International Journal of Built Environment and Sustainability

IJBES

Volume 5, Issue 2, 2018
May 2018

E-ISSN:2289-8948
ISSN: 1511-1369

Published by
Faculty of Built Environment
Universiti Teknologi Malaysia
In collaboration with
Penerbit UTM
Universiti Teknologi Malaysia
81310, Johor Bahru, Malaysia

IJBES

International Journal of Built Environment and Sustainability

http://ijbes.utm.my

Mail Address:
International Journal of Built Environment and Sustainability
Faculty of Built Environment
Universiti Teknologi Malaysia
81310, Johor Bahru, Malaysia
Telephone: +60-7-5537382
Email: ariva@utm.my and ijbes@utm.my

Cover Design and Type-set by: AS Permana/S Bandi

The IJBES is an international peer-reviewed Journal
Published in collaboration between Faculty of Built Environment and Penerbit UTM

E-ISSN: 2289-8948
ISSN: 1511-1369

IJBES

Volume 5, Issue 2, 2018

Table of Contents

INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 5(2)/2018, 127-133

Evaluating the Critical Success Factors of Industrialised Building System Implementation in Nigeria: The Stakeholders' Perception

Edo Oga Ojoko [a]; Mohd Hanim Osman [b]; Ahmad Baharuddin Abdul Rahman [b]; Norhisham Bakhary [b*]

[a] School of Environmental Studies, Federal Polytechnic Nasarawa, PMB 001, Nasarawa State, Nigeria.

[b] Faculty of Civil Engineering, 81310, Universiti Teknologi Malaysia, Johor Bahru, Malaysia.

[*] Email: norhisham@utm.my

History:

Received: 2 January 2018
Accepted: 10 April 2018
Available Online: 31 May 2018

Keywords:

Industrialised Building System, Critical Success Factors, Project Performance, Mass Housing Projects, Nigerian Construction Industry.

Corresponding Author Contact:
+607-5531587

DOI:

10.11113/ijbes.v5.2.240

ABSTRACT

Globally, the adoption of Industrialised building system (IBS) has been acknowledged as a panacea for housing delivery performance. However, in most developing nations, especially Nigeria, its successful adoption is confronted with myriad of factors that are differently perceived by stakeholders resulting in poor performance and low uptake. The focus of this study is, therefore, to identify and evaluate those inhibiting factors as perceived by key construction stakeholders in the Nigerian construction industry. Initially, sixty-four (64) factors were identified through literature and structured interview. After which, a panel of experts, through Delphi method, considered forty-seven (47) of the factors contextual to IBS performance in Nigeria. 210 (70%) multidisciplinary construction professionals responded to the 300 administered questionnaires anchored on a Likert scale of I-5, (1-least significant to 5-Most Significant). Mean score approach was employed for data analysis. All the success factors were perceived to be critical. However, while forty (40) factors were perceived to excise high influence, seven (7) factors were found to moderately influence IBS performance. The five (5) critical success factors (CSFs) based on mean score (MS) are; Clear and precise goals (3.986), knowledge & skills (3.976), planning & control (3.948), top management support (3.938), and transportation (3.924). Having the knowledge of factors critical to IBS performance will assist key stakeholders' in their decision-making towards achieving effective project delivery.

1. Introduction

A nation's construction industry is pivotal to its socio-economic development. Innumerable studies especially in the developed countries (DCs) such as the United Kingdom, United States of America and Australia attested to the construction industry's contribution to their GDP; predominantly due to successful project performance (UN-Habitat, 2006). Furthermore, the industry's significance is engrained in its congruent relationship with other sectors of the economy such as the manufacturing, agriculture, services etc. However, the construction projects in the less developed countries (LDCs) for decades continue to record unsatisfactory performances manifesting in project delays, cost overruns, inferior quality, disputes and conflicts, lack of sustainability, unprecedented abandonment and incessant building collapse. For instance, in Nigeria, this myriad of failure is reflected in the 17milion housing deficit (Federal Ministry Lands, Housing and Urban development, FMLHUD, 2013) and the minuscule contribution of the industry to employment generation and the nation's GDP in the last three decades (Oluwakiyesi, 2011).

In the building industry, these project failure attributes are mostly associated with the conventional method which typically involves massive on-site activity and unskilled labour (Rahman and Omar, 2006'; Aladeloba et al., 2015). The same method is also criticized for exposing stakeholders to high health and safety risks, low productivity and causing considerable damage to the environment (Jaillon and Poon, 2008). Unfortunately, since independence in 1960, the conventional method accounts for over 90% of buildings in Nigeria landscape (Jiboye, 2011). According to the Construction Industry Developing Board (CIDB, 2003), adopting IBS and its innovative tendencies in any construction process stimulates growth and output, thus positioning the building industry of any nation to becoming a prime contributor to the Gross Domestic Product (GDP). Various stakeholders attested that IBS contributes significantly to project performance and by extension, fulfils the demands of the construction industry (Egan et al., 1998; Pour Fahiniam et al., 2017).

The Nigerian Government in 2011 embraced a paradigm shift from the conventional method of construction to Alternative Building Technologies (ABT), also known as Industrialized Building System (IBS). The adopted four (4) IBS types are; i). America Light Gauge Steel ii). Plassmolite/Plasswall iii) Interlocking Masonry blocks and iv). Burnt bricks for a Pilot Housing Project in Kuje, FCT, Abuja (FMLHUD, 2013). However, despite the recorded favourable performances in other nations like UK, USA, Sweden and Singapore (Khafan and Maqsood, 2015) and lately in some LDCs, like China and Malaysia (Blismass and Wakefield, 2009), studies and empirical observation revealed a low IBS take up in the Nigerian construction industry (FMLHUD, 2013; Kolo et al., 2014; Aladeloba et al; 2015). A plethora of factors have been adduced which include institutional instability, cumbersome and slow foreclosure procedures, non-availability and high cost of construction materials, capacity gaps, inappropriate technology, dearth of technological innovations, strategy of housing delivery at the expense of mass housing development (FMLHUD, 2013; Aladeloba et al; 2015).

Although, there were few pioneer studies on the factors critical to IBS performance in Nigeria construction projects (Kolo et al., 2014; Aladeloba, 2015 and Pour-Fahimian et al., 2017), but a lot of the studies only suggested broad frameworks. The studies by Kolo et al (2014) and Aladeloba et al., (2015), only presented a generic list of IBS CSFs from anecdotal sources. The absence of context-specific approach in the studies makes their recommendations unlikely to be the appropriate solutions to Nigeria housing challenges. Although, Pour Fahimian et al., (2017) outlined IBS CSFs based on experts' opinion, however, the study did not reveal the severity of each factor on building performance. In addition, it is based on the general construction industry. The aim of this study, therefore is to bridge this research gap by identifying factors that are critically constraining IBS performance in Nigerian Mass Housing projects (MHPs) and evaluating and ranking the degree of CSFs significance to IBS performance in MHPs.

It is expected that the ranking of the CSFs based on key stakeholders' perception will strengthen the decision-making aptitude of stakeholders and by extension enhance IBS performance in MHPs.

2. IBS and Mass Housing Projects: A Background

IBS, a term adopted from the manufacturing industry, is variously defined by construction stakeholders. It designates a method of mass production of components/buildings. IBS is also variously perceived as a system and/or a process. Junid, (1986) defines IBS as an industrialized process by which components of a building are conceived, planned, fabricated, transported and erected on site. Trikha (1999) describes IBS as "a system in which concrete components prefabricated at sites of factories are assembled to form structures under strict quality control and minimum in situ construction activity." IBS is described by Lessing et al., (2006) as an integration of manufacturing and construction processes with a well-planned organisation to efficiently manage, prepare and control needed resources, activities and results using highly developed components. Thanoon et al (2003) presented IBS as a system of mass producing building components either in a factory or at the site according to the stipulated specifications with standard shapes and dimensions and transported to the construction site to be re-arranged according to a certain standard to form a complete building.

Blismas and Wakefield (2009) emphasise that IBS concept is premised essentially on organizational continuity of the production process that implies a steady flow of demand; standardization; integration of the various stages of the whole production process; a high degree of organization of work; mechanization to replace human labour wherever possible; and where research and organized experimentation are integrated with production. According to Kamar et. al., (2009) IBS concerns an innovative process of building construction using the concept of mass-production of industrialized systems, with components produced at the factory or on-site within controlled environments, it includes the logistics and assembly aspect of it, done in proper coordination with thorough planning and integration. This is in line with CIDB (2003) that perceives building industrialization as a process of social and economic change whereby a society is transformed from pre-industrial to an industrial state. As such, it is part of a wider modernization process through the gainful utilization of relevant and viable technologies. This study accepts that as development concept, IBS success is dependent on a balanced combination of the hardware and software components

In this study, mass housing is viewed as residential buildings, proposed and developed in standard multiple units on a substantial scale entirely by a government or in synergy with private concerns for citizens to rent, own-occupy or outright purchase (Ahadzie, 2007). It is recognized as one of the most all-encompassing projects to meet the shelter needs of a society most vulnerable (low-income earners); especially in most of the LDCs. However, for decades, its successful realization has been constrained by varied factors even where IBS is engaged. Given the current global trends towards competitiveness and future health of the industry, we are of the opinion that, the Nigeria building industry requires to identify and evaluate all CSF hindering the full realisation of IBS potentials with a view to successfully and adequately delivery mass housing; thus achieving stakeholders' objectives.

3. Critical success factors (CSFs) and IBS Performance

An increasing number of studies have revealed the benefits of IBS adoption for housing development. However, evidence of low performance of IBS projects is on ascendance (Kolo et al., 2014; Aladeloba et al., 2015). The factors responsible are not only generic and contextual but are as well multifaceted. More so, the rate is higher in the LDCs than in DCs (Lim and Mohammed, 1999). The first step in improving the performance of IBS projects lies in identifying the success factors.

