PGD	9	6.82
	BSc/B.Tech	69	52.27
	M.Sc/M.Tech	36	27.27
	PhD	2	1.52
	Total	**132**	**100.00**
Professional cadre	Fellow member	13	9.85
	Corporate member	109	82.58
	Probationer member	10	7.58
	Total	**132**	**100.00**

4.2 Level of Awareness of BIM

Figure 1 shows the result obtained from the analysis of the data gathered on the level of awareness of BIM in construction industry. It can be seen that the level of awareness of BIM is high. This decision is informed by the participants who indicated that they are aware of BIM. This finding supports the report of Hamma-Adama & Kouider (2018) who found that the awareness level of BIM is reasonable. However, it is not in line with the findings of Al-Ashmori et al. (2020) who reported low BIM awareness in Malaysia.

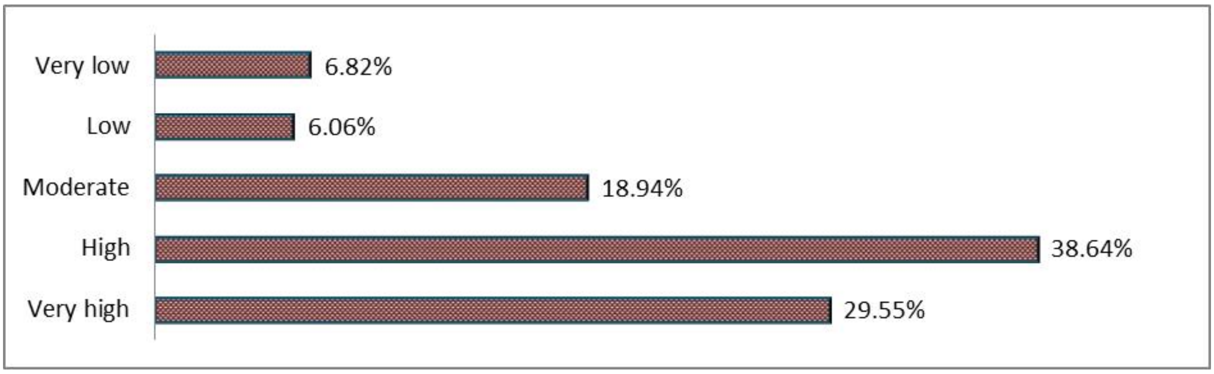

Fig. 1 - Level of awareness of BIM in construction

4.3 Level of Adoption of BIM

For the level of adoption of BIM in construction, the respondents indicate that BIM adoption is low. The respondents' responses show that BIM adoption ranges from moderate (21.97%) to very low (24.24%). Only are very few of the participants indicates that they adopt BIM, this is evidence as 11.36% indicate high adoption level and 5.30% indicate a very high level of adoption. It is obvious that there is a mismatch between the BIM awareness level and the adoption level. There is a considerable gap between BIM awareness and its actual adoption and implementation by construction organisations and professionals. This situation could be blamed on the existence of numerous barriers to its implementation in the industry. This finding is in line with the reports of (Nasila and Cloete, 2018; Othman et al., 2020; Fitrianimet al., 2019, Telaga, 2018; Saka and Chan, 2019; Olawumi and Chan, 2019)

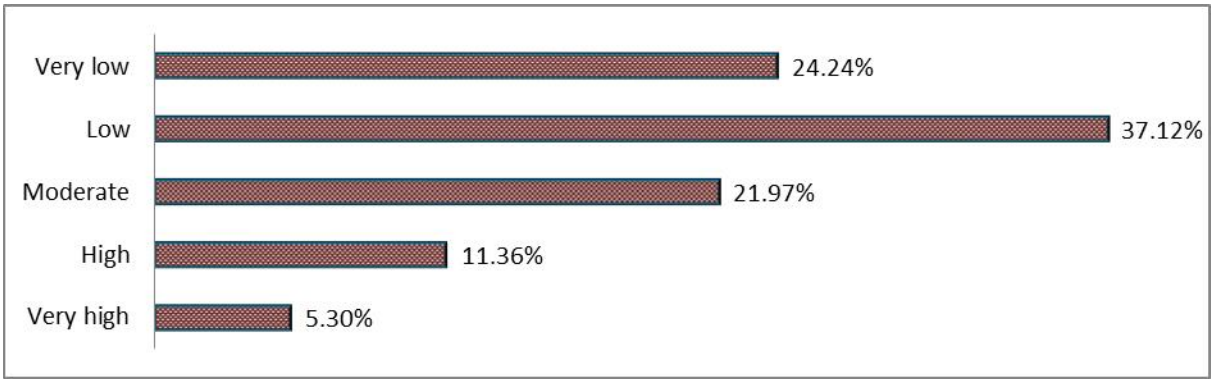

Fig. 2 - Level of adoption of BIM

4.4 Benefits of BIM Adoption in Construction

The result of the analysis of data gathered on the benefits of BIM adoption in construction is shown in Table 3. The most important benefits of BIM adoption in construction are; reduce rework in construction (RII=0.976), improve project quality (RII=0.962), minimise errors and mistakes (RII=0.956) better clash detection (RII=0.953), reduced construction time (RII=0.948), improve multi-party communication and collaboration (RII=0.947), improve project documentation (RII=0.944), improves efficiency and productivity (RII=0.939), project cost reduction (RII=0.933), and minimise disputes and conflicts (RII=0.932). While the least important benefits of BIM adoption based on this study is are; facilitating equipment and asset maintenance and management (RII=0.867), improvement in energy efficiency (RII=0.867), provision of accurate and updated information (RII=0.862), monitor and track progress during construction (RII=0.855), improving team-building skills (RII=0.853), give room for more off-site materials/components prefabrication RII=0.836), Access to information is fast and reliable (RII=0.823), improves decision making at the operation and maintenance of a facility (RII=0.820), more accurate and speedy estimation of project cost and time (RII=0.818), and allow for flexibility and sustainable design (RII=0.802).

Overall, regardless of the relative ranking of these variables, they still represent the vital function of BIM adoption in construction projects. This is based on the range of the RII values, with maximum RII being =0.976 (97.60%) and the Minimum=0.802 (80.20%), and an average RII of 0.895 (89.50%). BIM benefits in construction are very high and these innovative tools are shown to be adopted in the delivery of every construction project if resource permits. The result in this study supports what has been documented extant literature such as (Chen and Baddeley, 2015; Li et al., 2014; Farnsworth et al., 2014; Ibrahim et al.,2019; Latiffi et al., 2016; Ullah et al., 2019; Eastman et al., 2011; Fitriani et al., 2019; Al-Ashmori et al., 2020; Matarneh and Hamed, 2017; Samimpay and Saghatforoush, 2020). One of the greatest problems confronting the construction industry is 'rework'. Rework has been blamed for some of the issues related to cost overruns, time overruns, poor quality, increase waste, disputes and loss of profits. BIM is found to minimise this problem on construction projects as indicated by (Ibrahim et al., 2019; Matarneh and Hamed, 2017).

BIM allows for the visualisation of the proposed building as it provides a digital model of the object. Clashes in the building services and the system could be located and eliminated to improve project performances with regards to time, cost, quality, among others (Eastman et al., 2011; Al-Ashmori et al., 2020; Matarneh and Hamed, 2017; Samimpay and Saghatforoush, 2020). Farnsworth et al. (2014) reported that BIM had revolutionised the way construction projects are delivered. The key potentials of BIM are savings in cost, minimising design clash, enabling quality and informed decision making, improving the performance of projects, and better collaboration. Fitriani et al. (2019) reported that the most significant benefits of BIM are its tendency to reduce cost and project duration, which is consistent with the finding in this study.

BIM is one of the advances in a technological revolution that tends to reduce errors and mistakes in designs and project documentations. When errors in design and other contract documents are minimised or eliminated, changes and rework that could impact project baselines like the time and budget are reduced. Also, changes and rework during construction result to waste generation that impacts the environment. The finding of the study regarding BIM reducing project cost, duration, rework and mistakes are in line with the submission of (Samimpay & Saghatforoush, 2020).