In the UK, the study of Pan et al. (2007) revealed some benefits of IBS which they claimed were difficult to attain. Stakeholders' responses however identified initial high capital cost and complex interfacing of offsite and onsite components and systems as the leading factors limiting IBS performance. Other factors with considerable influence include the manufacturing capacity; the risk-averse culture; the nature of design development process; fragmented nature of industry; the local government planning system and concerns of mortgage lenders; and insurers with nonconventional buildings. In a related scoping study of IBS adoption in Australia, Blismas and Wakefield (2009) signposted IBS constraints that are although similar to those in UK and USA but differently rated by stakeholders. The leading factors include difficulties in adjusting to processing change, high initial capital outlay, supply chain restrictions, lack of skills and requisite knowledge. The study, with further commitment, demonstrated that IBS derivable benefits should be enough stimuli to overcoming the identified constraints.

In Hong Kong, Jaillon and Poon (2008) and Arif and Egbu (2010) are in consensus that conflict with design and construction processes and practices, lack of skilled labour and motivation, and lack of client support are the foremost factors influencing IBS project performance. In the same line of reasoning, Ojoko et al., (2016) opined that the foremost challenges border on cultural change within the construction industry, especially due to the preference for the conventional method. According to Khalfan and Maqood, (2014) overcoming such barrier requires education and motivation that only strong leadership and government can afford. Among several identified factors in the Indian construction industry, Arif et al (2012) highlighted ten prime constraints to IBS adoption to be: high initial capital cost, few codes/ standard, lack of guidance and information, low access to finance, skills shortage, industry fragmented nature, planning system, manufacturing low capacity, inexperience, legal issues and restrictive regulations. In a study that inclined to the soft issues of IBS, Lou and Kamar, (2012) observed 12 factors constraining IBS implementation in Malaysia. A close inspection reveals that, except for the factors of IT and procurement, differences with aforementioned constraints in other nations exist only in wordings.

Kolo et al. (2014), based on literature review and empirical observations, disclose that although IBS is still in its embryonic stage in Nigeria, reluctance to innovate, lack of codes and standards, supply chain integrations, and skill requirements are the leading constraints. Aladeloba et al (2015) adopting a qualitative research approach, itemized factors of costs, skills and requisite knowledge, supply chain, perception, motivation communication and integration as core constraints to an effective embrace of IBS in the Nigerian construction industry. Furthermore, Pour Fahimian et al. (2017) attributed stakeholders' negative perception as the overriding factor to IBS poor performance and low uptake in the Nigeria building industry. Other resilient factors besides the findings are those of lack of supporting infrastructure, wild fluctuation in housing demand, and low manufacturing capacity (Kamar et al., 2009).

It can be inferred from the above that not only are causative factors to IBS poor performance numerous, their severity differs between locations and project types. Such variability holds true even within the Nigerian construction industry as evident in the findings of earlier scholars (Ogwueleka, 2011). Therefore, to address these IBS constraints, this study combines multiple approaches in CSFs identification and evaluation.

Firstly, a compressive literature review was undertaken to identify the factors that generally inhibit IBS performance. This is complemented with structured interview to observe contextual factors. Since the study covers different building types located in different geo-political zones, the relevance of the factors was subjected to the confirmation of a panel of experts from different disciplines and organisations. Thereafter, questionnaire based on five-point Likert scale was administered on key construction stakeholders to rank their perception of the IBS success factors influence on housing project delivery.

4. Research Methodology

4.1 Expert opinion

The main purpose of this section is to provide a structured approach to collecting data in anecdotal situations for consensus to be attained in the decision-making process; since this study is premised on stakeholders' perception. There are various approaches (Delphi method, nominal groups, brain-storming, focus groups, analytic hierarchy process, and working groups) to achieve such. Except for the Delphi method, the others only take account of the perceptions of the most opinionated members of the group. Hence, the Delphi method is used in this study.

A preliminary list of sixty-four (64) causative factors influencing IBS performance identified through literature and a structured interview was presented to a panel of 30 experts. Their selection was premised on evidenced involvement in varied IBS projects. Twenty-seven (27) i.e. 90% responded in a two-phase Delphi technique. The experts are of diverse disciplines, consisting of six (6) Academia, seven (7) Contracting firms, ten (10) Consulting firms, and four (4) from client organization. While those in academics were approached individually, those in the industries were sourced from the directory of relevant professional bodies Nigerian Institute of Building, (NIOB), Nigerian Institute of Architects (NIA), Nigerian Society of Engineers (NSE), and Nigerian Institute of Quantity Surveyors (NIQS) etc. Table 1 shows the distribution of the experts in terms of organisations, positions, and numbers and average years of experience.

Table 1 *Expert Profile*

Expert	Role in IBS Usage	Position	Number	Av. Years' of Experience
1	Academia	Senior Lecturer-Professor	6	21
2	Contracting	Managing Director	7	15
3	Consulting	Project Manager	10	18
4	Client	Project Coordinators	4	13

The first phase required the experts to rate the success factors on a five -point Likert scale from 1-highly insignificant, 2- insignificant, 3-moderate, 4- significant and 5-highly significant. A total of forty-seven (47) success variables were selected based on a mean score of three (3). For the second phase, based on the same scale, the average score of the first exercise was provided to the experts and thereafter asked to further rate the factors indicating agreement or otherwise. The reassessed scores were used to calculate a final average score for all the CSFs. Any factor with a mean score of three and above (≥ 3) is

Table 2 *List of Accepted Success Factors Based on Expert Delphi Exercise*

Code	Factor	Code	Factor	Code	Factor
F1	Level of Automation	F17	Technology Transfer	F32	Motivation
F2	Team Integration	F18	Communication	F33	Personnel Commitment
F3	Training of Personnel	F19	Warrant /Insurance Coverage	F34	Authority/ Responsibility
F4	Clear and Precise Goals	F20	Innovation	F35	Permit/ Regulations
F5	Supply chain collaboration	F21	Standardisation	F36	Product & Service Cert
F6	Monitoring & Feedback	F22	Stakeholder Management	F37	Locations
F7	Knowledge & Skills	F23	Modularisation	F38	Strategic Value Chain
F8	Component Reuse.	F24	Code & Standard	F39	Conflict Resolution
F9	Buildability/Constructability	F25	Project size &Value	F40	Water
F10	Planning & Control	F26	Socio-Cultural	F41	Budget Update
F11	Transportation	F27	Weather/Act of God	F42	Procurement management
F12	Top Management Support	F28	Economics	F43	Vested Interest
F13	Component repeatability	F29	Waste Disposal	F44	Schedule Updates
F14	Components interfacing	F30	Risk management	F45	Storage
F15	Equipment	F31	Power (electricity)	F46	Manufacturing capability
F16	Raw Material			F47	Sewage

Table 3 *Ranking of Success Factors influencing IBS performance*

S/N	CODE	FACTOR	MS	SD	RANK
1	F4	Clear and Precise Goals	3.986	0.904	1
2	F7	Knowledge & Skills	3.976	0.935	2
3	F10	Planning & Control	3.948	0.919	3
4	F12	Top Management Support	3.938	0.479	4
5	F11	Transportation	3.924	0.909	5
6	F3	Training of Personnel	3.914	0.903	6
7	F40	Water	3.905	0.913	7
8	F18	Communication	3.905	0.954	8
9	F8	Component Reuse.	3.904	0.954	9
10	F2	Team Integration	3.891	0.871	10
11	F22	Stakeholder Management	3.890	0.893	11
12	F24	Code & Standard	3.895	0.869	12
13	F16	Raw Material	3.895	0.906	13
14	F36	Product & Service Certification	3.886	0.856	14
15	F5	Supply chain collaboration	3.886	0.873	15
16	F23	Modularisation	3.886	0.921	16
17	F21	Standardisation	3.886	0.895	17
18	F13	Component repeatability	3.885	0.976	18
19	F46	Manufacturing capability	3.881	0.912	19
20	F9	Buildability/Constructability	3.876	0.904	20
21	F31	Power (electricity)	3.867	0.865	21
22	F14	Components interfacing	3.867	0.913	22
23	F33	Personnel Commitment	3.862	0.910	23
24	F2	Motivation	3.857	0.968	24
25	F1	Level of Automation	3.843	0.933	25
26	F35	Permit/ Regulations	3.838	0.950	26
27	F41	Budget Update	3.819	0.912	27
28	F25	Project size &Value	3.819	0.966	28
29	F43	Vested Interest	3.819	0.988	29
30	F15	Equipment	3.810	0.908	30
31	F39	Conflict Resolution	3.808	0.960	31
32	F17	Technology Transfer	3.786	0.940	32
33	F42	Procurement management	3.786	0.942	33
34	F6	Monitoring & Feedback	3.776	1.000	34
35	F19	Warrant /Insurance Coverage	3.767	0.932	35
36	F44	Schedule Updates	3.767	0.972	36
37	F28	Economics	3.748	0.967	37
38	F38	Strategic Value Chain	3.733	0.991	38
39	F34	Authority/ Responsibility	3.729	1.000	39
40	F26	Socio-Cultural	3.681	0.927	40
41	F37	Locations	3.557	0.933	41
42	F30	Risk management	3.529	0.707	42
43	F20	Innovation	3.529	0.771	43
44	F29	Waste Disposal	3.510	0.766	44
45	F45	Storage	3.448	0.812	45
46	F47	Sewage	3.314	0.810	46
47	F27	Weather/Act of God	3.252	0.829	47

NOTES

Number of Respondents = 210; Kendall's coefficient of concordance = 0.115; Level of significance: 0.00.

considered to have a reasonable influence on project performance and thus accepted, while those with values below 3 are rejected (Chan et al., 2004). Table 2 shows the 47 factors ranked above the threshold of 3 and thus, met the acceptance criteria based on the Delphi Exercise.

4.2 Design and Administration of the Questionnaire

In comparison to other instruments for descriptive and analytical surveys in construction management research, questionnaire studies provide less biased results (Enshassi et al., 2010). As such it is the method selected. A two-segment pilot questionnaire was developed for the data instrument. The first segment was to elucidate information on the respondents' background, while the second part investigated the influence of each factor on project performance. The exercise was conducted within only FCT, Abuja. The target of this study were professionals of managerial cadre working in the client, consulting, contracting, and project management, manufacturing and supply organisations. Except for the client organisation, where stratified sampling approach was employed, for a wider reach snowballing method was employed in the rest. Developers were not included because of the observed multiple roles they assume in the Nigeria construction industry.