Enhancement of efficiency and productivity is another critical advantage of the adoption of BIM. The potential causes of delays, mistakes in designs and other documents are eliminated during visualisation using BIM, delays and interferences are avoided during the production stage. Thus, work will progress with ease with better productivity. Effective communication and collaborative working among the multi-stakeholders of the construction project is another vital benefit of BIM adoption. Effective communication and information sharing is major element of good teamwork and driver of a successful project. Al-Ashmori et al. (2020) reported that increasing productivity and efficiency, and improve multi-party communication and maintaining synchronise communication are among the most essential benefits of BIM adoption in the construction industry.

To determine if there is a significant difference in the view of the participants regarding the rating of the assessed variables, The Kruskal– Wallis test was conducted. It is obvious from Table 3 that the p-value of 22% (7) variables are below the significant value of 0.05. This means that the participants hold a divergent opinion on the rating of the affected benefits of BIM. These variables in which the perception of the respondents differ are; Improve services delivery (RII=0.914, Sig=0.000), provides a digital model that can be utilized throughout the building life cycle (RII=0.894, Sig=0.017), effective management of project resources procurement and storage (RII=0.885, Sig. =0.000), facilitate equipment and asset maintenance and management (RII=0.867, Sig.=0.001), Provision of accurate and updated information (RII=0.862, Sig.=0.016), monitor and track progress during construction (RII=0.855, Sig.=0.003), improve decision making at the operation and maintenance of a facility (RII=0.820, Sig.=0.014).

The difference in rating by the different professionals does not invalidate these roles played by BIM in the construction industry. The difference in the ranking of the affected variables by the participants showed the different levels of knowledge and usage by the professionals and their employers. It further reflects the unevenness in the usage and knowledge of BIM in the construction industry of developing countries. It also shows the relative application of BIM at various stages of construction project development. However, 25 (78%) of the assessed variables had their p-value of greater than 0.05, implying that there a no significant statistical difference in the rating by the respondents. The respondents' have a convergent opinion on these variables. It can be concluded that the construction industry stakeholders agree on the assessed benefits of BIM, especially as it has to do with its adoption in construction.

Table 3 - Benefits of BIM adoption in construction

S/N	Variables	RII	Rank	Kruskal Wallis Test		
				Chi-Square	**P-value**	**Decision**
1	Improve project design	0.915	13	7.657	0.054	Accept
2	better clash detection	0.953	4	3.013	0.390	Accept
3	better coordination	0.871	20	1.205	0.974	Accept
4	Reduce Rework in Construction	0.976	1	3.557	0.313	Accept
5	better synchronization	0.870	21	6.733	0.081	Accept
6	better projects sequencing	0.867	22	7.104	0.069	Accept
7	give room for more off-site materials/components prefabrication	0.836	28	2.284	0.516	Accept
8	enable visualization of the built environment	0.891	17	4.903	0.179	Accept
9	improves health and safety	0.923	12	4.862	0.095	Accept
10	Allow for flexibility and sustainable design	0.802	32	0.474	0.407	Accept
11	facilitate equipment and asset maintenance and management	0.867	22	15.920	0.001*	Reject
12	Provides digital model that can be utilized throughout the building life cycle.	0.894	16	10.249	0.017*	Reject

13	more accurate and speedy estimation of project cost and time	0.818	31	4.363	0.225	Accept
14	improvement in energy efficiency	0.867	22	7.096	0.069	Accept
15	improve resources planning and sequencing	0.876	19	4.203	0.240	Accept
16	effective management of project resources procurement and storage	0.885	18	18.968	0.000*	Reject
17	allows for effective and efficient utilization of site	0.924	11	0.962	0.294	Accept
18	Improves efficiency and productivity	0.939	8	0.947	0.814	Accept
19	Improves decision making at the operation and maintenance of a facility.	0.820	30	10.579	0.014*	Reject
20	Access to information is fast and reliable	0.823	29	7.391	0.060	Accept
21	Provision of accurate and updated information	0.862	25	10.341	0.016*	Reject
22	Improving team building skills	0.853	27	0.615	0.720	Accept
23	monitor and track progress during construction	0.855	26	13.847	0.003*	Reject
24	Improve services delivery	0.914	15	21.279	0.000*	Reject
25	Project cost reduction	0.933	9	7.293	0.063	Accept
26	Reduced Construction Time	0.948	5	3.456	0.326	Accept
27	Improve project Quality	0.962	2	4.049	0.088	Accept
28	Improve project documentation	0.944	7	1.378	0.711	Accept
29	improve multi-party communication and collaboration	0.947	6	5.381	0.146	Accept
30	Minimize Errors and mistakes	0.956	3	1.924	0.588	Accept
31	Constructability improvement	0.915	13	0.907	0.819	Accept
32	Minimizes disputes and conflicts	0.932	10	0.738	0.864	Accept