To eliminate ambiguity from the result, ensure easy interpretation, with appropriate measurement of data on the ordinal scale, the Likert five-point scale was employed (Ekanayake and Ofori, 2004). The Likert scale of 1-5 point was adopted, where 1-represents-least significant, 2- less significant, 3- significant, 4- more significant and 5-most significant. Based on snowballing technique, 300 questionnaires were administered on the various stakeholders working in various organisations (Client, Consultant, and Contractors, project manager, manufacturing and supply). 210 (70%) stakeholders made up of various professionals responded within the last three weeks of October 2015. This response rate in construction management field meets the threshold of subjects to an item of 20-30 % acceptable range (Akintoye, 2000). Consulting organisation constitutes the overall highest respondents (29.7%), followed by the contractor (26.5%), project manager (20.3%), the client (15%), and manufacturing and supply (9%).

4.3 Data Analysis and Results

The Statistical Package for Social Sciences (SPSS Version 20) software aided the analysis of the survey data. In determining the internal consistency test of the data, the Cronbach coefficient alpha an accepted relevant criterion was employed (Zhai t al., 2014). The analysis of the 47 factors signposts an internal consistency with a Cronbach's alpha value of 0.843 which exceeds the minimum threshold of 0.7. This study made use of three types of analysis as obtainable in other in similar studies (Chan et al. 2004; Yang et al., 2012). Civil engineers constitute the highest (33.5%) professionals of all respondents and are present in all the Organisations. Almost 70% of the respondents are within the 31 -50years age bracket; an active age bracket for optimum performance in the construction industry. More than 65% of the respondents have over 11years experience in the construction industry with not less than 5years in IBS. Over 50% of the respondents work in the consulting and project management firms. These firms were the domain of experts in project performance evaluation and management, which further adds validity to this study. Interestingly, the usage of IBS in mass housing will be enhanced by the continuous participation of such professionals. This can be achieved by using tools and strategies which may well be usefully integrated into the process of implementing IBS.

Using the statistical package for social sciences (SPSS version 20), mean scores and standard deviations for the variables were derived. Based on the response, the 47 factors influencing IBS project performance were determined. A similar approach has been observed to be acceptable in previous studies (Chan et al., 2004; Yang et al., 2012). In order to determine if the 47 CSFs (Table 3) were similarly perceived by the respondents, Kendall's concordance coefficient was employed. Yeung et al. (2007) opine that, if Kendall's coefficient is equal to one (1), it implies that the CSFs were identically ranked by all the respondents. However, if Kendall's coefficient is equal to zero (0), it then signifies that the CSFs were differently ranked by the respondents. For the ranked 47 CSFs, the value of Kendall's coefficient is 0.115 which is statistically significant at 1% level. This suggests a general consensus among the 210 respondents. Thereafter, Spearman's rank correlation test was employed to establish the general similarity of the respondents' rankings of between the respondents; client, consultant, contractor,

Table 4 *Conversion of Table of five-point Likert scale to three scale points (Adapted)*

Likert Scale (five points)	Researcher Scale (three points)	Differential Calculation
1, 2, 3, 4, 5 / SD, D, N, A, SA	L, M, H	5 -1/3=1.333

1	2	3	4	5
SD	D	N	A	SA

L	M	H

L-Low, **M**-Moderate, **H**- High

project manager, and manufacturer and supply organisations. Correlation coefficient (r) is employed for this purpose and it indicates the strength of the correlation between two factors. At 5% level, the least correlation coefficient (r) for the different pairs is 0.621 (Client-Contractor). Therefore, statistically, there is a general consensus among the stakeholders.

4.4 *Ranking of Success Factors*

In the ranking of factors, where more than one factors have same mean score (MS), the one with lower standard deviation (SD) takes supremacy since a low standard deviation (SD) implies that most of the responses are close to the mean (Table 3).

In addition, Dawes, (2007) opines that the strength of factors in any study is partially influenced by the choice of the scale format. On attitudinal response to public opinion, like in this study, Matell and Jacoby (1971) in support of Likert (1932) assertion argues for the conversion of any ubiquitous scale to three scale point in order to enhance decision-making. Based on this submission, the five-point Likert scale used in this study to derive the factors mean score was converted to three (Table 4).

Since the Likert scale used for this study ranges from 1-5, then based on Table 4, the three levels of causative factors influence on project performance are as shown in Table 5.

Table 5 *The Level of mean Value distribution*

Mean Value	Level
1.00 - 2.33	Low
2.34 - 3.67	Moderate
3.68 - 5.00	High

5. Finding and Discussion

From the survey responses ranked in Table 3, the mean scores for the 47 CSFs range from 3.986 to 3.252. According to Table 5, the influence of all the factors are above the low mean value of 2.33. This implies that each of the 47 factors can noticeably influence the performance of IBS in housing project delivery. Forty (40) factors however have high influence on project performance, while the remaining seven (7) are perceived by stakeholders to moderately influence IBS project outcome. The Ten factors with the highest influence on project performance are shown in Table 6.

Having clear and precise goals was ranked the highest CSFs by all stakeholders. It attracted a mean score value of 3.986. This finding agrees with that of Ogwueleka (2011). For project success, all decisions must emanate from the premise of definite needs and demand, subjected to rigorous trade-offs. However, due to vested interest and political exigencies, that most government decisions are hardly accorded this consideration. Having the requisite knowledge and skills (3.976) was perceived to have the second highest influence on IBS performance. This rating is in consonance with the observations of Hamid (2009). A major reason is that from conception to installation, the whole process of IBS is knowledge-driven, making precision of utmost requirement in its usage, since remedying any defect is always at a higher cost. In addition, the level of mechanization is high thus necessitating sufficiently qualified personnel. Need for sufficient planning and control was rated third, and it attracts a mean score value of (3.948). Being an asset of huge life time investment, the importance of careful planning of resource requirement and necessary control to attain the set objectives cannot be overemphasized. One major difficulty lies in the fact that each experience differs, as such it requires professionals with a range of experience.

The support of management was considered an extremely influential factor with a mean score value of (3.938). As against the findings of Hamid (2009) and Ogwueleka (2011), which considered it prime, stakeholders in this study perceived it to be the fourth ranked factor. For the success of any physical project, resources must be moved between locations. As such, the availability of appropriate and adequate means of transporting components remains vital. Transportation means was rated fifth (3.924). The availability of water (3.905), contrary to the dry construction IBS is grouped occupies the sixth significant leading position. This could be to the fact that the two predominant IBS currently the in Nigeria building industry are the interlocking masonry blocks and burnt bricks; and both require a good measure of wet trade. The remaining leading factors are training of personnel, effective communication, component reuse and team integration but they are however rated higher in other literature (Thanoon et al. 2003; Blismas and Wakefield, 2009; Lou and Kamar, 2014).

Table 6 *Ten Success Factors with High Influence on IBS Project Performance*

CODE	FACTOR	MS	SD	RANK
F4	Clear and Precise Goals	3.986	0.904	1
F7	Knowledge & Skills	3.976	0.935	2
F10	Planning & Control	3.948	0.919	3
F12	Top Management Support	3.938	0.479	4
F11	Transportation	3.924	0.909	5
F3	Training of Personnel	3.914	0.903	6
F40	Water	3.905	0.913	7
F18	Communication	3.905	0.954	8
F8	Component Reuse.	3.904	0.954	9
F2	Team Integration	3.891	0.871	10

6. Conclusion

This study has demonstrated that adopting IBS for housing delivery reduces its construction duration and overall cost, enhances its quality and safety, and contributes significantly to it sustainability. However, in spite of these well-documented attributes, its performance and uptake in Nigeria is still low even well over after six years it was embrace. From the sixty-four (64) identified success factors, experts and stakeholders (client, consultants, contractors, project managers, manufacturers and suppliers) perceived forty-seven (47) as critical success factors (CSFs) for IBS poor performance in the Nigerian building Industry. Analysis shows that the factors have varying significant influence on IBS performance in the housing project delivery process. While forty (40) factors exercise high influence on performance, only seven of the CSFs were considered to moderately influence IBS performance.

In addition to identifying the CSFs from literature and semi-structured interviews, the other main contribution of this study lies in the rank ordering of the factors by key stakeholders based on their experience. Although, IBS is akin to dry construction, we observed during the site visits that most of the ongoing projects are predominantly of burnt bricks and interlocking blocks. Hence, the high rating accorded water by the stakeholders in this study may probably be due to the embryonic phase of IBS implementation in the country or the dominance of wet trade of IBS buildings in the area of study. A further study is required for clarification in this regard. In addition, there is also the need to establish the degree of interrelationships between the CSFs. Factor analysis method would be employed in future studies to investigate these underlying relationships among the identified CSFs.

Also, the influence of these factors on identified IBS benefits shall be explored in order to maximize project objectives. Hopefully, the awareness created by this study will strengthen the stakeholders' decision-making skills on IBS CSFs influence on housing performance. It is envisaged that the findings of this study will assist the policy makers in establishing a more reliable reference in their drive towards effectively repositioning the Nigerian building industry on employment generation and wealth creation in Nigeria.

References

Ahadzie, D. K., Proverbs, D. G., & Olomolaiye, P. O. (2008) Critical Success Criteria for Mass House Building Projects in Developing countries. International Journal of Project Management, 26(6), pp.675–687

Akintoye, A. (2000) Analysis of factors influencing project cost estimating practice. *Construction Management & Economics*, *18*(1), 77–89

Aladeloba, E. A., Okesoto, J. O. And Olawale, S. O. (2015) Prospects of Industrialized Materials in Building Production in Nigeria International Journal if Development Research, 5 (01), pp. 3143-3148

Arif, M., and Egbu, C. (2010) Making a case for offsite construction in China. Engineering, Construction and Architectural Management, 17(6), 536-548.

Blismas, N and Wakefield, R. (2009) "Drivers, constraints and the future of offsite manufacture in Australia," *Construction Innovation*, vol. 9, no. 1, pp. 72–83Goodier, C and Gibb, A. (2007)"Future opportunities for offsite in the UK," *Construction Management and Economics*, vol. 25, no. 6, pp. 585–595

Chan, A. P. C. & Chan, D. W. M. (2004) Developing a benchmark model for project construction time performance in Hong Kong, Building and Environment, 39: pp.339–349.