*p-value <0.05

The level of significance of the respondents' perception was further assessed by combining the general rating of BIM benefits. Kruskal-Wallis Test result in table 4 shows that there is no significant difference in the view of the respondents regarding the rating of the assessed benefits of BIM adoption. The p-value of 0.178 obtained for the variables assessed is greater than the significant value of 0.05. The participants' opinions converge on the assessed variable, and this implies that the construction industry stakeholders agree on the potential benefits of BIM adoption in the construction industry of Nigeria and, by extension other developing countries of Africa which have similar economic terrain.

Table 4 - Kruskal-Wallis Test for the participants

Variable	Respondents category	N	Mean Rank	df	Chi-Square	Asymp. Sig.
Benefits of BIM adoption	Architects	20	91.40	3	5.221	0.178
	Builders	17	79.06			
	Engineers	53	55.39			
	Quantity Surveyors	42	63.58			
Total		**132**				

5. Conclusion and Recommendations

The purpose of this study was to assess the potential benefits of BIM adoption in the construction industry, with a view to encouraging BIM implementation. The study sampled the opinion of construction professionals using a questionnaire and snowball sampling technique in Port Harcourt, River State, Nigeria. The study assessed the benefits of BIM and the level of awareness and implementation of BIM in construction, and critical findings were made.

The study concludes that the level of awareness of BIM is high while its adoption and implementation is low. Also, the potential benefits of BIM adoption that could encourage wider implementation in Nigerian are; improve project quality, minimise errors and mistakes, better clash detection, reduce construction time, improve multi-party communication and collaboration, improve project documentation, improves efficiency and productivity, project cost reduction, and minimises disputes and conflicts. BIM implementation in construction has the potential to resolve the numerous problems that normally mar construction projects globally. Construction projects are usually characterised by time overruns, cost overruns, poor quality, rework, wastes, disputes, poor communication and collaboration among project participants. BIM is a panacea to these problems, and it is obvious that there is a wide gap in its implementation. This can hamper the construction industry not to enjoy the benefits associated with this innovative technology fully.

Professional organisations in the construction industry are encouraged to widen and strengthen the campaign on BIM, this is to further ensure that the benefits are properly communicated to the construction community. Government should come up with a policy that will make BIM application in construction mandatory. The government is the largest client of the construction industry and therefore a critical stakeholder that should make strategies policies and regulations that should mandate public projects to implementation BIM. Appropriate legislation targeted at meeting the concern of sustainable development goals should be enacted by the government. This must be followed by strict monitoring to ensure total compliance in the use of BIM on construction projects. This is because BIM driver sustainability in construction project delivery.

The implication of this study is that construction experts are informed of the benefits associated with BIM adoption, which will go a long way in influencing the decision of clients and management to implement BIM on their projects. Also, contractors are exposed to BIM benefits which could help drive and propel the adoption level of BIM in the industry. Knowing the benefits of an innovative practice could trigger the demand and supply, leading to the creation of a market. This is true as there exists a wide gap between BIM awareness and actual implementation in the construction industry. This study adds to the few existing bodies of knowledge on BIM, especially in Nigeria and other BIM infant nations. This study is however limited by its geographical boundary and sample size. Adequate care should be taken in generalizing the outcome of this study. A similar study is, therefore, recommended in other states of Nigeria or other African countries, so that information will be available for comparison. This study is focused on the potential benefits of BIM application in construction. However, its use if low while the awareness is high. A study that will investigate the problems or challenges, or drawbacks to the full implementation of BIM in the Nigerian construction industry is needed. Rework is a systemic problem in construction, a study that could develop a BIM-based model for managing rework could be embarked upon.

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