CIDB. (2003). Industrialized building system (IBS) roadmap 2003e2010. Kuala Lumpur: Construction Industry Development Board (CIDB).

Dawes, J. (2007) Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and10-point scales, International Journal of Market Research Vol. 50 Issue 1

Egan, J. (1998) "Rethinking construction, Construction Task Force report", Department of the Environment, Transport and the Regions HMSO, London.

Enshassi, A., Mohamed, S., & Abushaban, S. (2010) Factors affecting the performance of construction projects in the Gaza strip. Journal of Civil Engineering and Management, 15(3), 269–280

Ekanayake, L. L. and Ofori, G. (2004) Building waste assessment score: design-based tool. Building and Environment, 39, (7) pp851–861

FMLHUD (2013) Mid-Term Report Taking Stock, Moving Forward. Being a report of Federal Ministry of Lands Housing and Urban Development Stewardship of the Transformation Agenda (May 2011 – May 2013)

Goulding J S, Rahimian F P, Arif M, and Sharp M (2012) "Off-Site Construction: Strategic Priorities for Shaping the Future Research Agenda", Architectoni.ca, Canadian Centre of Academic Art and Science (CCAAS), 1(1), 62-73

Hamid, A. K. (2009) Barriers to Industrialized Building System (IBS): The Case of Malaysia; the Problem Statement Research Methodology. A preliminary PhD study on Industrialised Building System. Built and Human Environment 9th International Postgraduate Research Conference, pp.1–16.

Jacoby, J. and Matell, M. (1971) Three-Point Likert Scales Are Good Enough. Journal of Marketing Research. Vol.VIII, 495-500

Jiboye, A. D. (2011) Urbanization challenges and housing delivery in Nigeria: The need for an effective Policy framework for Sustainable Development. International Review of Social Sciences and Humanities, 2(1), 176–185.

Jaillon, L. and Poon, C.S. (2008) Sustainable construction aspects of using prefabrication in dense urban environment: a Hong Kong case study. Construction Management and Economics, 26(9), 953–66.

Junid, S. M S. (1986) Industrialized Building System. In book of Proceedings of UNESCO/FEISEAP Regional workshop, UPM serdang

Kamar, K. A. M. Alshawi, M. and Hamid, Z. A. (2009) Barriers to Industrialised Building System m (IBS): The Case of Malaysia, In BuHu 9th International Postgraduate Research Conference (IPGRC) (Eds. Alshawi, M., Ahmed, V.,

Egbu, C. and Sutrisna, M.), Salford, United Kingdom

Khalfan, M. M. A. and Maqsood, T. (2014) Current State of Off-Site Manufacturing in Australian and Chinese Residential Construction, Journal of Construction Engineering Vol. 2014.

Kolo, S. J, Rahimian, F. P., & Goulding, J. S. (2014) Offsite Manufacturing Construction: a big opportunity for housing delivery in Nigeria. Procedia Engineering, 85, 319–327.

Lessing, J., Ekholm, A., and Stehn, L. (2005) Industrialised Housing-Definition and Categorisation of the concept, Proceeding of 13th International Group for Lean Construction, Sydney, Australia

Lim, C. S. & Mohamed, M.Z. (1999) Criteria of project success: an exploratory re-examination. International Journal of Project Management, 17 (4), 243-48.

Lou E. C. W. and Kamar, K. A. M. Industrialized Building Systems: Strategic OutLook for Manufactured Construction in Malaysia, Journal of Architectural Engineering 18(2) 69-74.

Matell, M. S. and Jacoby, J. (1971) Is there an Optimal Number of Alternatives for Likert Scale Items? Study 1: Reliability and Validity. Educational and Psychological Measurement 1971, 31, 657-674

Ojoko, E.O., Osman, M.H., Rahman, A.B.A.,Omar, W.S.W and Ojoko, O. (2016). Critical Success Factors of Industrialised Building System Implementation in Nigerian Mass Housing Projects. Proceedings of the 2nd International Conference on Science, Engineering and Social Sciences (ICSESS 2016) 29th May- 1st June 254-255.

Oluwakiyesi, T. (2011). Construction Industry Report: A Haven of Opportunities. Vevitas Publications of Trends in Nigerian Construction Industry.

Ogwueleka, A. (2011). The critical success factors influencing project performance in Nigeria. International Journal of Management Science and Engineering Management, 6(5), 343–349.

Pan, W., Gibb, A. and Dainty, A. (2007) Perspectives of UK housebuilders on the use of offsite modern methods of construction. Construction Management and Economics, 25(2), 183–94.

Rahman, A. B. A., & Omar, W. (2006). Issues and Challenges in the Implementation of Industrialised Building Systems in Malaysia. In Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006) (pp. 5–6).

Pour Rahimian, F. and Goulding, J. and Akintoye, A. and Kolo, S. (2017). *Review of motivations, success factors, and barriers to the adoption of offsite manufacturing in Nigeria.* Procedia Engineering, 196. pp. 512-519.

Thanoon, W. A., Lee, W. P., Kadir, M. R. A., Jaafar, M. S., & Salit, M. S. (2003) The Experiences of Malaysia and Other Countries in Industrialised Building System. Proceedings of International Conference on Industrialised Building Systems, (p. 7). Kuala Lumpur, Malaysia.

Trikha, D.N. (1999) Industrialised building systems: Prospects in Malaysia, Proceedings World Engineering Congress, Malaysia

UN-Habitat-Agenda (2006). Available at The-Habitat-Agenda-Istanbul-Declaration-on-Human-Settlements-2006.pdf

Yang, J. K., Zhu, X. F., & Zhang, H. (2012). Group model exploration of housing industrialization. Construction Technology, 364(41), 95e98. In Chinese

Zhai, X. Reed, R.and Mills, A. (2014) "Factors impeding the offsite production of housing construction in China: an investigation of current practice," *Construction Management and Economics*, vol. 32, no. 1-2, pp. 40–52

INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 5(2)/2018, 134-144

Facility Management of Nigerian Universities: Case of University of Lagos, Lagos and the Bells University of Technology, Ota, Nigeria

Oyedeji, Joseph Oyewale
Department of Estate Management, the Bells University of Technology, Ota, Nigeria
Email: diranjosh@yahoo.com

History:

Received: 29 March 2018
Accepted: 29 April 2018
Available Online: 30 May 2018

Keywords:

Facility, Facility management, Soft Services, Hard Services, Universities

DOI:

10.11113/ijbes.v5.n2.257

ABSTRACT

Universities which are citadel of research and learning have many facilities that need to be well maintained in order to achieve the designed aim and sustain value of the institution. This necessitates the need for this study to examine facility management practice and the level of satisfaction of users of facility management in the study areas. The study populations are the students and staff of the institutions who are the users of the facilities. The sampling technique is systematic random sampling technique where respondents were selected from all the academic faculties, student's hostels, and staff quarters which makes all categories of facilities users to be captured. The analysis was done using tables, 5-point Likert scale. The facility management services were categorized into hard and soft services. The modes of execution of the two were studied. It was gathered that some of the hard and soft services were outsourced while some are done in-house. The levels of satisfaction of the users on the hard and soft services were measured. It was gathered that soft services like move management have least ranking in the two universities and hard services like decoration and refurbishment have least ranking in the two universities. Recommendations were made on how the two universities can improve facility management services.

1. Introduction

The deplorable state of facilities in Nigerian universities is alarming. This assertion was corroborated by Babatope (2010) who identified poor facility management practice as one of the bane of facility inadequacies in Nigerian Universities. The implication of the facility inadequacies has been linked to poor students and staff productivity (Ajayi and Ayodele; 2001). Isa and Yusoff (2015) reiterated the need for provision and management of facilities in Nigerian tertiary institutions in order to produce graduates that will be able to compete worldwide. The scholars employed secondary data of facility provision and management in Nigerian tertiary institutions in the study. It was gathered from the study that the performance of physical, technical and support facilities in the tertiary institutions sampled are below average. The study further recommended facility management as a holistic solution to facility inadequacies.

Facility management is a holistic concept that covers different aspects of human endeavor. It was defined by different scholars in order to establish its applicability to functionality of different human investments. Becker (1999, Cited in Cowan, 2001) defined facility management as "being responsible for all efforts relating to planning, designing, and managing building and their system, equipment and furniture to enhance the organization's ability to compete in a rapidly changing world". The definition focused on building with an attempt to achieve a broad definition. FMA Australia (2012) defines facility management as guiding and managing the operations of buildings, precinct and community infrastructure on behalf of property owners. The definition also focused on building.

However, the applicability of facility management is beyond buildings but cut across a broad human endeavor. This assertion was corroborated by the definition of Engineering News-Record of April 4th, 1985 (Cited in Hamer (1988:1) where facility management was defined as the discipline of planning, designing, constructing and managing space in every type of structures from office buildings to process plants. It involves developing corporate facilities policy, long-range forecasts, real estate, space inventories, projects through design, construction and renovation, building operation and maintenance plans and furniture and equipment inventories. The definition emphasized the importance of space management and the expectations of a good facility management process. Also, the definition signified the applicability of facility management to diverse human endeavor.

However, special consideration should be given to peculiarity of an organization or a work place where facility management is to be applied. Sekula (2003) emphasized that for a facility manager to succeed in an organization, it is important for the facility manager to understand the overall organization and their culture. Therefore, it could be inferred that consideration for peculiarity of an organization is important for the success of facility management. Also, Lennerts (2011) identified the task of a facility manager as management and coordination interrelated people, process, and place. It can be deduced from this assertion that people, process and work place of different organizations are different. In line with this thought, Gillead and Tam (2002) introduced the concept of appropriate workplace strategies. The strategies are new ways of coordinating work process, organizing office culture, applying IT and generally improve staff morale. Durodola (2009) posited that appropriate workplace strategies is increasingly seen as changing work practices, reducing space costs, and meeting workers preference. The researcher posited that this process is referred to as Churn rate by the American and British facility management practitioners. In addition, this process was referred to as the heart of facility management.

As a result of the established fact of deplorable state of facilities in Nigerian Universities, it becomes imperative to examine the facility management practices in two Universities with different population strength and ownership status. Odediran, Gbadegesin and Babalola(2015) examined the facility management practice of public Universities in Nigeria. The study established that facility management practice of Nigerian public universities is poor. This study will be examining facility management practice in public and private universities in order to establish if there is difference in the two. The study will adopt two proxim universities located in an urban area. The study will adopt University of Lagos, Lagos and Bells University of Technology Ota as case study. The two institutions were selected based on their location in an urban area and ownership status which are; public and private institutions. Peculiarities of the two study areas will be considered in appraising the application of facility management to the operation of two organizations. Application of facility management to the operation of the two organizations will be done in the light of the products or services rendered by the two organizations. The aim of the study is to assess application of facility management in Nigerian public and private universities. The objectives are: to establish the hardcore and soft facility management services rendered in the universities and the mode of execution. Also, the study will examine the level of user's satisfaction with the facility management services rendered in the two institutions. The next sections of the study will be divided as follows: study areas, literature review and conceptual framework, methodology, analysis and discussion, and conclusion.

2. Theoretical Background and Conceptual Framework

FMA Australia (2012) identified activities of some professionals that could be mistaken for facility management. The body identified that the following professionals activities could be facility management at the same time could be another thing apart from facility management: accommodation manager, building manager, building supervisor, caretaker, contracts manager, essential services manager, maintenance and service manager, facilities services manager, facility administrator, facility management consultant, facility operations manager, operations manager, and property manager. Organizations could mistake activities of these professionals as facility management while what they are doing is totally different from facility management. Hammer (1988) described facility management as practice that includes; maintenance management, property management but more importantly, workspace management, churn management, strategic property management, and the management of support services. It can be deuced from the definition that facility management includes maintenance management and property management. Many professionals including the above listed professionals do confuse execution of property management and maintenance management works as against facility management.

The IFMA model of a triangle of P's summed up facility management focus in today workplace into: people, process and place. These three factors are interdependent and have reciprocal relationship. Armstrong (1992) substantiated the IFMA position by asserting that physical environment needs to be managed in concert with people and job process.

Kincaid (1994) describe facility management as a support role or service part of organization's non-core business (Supply side) and serving the needs of primary activities or core business (demand side). The researcher concluded by saying a facility manager work is to reconcile the demand and supply aspects in an organization. Reconciliation of people, work process and work place in a harmonious way is the work of a facility manager. However, during the course of reconciling these major components of an organization, it became imperative to identify the core function of an organization and the supporting functions that facilitate the core business. Ability to reconcile the core and supporting functions is what make a good facility manager.

Furthermore, Patanapiradej (2002) identified workplace management as the central focus of a facility manager in an organization. However, while managing workplace, a facility manager needs to fulfill two roles. The first role is using the organization's capital resources, especially, property, physical plant and facilities. The second is managing the organization's support services both routinely and in emergencies. The research work posited further that the two management roles integrate three main activities which are: property management (real estate), property operations and maintenance and office administration. Barrett and Owen (1992) divide facility management into two broad categories by function analysis: operational or implementation functions and management functions. It can be deduced that facility management in an organization involves core business function of an organization and supporting functions. The core function is the primary function of an organization and the supporting functions are the roles to ensure smooth running of an organization in order to achieve the primary objective.

Probst-Wallace (2012) classified facility management into hard and soft services. Furthermore, the study identified the various services that belong to each classification. Hard services relate to services that as to do with fabric and building system and might also be considered as the more traditional property management and maintenance services, this include: building fabric maintenance, decoration and refurbishment, M&E plant maintenance, plumbing and drainage, air-conditioning maintenance, lift & escalator maintenance, fire safety system maintenance, minor project management. Soft services include: cleaning, security, handyman services, waste disposal, recycling, pest-control, grounds maintenance, internal plants. The study further classified the following as additional services: move management (churn), pace planning, business risk assessment, business continuity planning, benchmarking, space management, contract procurement, performance management, information systems, telephony, travel booking, utility management, meeting room services, catering services, vehicle fleet management, printing services, postal services, archiving, concierge services, reception services, health and safety advice, and environmental management. Furthermore, the study revealed that all the services can be executed in house or out-sourced or by adopting the two methods depending on the policy of an organization. This study will examine application of facility management to universities and stadia by accessing how all the above listed functions are executed in the two study areas.

3. Facility Management of Universities

Ogebifun (2011) evaluated facility management in a multi-campus setting adopting University of Witwatersrand as a case study. The study evaluated facility management system in use in the multi-campus university and how the university administration and academic staff perceive facility management contribution to the core objectives of the university. The scholar employed questionnaire and interview to gather data and the data were analyzed through descriptive statistics. Findings from the study revealed that two agencies were charged with the responsibility of facility management in the university. One of the agencies is charged with construction works and the other charged with maintenance. The first agency was assessed by administrative and academic staff on the following criteria; level of consultation, quality of internal management and reporting, quality of project delivery, delivering within budget and delivering within time. The academic and administration staff rated the agency high on quality of project delivery and delivering within budget and in time but low on level of consultation and reporting. The other agency was rated based on the following criteria; space management, consultation, functional services and response. The academic and administration staff rated the agency low in response and consultation but high in space management and functional services.

Hashim et al. (2011) assessed facility management performance in International Islamic University Malaysia. The study stated that the facility management services were handled in-house before the setting up of IIUM Properties Facilities Management Services charged with the responsibility of leading with a new concept of outsourcing the facility management services. The scholar posited further that the agency outsourced some services and collaborates with the contracting firm for execution of the facility management services with sole aim of technology transfer. The study categorized facility management services into technical services and non-technical services. The scholar employed four key performance indicators to evaluate the performance of facility management in the university. These key performance indicators are: flexibility, effectiveness, efficiency and creativity. The scholar emphasized the flexibility structure of the facility management unit which is public-private in nature. Also, the facility management was adjudged effective and efficient. The introduction of retrofits as a power saving mechanism was adjudged as a creative measure.

Ikediashi et al. (2012) in a study outsourcing of facility management services among Nigeria public universities, established that outsourcing is a novel management strategy for improving service delivery. The study emphasized that outsourcing is gaining popularity among Nigeria public universities as a way for improving value for money in public service delivery. The study reviewed literatures on the concept of outsourcing and facility management as part of a larger study. Findings from the study reveal that there is paucity of research on best practices of outsourcing support tools and management of outsourcing risk.

Kamarazally et al. (2013) examined the current and future challenges faced by Australasian universities facilities managers, analyze their associated risk levels and establish practical ways to address the identified challenges. Interviews were conducted with 25 members of Australasian facility managers (UFMs). The construct at the pilot interviews were used to design a structured but open-ended questionnaire with which the Tertiary Education Facilities Managers Association (TEFMA) members were surveyed. The analysis was done using multi-attribute method. Findings from the study revealed that the following are the challenges faced by facility managers in diminishing order of significance; inadequate funding, emergency management and business continuity planning, statutory compliance, sustainability and environmental stewardship, keeping up with rapid changes in technology, operational efficiency, identifying and meeting stakeholder needs, maintenance and manpower. Preparing and responding to disaster was perceived as the most critical challenge of facility management. Overall, poor funding was identified as the cause of other challenges. The following were suggested as possible solutions; optimized asset utilization, supporting business for capital investment with verifiable rate of return, linking facility management and corporate strategies and investment in efficient technologies.

Odediran et al. (2015) examined the facility management practices in the Nigerian public universities. The study was designed to achieve the following objectives; to examine the facility management practices in the study areas, to examine factors influencing facility management practices in the study areas, and strategies for improving facility management practices in the study areas. Data were collected through a well-structured questionnaires administered on both the managerial and technical officers charged with the responsibility of facility management. Data collected were subjected to descriptive and inferential statistical tool. Findings from the study revealed that facility management practices in the study areas are mostly reactive and reliability centered. Also, the following are factors influencing facility management practices in order of importance; state of deterioration of facilities, level of technology for facility management and funding. The study suggested outsourcing, enhanced managerial goal, facility inspection and facility management plan as strategies for improving facility management practices. All the studies examined different aspects of facility management. However, none of the study examined the level of satisfaction of facility management users with each facility in a university community.

4. Methodology

Data for the study was gathered through administration of structured questionnaires, and interview of staff and students in the study areas. The core services and support services of the two study areas were also observed. The study examined how facility management is effective in the smooth running of the universities. The study also examined how facilities in the study areas are managed to ensure that the core and supporting services of the study areas are achieved. It also examined the satisfaction of the users of these facilities.

The study population in the study areas is depicted with Table 1.

Table 1 *Population of Universities under study*

	University of Lagos		The Bells University	
	N	n	N	n
Student	57,000	164	2,300	154
Staff	2,520	155	450	121
Total	59,520	319	2,750	275

The sample size was determined by employing Frankfort-Nachmias model 1996:

$$n = \frac{Z^2 \times p \times q \times N}{e^2 \times (N-1) + (Z^2 \times p \times q)}$$

Where:
Z: Area under normal curve
p: Estimated proportion of population
q: 1-p
e: Margin of error

Out of the 319 questionnaires administered in University of Lagos, 258 questionnaires were retrieved which translate into 81% of the respondents and 228 questionnaires were retrieved from Bells University of Technology which translate into 82%. The questionnaires were administered to lecturers in their offices in the various faculties through the help of the faculty administrative officers and at the student's hall of residence through the help of the student's hall executives. This led to the high retrieval rate of the questionnaires. Data gathered were analyzed through the aid of thematic diagrams, tables, descriptive statistics and relative importance index. The relative importance index shows the level of satisfaction of the users with the facility management services rendered.

5. Discussion

Facility management at two universities was undertaken with respect to two categories, which are hard services and soft services. These two services complement one another towards the success of overall facility management progress Tables 2 to 5 show facility management methods done in two universities based on field survey.

Core function of the university- The core business of the university is teaching and research. The facility management department functions observed in ensuring that the core business of the university is achieved are the following: maintenance of the lecture rooms, maintenance and management of the teaching materials like projector, electronic boards, white board, lecture room sits and tables, maintenance of student hostels, maintenance of the laboratories and workshops, maintenance and upkeep of lecturers offices, maintenance of library, Information technology management, maintenance of the computer hardware and software, Construction works for lecture rooms, hostels, library, laboratory, staff quarters, archiving and record keeping, cleaning of lecture rooms, offices, laboratories, libraries, conference rooms, conference room management, janitorial services.

Allied function of the university – These are the activities that are in place for the smooth running of the

Table 2: *Facility Management of Hard Services at the Bells University of Technology*

Services	Method of Facility Management	Remarks
Building/Road Fabric Maintenance	Direct labour and contract by Department of Physical Planning (DPP)	DPP normally carry out corrective maintenance
Decoration and Refurbishment	In house done by Department of Physical Planning	DPP works are coordinated by the Architectural section.
M&E Plant Maintenance	In house done by Department of Physical Planning/Outsourced if it requires advance technical work	Generating sets routine maintenance are done by the DPP Staff but technical repairs are outsourced
Plumbing and Drainage	In house done by Department of Physical Planning	Plumbing works are done by DPP Staff but bore-hole drilling is outsourced.
Air conditioning Maintenance	In house DPP	DPP staff carry out the air conditioning maintenance
Lift & Escalator Maintenance	Not applicable	No high rise building
Fire Safety System Maintenance	In house by DPP	It was noted during observation that fire extinguishers expiring dates are not usually considered.
Minor Project Management	In house DPP	DPP execute project management

Table 3: Facility Management Method of Soft Services at The Bells University of Technology

Services	Method of Facility Management	Remarks
Cleaning	In house coordinated by a supervisor under DPP	The university executes cleaning services in house through the DPP
Security	Outsourced coordinated by Chief Security Officer (CSO)	Coordinated by office of the CSO
Handyman Services	In house DPP	DPP
Waste Disposal	Private Sector Participation (PSP)	Cleaners packed waste products to a central location where PSP and waste recycling company lift the waste.
Recycling	Outsourced	Sorted Out waste products are lifted by recycling companies
Pest Control	In house DPP	Fumigation activities are carried out by DPP staff
Grounds maintenance	In house DPP	DPP Staff
Internal Plants	In house DPP	DPP Staff
Move Management (Churn)	In house DPP	There is no arrangement for move management in assigning offices that corresponds with post.
Pace Planning	Not Applicable	N/A
Business Risk Assessment	Bursary department	The bursary carry out the business risk assessment study for any venture to be carried out by the university consult.
Benchmarking	Vice-chancellor office	Done through the office of Deputy Vice-Chancellor
Space Management	In house DPP	DPP.
Contract Procurement	In house Bursary department	Done by procurement section of the bursary. It was discovered that the officers in charge lack knowledge of procurement of specialized goods but are still entrust with such assignment.
Performance Management	Registrar office	This is coordinated through the department of Human Resources
Information Systems	Directorate of Computer services	Information Technology coordinated by Directorate of Information Services
Telephony	Not Applicable	N/A
Travel booking	Vice-chancellor office	Protocol Office ,Vice-Chancellor Office
Utility management	Procurement/Store office under bursary	Bursary Office
Meeting room services	Protocol under Vice-chancellor's office	Protocol Office, Vice-chancellor Office
Catering Services	Protocol under vice-chancellor's office	Protocol Office, Vice chancellor office
Vehicle fleet management	In house DPP	DPP office
Printing Services	Outsourced	Outsourced
Postal services	Registrar Office	Registrar Office
Archiving	Registry under registrar office	Registrar Office
Concierge Services	N/A	N/A
Reception Services	Protocol, Vice-chancellor's office	Protocol Office, Vice-chancellor office
Health & Safety Advice	No structure on ground	No structure for Health and Safety
Environmental Management	No structure on ground	No structure for Health and Safety

university and for achieving the primary objective of the university. The following are the allied factors: Catering services, Security, Cleaning, Vehicle fleet management, waste disposal, Power generating set maintenance, space management, Mechanical and Electrical maintenance, arterial roads construction and maintenance, input for strategic planning, protocol services.

It was discovered that facility management functions in Bells University of Technology, Ota are executed by six departments or sections. The following sections are charged with different facility management functions: Vice -chancellor office, Registrar office, Bursary department, Directorate of Information Technology and Computer Services, Chief security Officer Office, and Directorate of Physical Planning. The disadvantage of entrusting facility management functions to different department is difficulty in reconciling information. It will be difficult for the various departments to reconcile necessary information that could foster decision making. Also, this arrangement can lead to duplication of roles and delay in execution of projects due to uncoordinated structure.

Also, it was discovered that procurements are done through the bursary department with little inputs from professionals who have expertise in the field where the goods are needed. This could lead to procurement of inferior goods or unspecified goods in some instance. Also, there is no arrangement for move management or churn management in the university. Employees are not moved to new offices when they attain new status and designations. Majority of staff are in the same office for years even after their promotion. In addition, maintenance policy in the university is corrective and not preventive. Maintenance works are executed after damage has been done. It was also observed that there is no laid down procedure for health

Table 4: *Facility Management Methods of Hard Services at the University of Lagos*

Services	Method of Facility Management	Remarks
Building/Road Fabric Maintenance	Contracted	Department of works coordinate activities of the contractor.
Decoration and Refurbishment	Outsourced and supervised by department of works.	Department of works supervise refurbishment.
M&E Plant Maintenance	Minor problems fixed by in-house Mechanical/Electrical technicians and Major problems outsourced	Technicians use to do routine maintenance of the generating sets, flood light and other electrical fittings.
Plumbing and Drainage	In house done by an in house Plumber	Major plumbing works coordinated and supervised by staff of M&E department at the department of works attached to stadium.
Air conditioning Maintenance	In house by Technicians	Supervised by electrical and mechanical engineers of the department of works
Lift & Escalator Maintenance	Outsourced	Supervised by the department of works
Fire Safety System Maintenance	In place	Ensured to be in good condition by the attached supervisor.
Minor Project Management	In house, supervised by attached staff of the department of works.	Department of works officers.

Table 5: *Facility Management Method of Soft Services at the University of Lagos*

Services	Method of Facility Management	Remarks
Cleaning	Outsourced	The cleaning services is outsourced
Security	In house coordinated by Chief Security Officer	Coordinated by office of the CSO
Handyman Services	Done by Department of Works	department of works
Waste Disposal	Private Sector Participation (PSP)	Cleaners packed waste products to a central location where PSP and waste recycling company lift the waste.
Recycling	Outsourced	Sorted Out waste products are lifted by recycling companies
Pest Control	Outsourced	Done by fumigation contractors
Grounds maintenance	In house supervised by the Department of Works	Department of Works
Internal Plants	In house supervised by the Department of Works	Department of Works
Move Management (Churn)	In house done by the Director of works.	There is no arrangement for move management in assigning offices that corresponds with post.
Pace Planning	Not Applicable	N/A
Business Risk Assessment	Bursary Department	The bursary department carries out the business risk assessment study for any venture to be carried out by the stadium consult.
Benchmarking	Office of the Deputy Vice-Chancellor academics and Deputy Vice-Chancellor Administration with the approval of the Vice-chancellor	Deputy Vice-chancellor academics, Deputy Vice-chancellor administration
Space Management	In house	In house
Contract Procurement	Deputy of Vice-chancellor Administration, Bursar and Director of works.	Approved by the Vice-chancellor, with the recommendation of the director of works and the bursar.
Performance Management	Head human resources and the registrar	This is coordinated by the office of the registrar.
Information Systems	Computer services department	Information Technology coordinated by department of computer services
Telephony	Director of works	Director of works
Travel booking	Protocol Units, Vice-chancellor office	Office of the Vice-Chancellor
Utility management	Director of works	Director of works
Meeting room services	Director of works	Coordinated by Director of works
Catering Services	Outsourced	Outsourced to private food vendors
Vehicle fleet management	In house Coordinated by Director of works	Director of works
Printing Services	Outsourced and In house	Some printing are done in house, while some are out-sourced
Postal services	The registrar	Registrar office
Archiving	Registry under Registrar	Registrar
Concierge Services	N/A	N/A
Reception Services	Vice-chancellor's office	Vice-chancellor's office
Health & Safety Advice	Director of health services	Director of health services
Environmental Management	Director of health services	Director of health services

and safety advice and environmental/sustainability management.

It can be concluded that facility management functions in the university is un-coordinated. Various agencies execute different functions which will make it difficult to reconcile information in order to formulate policy.

Table 6 examined the user's satisfaction with the facility management of hard services at Bells University of Technology, Ota. Fire safety system maintenance ranked first with a relative importance index of 4.7193 as the most satisfied hard core facility management services rendered in the study area. Building/Road fabric maintenance ranked second as the most satisfied hard services in the study area with a relative importance index 4.0965. It was gathered that the users of services in the university community are satisfied with the maintenance of building and road structure in the university. Maintenance of mechanical and electrical fittings ranked third with a relative importance index of 3.9211. Maintenance of minor projects ranked fourth with a relative importance index of 3.3246 and maintenance of air-condition ranked fifth with a relative importance index of 2.9868. Lastly, plumbing and drainage ranked sixth and decoration and refurbishment ranked seventh with a relative importance index of 2.7456 and 2.6798 respectively.

The findings in table 6 were corroborated by the users. The respondents revealed that there are good fire precautionary measures in the university. Also, the staff and student of the university attest to good road and building maintenance policy in the institution. This was also observed as there were no noticeable bad roads in the university. However, the respondents complained about beautification of the campus in terms of refurbishment and decoration. Also, the plumbing and drainage facilities were reported to be in poor state by the respondents and this ranked sixth.

Table 6: *Users satisfaction with Facility Management of Hard Services at the Bells University of Technology Ota*

Services	**Excel-lent=5**	**Good=4**	**Fair=3**	**Less Fair=2**	**Poor=1**	**Weight= EFX**	**RII=EFX /Ef**	**Rank**
Building/Road Fabric Maintenance	78	112	20	18	-	934	4.0965	2nd
Decoration and Refurbishment	-	32	117	53	26	611	2.6798	7th
M&E Plant Maintenance	21	168	39	-	-	894	3.9211	3rd
Plumbing and Drainage	-	40	110	58	20	626	2.7456	6th
Air conditioning Maintenance	1	**77**	94	30	26	681	2.9868	5th
Fire Safety System Maintenance	86	118	24	-	-	974	4.7193	1st
Minor Project Management	24	78	100	26	-	758	3.3246	4th

Table 7: *Users satisfaction with Facility Management of Soft Services at the Bells University of Technology Ota*

SERVICES	Excel-lent=5	Good=4	Fair=3	Less Fair =2	Poor=1	Weight=EFX	RII=EFX/EF	Rank
Cleaning	53	117	32	26	-	881	3.8640	3rd
Security	30	71	94	26	1	768	3.3684	9th
Handyman Services	-	40	110	58	20	626	2.7456	16th
Waste Disposal	94	77	30	26	1	921	4.0395	1st
Recycling	26	118	60	24	-	830	3.6404	4th
Pest Control	24	78	100	26	-	784	3.4386	8th
Ground maintenance	11	39	168	10	-	735	3.2237	12th
Internal Plants	-	28	150	41	9	653	2.8640	14th
Move Management (Churn)	-	10	109	79	30	555	2.4342	18th
Benchmarking	29	98	73	25	3	809	3.5132	7th
Space Management	7	100	56	55	10	723	3.1711	13th
Contract Procurement	4	78	100	40	36	748	3.2807	11th
Performance Measurement	-	73	115	40	-	757	3.3202	10th
Information Systems	-	26	139	60	3	644	2.8246	15th
Meeting room services	32	77	118	1	-	824	3.6140	5th
Catering Services	50	110	60	8	-	886	3.8859	2nd
Printing Services	-	23	60	75	70	492	2.1579	19th
Postal Services	7	48	73	65	35	611	2.6798	17th
Archiving	53	65	82	19	9	811	3.5877	6th

Table 8: *Users satisfaction with Facility Management of Hard Services at University of Lagos, Lagos*

Services	Excellent=5	Good=4	Fair=3	Less Fair =2	Poor=1	Weight= EFX	RII=EFX /Ef	Rank
Building/Road Fabric Maintenance	84	53	38	72	11	901	3.4922	1st
Decoration and Refurbishment	24	39	50	83	62	654	2.5349	7th
M&E Plant Maintenance	12	38	116	60	32	712	2.7597	5th
Plumbing and Drainage	2	15	30	172	39	543	2.1047	8th
Air conditioning Maintenance	44	86	53	37	38	835	3.2364	3rd
Lift & Escalator Maintenance	11	56	72	80	39	694	2.6899	6th
Fire Safety System Maintenance	52	77	69	43	17	878	3.4031	2nd
Minor Project Management	26	60	119	33	20	813	3.1512	4th

Table 9: Users satisfaction with Facility Management of Soft Services at University of Lagos, Lagos

SERVICES	Excellent=5	Good=4	Fair=3	Less Fair =2	Poor=1	Weight=EFX	RII=EFX/EF	Rank
Cleaning	40	121	70	27	-	948	3.6744	3rd
Security	13	86	77	69	13	791	3.0659	6th
Handyman Services	1	63	88	79	27	706	2.7364	15th
Waste Disposal	44	139	36	30	9	953	3.6938	2nd
Recycling	14	36	100	80	28	702	2.7209	16th
Pest Control	36	113	67	34	8	911	3.5310	4th
Ground maintenance	4	46	60	117	31	649	2.5155	18th
Internal Plants	6	42	120	76	14	724	2.8062	12th
Move Management (Churn)	-	-	80	160	18	578	2.2403	19th
Benchmarking	3	86	82	49	38	741	2.8700	11th
Space Management	6	44	126	52	30	718	2.7829	14th
Contract Procurement	36	70	100	33	19	845	3.2752	5th
Performance Measurement	-	80	112	36	30	758	2.9380	10th
Information Systems	3	37	170	48	-	769	2.9806	8th
Meeting room services	13	26	99	97	23	683	2.6473	17th
Catering Services	7	40	163	42	6	774	3.0000	7th
Printing Services	51	118	72	17	-	977	3.7868	1st
Postal Services	3	68	121	49	17	765	2.9651	9th
Archiving	17	42	103	69	27	719	2.7868	13th

Table 7 examined user's satisfaction with the soft facility management services rendered in the study area. Waste disposal ranked first with a relative importance index of 4.0395, catering services ranked second with a relative importance index of 3.8859 and cleaning ranked third with a relative importance index of 3.8640. Also, recycling service ranked fourth, meeting room services ranked fifth and archiving ranked sixth with relative importance index 3.6404, 3.6140 and 3.5877. Benchmarking service ranked seventh with a relative importance index of 3.5132 and pest control ranked eight with a relative importance index of 3.4386. Security ranked ninth with a relative importance index of 3.3684 and performance measurement ranked tenth with a relative importance index of 3.3202. Contract procurement ranked eleventh with a relative importance index of 3.2807 and ground maintenance ranked next with a relative importance index of 3.2237. Space management ranked thirteenth with a relative importance index of 3.1711 and internal plants ranked fourteenth with a relative importance index of 2.8640. Information systems, handyman services, postal services, move management and printing ranked as follows; fifteenth, sixteenth, seventeenth, eighteenth and nineteenth respectively.

The findings from table 7 were corroborated by interview. It was gathered from the respondents that the university has a good waste disposal system. This corroborates its ranking as first. Also, the students and the staff of the university attest to the good catering services rendered by the food vendors of the university. Furthermore, it was gathered that the respondents are satisfied with the cleaning services rendered by the employed cleaners which also corroborate the ranking of cleaning as third. However, the staff and students of the university are least satisfied with the printing services rendered in the university that ranked 19th. Also, move management (churn) ranked 18th. The staff revealed that their offices remain constant despite change in their status which justified that churn management in the university is poor. It was also gathered from interview that there is no post-office or posting outlet in the university. However, it was gathered that staff of Nigerian postal services use to visit the intuition ones in a week to deliver and collect letters. This justified why postal services ranked 17th.

Table 8 examined facility management services at University of Lagos, Lagos, Nigeria. Building/road maintenance fabric ranked first with a relative importance index of 3.4922. Fire safety system maintenance ranked second and air conditioning maintenance ranked third with relative importance index of 3.4031 and 3.2364 respectively. Minor project management ranked fourth and Mechanical and Electrical plant maintenance ranked fifth with relative importance index of 3.1512 and 2.7597 respectively. Lift escalator maintenance and decoration and refurbishment ranked sixth and seventh with relative importance index of 2.6899 and 2.5349. Lastly plumbing and drainage ranked eight with a relative importance index of 2.1047.

The findings from table 5 were corroborated with interview. It was gathered from the users that the university's plumbing and drainage system is poor. This corroborates its ranking as eight. Also, it was gathered that the refurbishment and decoration of the university is not encouraging which also corroborate its ranking as seventh. However, the users stated that they are mostly satisfied with the maintenance of the building/road fabric and this corroborate with its ranking as first. Also, it was gathered from the interview that the university have firefighting equipment in place which justify its ranking as second. The air-conditioning in the staff offices and lecture rooms are said to be working well which justified the ranking of air-conditioning as third.

Table 9 examined user's satisfaction with the soft facility management services rendered in the University of Lagos. Printing services ranked first with a relative importance index of 3.7868, waste disposal ranked second with a relative importance index of 3.6938 and cleaning ranked third with a relative importance index of 3.6744. Also, pest control ranked fourth, contract procurement ranked fifth and security ranked sixth with relative importance index 3.5310, 3.2752 and 3.0659. Catering service ranked seventh with a relative importance index of 3.0000 and information system ranked eight with a relative importance index of 2.9806. Postal services ranked ninth with a relative importance index of 2.9651 and performance measurement ranked tenth with a relative importance index of 2.9380. Benchmarking ranked eleventh with a relative importance index of 2.8700 and internal plants ranked next with a relative importance index of 2.8062. Archiving ranked thirteenth with a relative importance index of 2.7868 and space management ranked fourteenth with a relative importance index of 2.7829. Information systems, handyman services, recycling, meeting room devices, ground maintenance and move-management ranked as follows; fifteenth, sixteenth, seventeenth, eighteenth and ninth. All these ranking were corroborated with the interview conducted.

6. Conclusion and Recommendations

The study examined application of facility management in two Nigerian Universities. The study examined the hard and soft facility management services in the two universities. The modes of execution of the soft and hard services in the study areas were examined. It was gathered that some services were outsourced while some were executed in-house in the study areas. The study revealed further that the hard services have direct impact on the primary function of the university which is research and teaching. Also, it was gathered that the soft services are necessary for the smooth running of the universities. The classification of facility management into soft and hard services is in line with Probst-Wallace (2012) model. Also, the study was structured based on International Facility Management Association model of facility management which recognizes; people, process and place.

The study examined the user's satisfaction with the soft and hard services in the study areas. It was gathered that the ranking varies from one university to another. Some of the implied cause of the variation has to do with funding, the ownership status of the two institutions and facility management policy of the two institutions. However, facility management best practices should not be compromised irrespective of the causative factors. Hard services like plumbing and drainage and refurbishment and decoration need to be addressed in the two universities due to their poor ranking. Also, soft service like move management (churn) needs to be well addressed. There should be policy in place that will move staff to another office whenever their status changes. Finally, the two universities need to establish a facility management department that will coordinate both the hard and soft services. Also, the composition of the department must include all necessary professionals ranging from: Builders, Electrical Engineers, Mechanical Engineers, Civil

Engineers, Human resources practitioners, Air-conditioning technicians and other allied professionals.

References

Armstrong D (1982) 'Is facility management a fad? Why all the hoopla now? Interiors, Dear Dare Series, June.series

Ajayi, I.A and Ayodele J.B (2001) Introduction to Educational Planning, Administration and Supervision, Ado-Ekiti Yemi Prints and Publishing Services

Babatope, B.A (2010) Problems of Facilities in South-West Nigerian Universities and the way forward. Journal of Eduaction Administration and Policy Studies , 2(2), 039-043.

Barrett P.S And Owen D.D (1992) ' The Outstanding Balance: Is There an Optimum? Facilities Management Research Directions (ed Peter Barrett) University of Salford.

Cowan (2001) Information is key to Facilities Management Planning Chattered Surveyor Monthly, April, 32-33

Durodola O.D (2009) Management of Hotel Properties in South-Western Nigeria: Facilities Management Perspectives. Unpublished PhD thesis submitted to department of Estate Management, Covenant University, Ota.

FMA Australia (2012) Facility Management Good Practice Guide: Multi-Unit Residential, A publication of Facility Management Association of Australia

Frankfort-Nachmias, C (1996) Research Methods in the Social Sciences. Aukland: Hodder Arnold Ltd.

Gilleard and Tam H(2002) Appropriate Workspace Strategies in Hong Kong Facilities, Hong Kong Journal of Facility Management, 20(3/4), 113-118

Hamer, J.M (1988) Facility Management System, 1st Edition, New York: Van Nostrand Reinhold Inc

Hashim, H, Saleh, A.A, Kamarulzaman, N and Hashim, S.Z (2011) Assessment of Facilities Management Performance in International Islamic University Malaysia (IIUM). Publication of The 2nd International Building Control Conference. Procedia Engineering, 284 -290

Ikediashi, D.I; Ogunlana, S.O; Bowles, G; and Mbamali, I (2012) Outsourcing of facilities management services in Nigeria's public universities In: Laryea, S. Agyepong, S.A. Leiringer, R and Hughes, W (Eds) Procs 4th West Africa Built Environment Research (WABER) conference, 24 – 26 July, 2012, Abuja, Nigeria, 725- 735

Isa, A and Yusoff, W.Z.W (2015) State of Physical Facilities of Higher Education Institutions in Nigeria. International Journal of Scientific and Research Publications, 5(4), ISSN 2250-3153

Kamarazally, M.A, Mbachu, J and Phipps, R (2013) Challenges faced by facilities managers in the Australasian Universities, Journal of facilities management, 11(2), 136 – 151.

Kincaid, D (1994) ' Integrated Facility Management. Facilities Journal Vol. 12, No. pp 20-23.

Lennerts I.K (2001) Facility Management Basics, A publication of Institute for Technology Management in Construction, Kadsruhe Institute of Technology.

Odediran, S.J, Gbadegesin, J.T and Babalola, M.O (2015) Facilities Management Practice in Nigerian public Universities, Journal of Facility Management 13(1), pp 5 – 26

Ogbeifun, E (2011) Facilities Management in a Multi-Campus Setting: A Case Study of the University of the Witwatersrand. An Unpublished M.Sc thesis Submitted to the Faculty of Engineering and Built Environment, University of Witwatersrand, Johannesburg.

Sekula, M (2003) "Days as Head of Facilities" Facility Management Journal (FMJ) \March/April, pp 13-16

Patanapiradej W (2002) The Scope of Facility Management. Nakhara Publications.

Probst-Wallace, D (2012) What is facility management? www.ifma.org.hk/download/what_is_facility_management.pdf

INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 5(2)/2018, 145-154

An Appraisal into the Potential Application of Big Data in the Construction Industry

Siti Aisyah Ismail; Shamsulhadi Bandi and Zafira Nadia Maaz
Department of Quantity Surveying, Faculty of Built Environment, Universiti Teknologi Malaysia
Email: aisyaaahismail@gmail.com

History:
Received: 5 April 2018
Accepted: 26 April 2018
Available Online: 31 May 2018

Keywords:
Big Data, Construction Industry, Disruptive Technology, Nvivo, Qualitative research.

Corresponding Author Contact:
+607-5537378

DOI:
10.11113/ijbes.v5.2.274

ABSTRACT

The volume of data generated by the construction industry has increased exponentially following an intense use of modern technologies. The data explosion thus lead towards the big data phenomenon which is envisioned to revolutionize the construction like never before. Like any other technologies, big data is a disruptive paradigm and inevitably will give impact to the construction industry. As the industry is refocusing towards an improved productivity, the appeal to embrace big data is certain given the value it offers. This certainly will benefit construction akin to the manufacturing and the retail industry alike. Nevertheless, a review of the literature suggested a limited coverage on the potential application of big data in construction as compared to other industries. This limits understanding of its potential, where the industry is seemingly unaware thus could not relate and extract its real value. Hence, this study aims to draw insights on the specific areas of construction big data research. The research objectives include: (1) to analyse the current extent of construction big data research; (2) to map out the orientation of the current construction big data research; and (3) to suggest the current directions of construction big data research. The qualitative method through a desk study approach has been carried out to attain the first two objectives. It involved a structured review process which covered articles from the online databases assisted by the Nvivo software. This resulted in the theoretical orientation which was conceptualized as: (1) project management; (2) safety (3) energy management; (4) decision making design framework and (5) resource management. The theoretical orientation discovered from the review process will form the basis to suggest the prospective directions of research on big data in construction. This exploration is substantial as a precursor to a much deeper study on big data. As big data is set to influence the industry, the finding made would be a catalyst for creating an awareness to support the development of big data for the construction industry.

1. Introduction

Big data has been buzzing among many industries around the world on its potential in dissolving most of the industries' common issues and transform them into a smarter way of operating. The advent of big data era is initiated by the data explosion resulted from the presence of advanced technology in today's world. According to Waal-Montgomery (2015) prediction, the world's data volume will rise at approximately 40% per year, and will continue to intensify fifty times from the current volume by the year 2020. The pace in which data is being generated has lead towards data explosion hence big data gain its traction. Basically, big data is often termed based on the 3Vs namely (i) Volume - amount of the data itself, (ii) Velocity – the speed where the data is generated and (iii) Variety – the diversity and complexity of data sources. The construction industry is known to deal with enormous amount of data that reflects the 3Vs and the utilization of these data could be the next frontier for construction industry development.

Peiffer (2016) asserted big data as one of the significant driving factor in configuring the direction which should lead towards improving the industry's efficiency. Though the construction industry is acknowledged as one of the indicator for economic wellbeing, productivity and efficiency are at an all-time low which Harenberg (2017) sorely contended in comparison to when it was in the year 1993. This inefficiency, according to Santiago Castagnino, Christoph Rothballer, and Gerbert (2016) was the result of the slow movement made by the industry in adopting new technologies. This is supported by the MGI's digitization index that put construction sector as the least digitized industry in the world. Santiago Castagnino et al. (2016) added the deliberate changes made by the industry is caused by the insufficient data-driven decision making.

Data is said to be the poster child in enhancing the industry's productivity. This follows as a real-time data exchange could lead to a broadened insight into the industry's operational performance thus making way for a smarter working (Peiffer, 2016). However, albeit of the massive amount of data that is generated in the construction industry, the big data is usually siloed and not being fully utilized for a bigger picture. According to Burger (2017), the inefficiencies of data usage is due to the limited ability in dealing with unstructured data such as free text, images or sensors reading. This is where big data could be the saviour in improving the utilization of data.

According to the Construction Industry Development Board Malaysia (CIDB), reliable and quality big data is currently in demand to align with the board's initiatives under the aspiration of the Construction Industry Transformation Programme (CITP). In conjunction with this, it is essential to identify the level of big data needs for the industry. The current move by CIDB is justified as the most typical error made by organizations was to utilize big data without assessing whether their needs could be satisfied by the use of the technology (Portela, Lima, & Santos, 2016). Likewise, Addo-Tenkorang and Helo (2016), added that there appear to be a limited understanding on the value and the potential of big data for construction. This had resulted in a consequential discouragement in the progress for the adoption of big data in construction industry as compared to other industries.

Data and the construction industry are indivisible as the industry are dealing with a huge amount of heterogeneous data. This follows as data related to construction industry has been predicted by Bilal, Oyedele, Qadir, et al. (2016) to rise exponentially with the advancement of technologies and the Internet of Things (IoT). According to Addo-Tenkorang and Helo (2016), new opportunities in the form of valuable insights can be developed by excerpting the huge amount of data obtained. Despite, a study that focuses on the potential application of big data particularly in the construction industry has not been comprehensively undertaken (Bilal, Oyedele, Qadir, et al., 2016). This limits understanding of its potential, where the industry is seemingly unaware thus could not relate and extract its real value.

Hence, this study aims to draw insights on the specific areas of construction big data research. The research objectives include: (1) to analyse the current extent of construction big data research; (2) to map out the orientation of the current construction big data research; and (3) to suggest the current directions of construction big data research. As big data is set to influence the industry, the research findings would be a catalyst for creating the much-needed awareness to support the development of big data for the construction industry. This would further lead the industry to gear up in developing their capabilities in harnessing the potential of big data as well as encouraging talent and infrastructure development to engage in the forthcoming wave of big data technology in the construction industry.

2. Literature Review

2.1 An overview of Big Data

The renowned 3Vs characteristics which form the big data concept were established by one of the Gartner analyst named Laney Doug in 2001. Respectively, the Gartner's IT Glossary defined big data as a high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making and process automation (Gartner, 2014).

With the arrival of big data, data will no longer be viewed as stagnant whose worth is limited to the accomplishment of its gathering purposes (Viktor & Kenneth, 2013). Whereas, in order to cross the boundary of data collecting purposes, the data need to be handled by means of advanced technologies and human skills as well as data entry base. However, according to Akbar (2017), the current amount of digital information had surpassed the ability of the present tools to process it. This situation is described as "The Industrial Revolution of Data" by Joe Hellerstein, a computer scientist at the University of California in Berkeley and it has affected various public and private sectors (Cukier, 2010).

Definition of big data might varies in different literature, but the domain of the concept is the 3Vs characteristics. Volume is the most important characteristic that represents the extent of big data magnitude. According to C. P. Chen and Zhang (2014) volume is epitomized as the size of the data itself that are generated by the advanced technologies, networks and human interactions especially on the nets (Hammer, Kostroch, & Quiros, 2017). On the other hand, velocity signifies that data is produced at a remarkably high speed which outstrips the conventional systems (Zikopoulos, Parasuraman, Deutsch, Giles, & Corrigan, 2012). Data velocity is regarded as a supplementary to data volume as greater data volume requires the data processing to be winged (Özköse, Arı, & Gencer, 2015). As Gartner (2015) has profoundly predicted, there will be as much as 20.8 billion connected devices by the year 2020 as compared to 6.4 billion as reported in 2016. This shows that the pace of data velocity will continue to speed up following the connected devices' enhanced features for data streaming (Lee, 2017). Last is variety which means the diversity and complexity of data categories and sources (Zikopoulos et al., 2012). According to Özköse et al. (2015), data may be derived from various resources both internally and externally. Similarly, O'Reilly (2014) emphasized in his book that these data come from an assortment of structures and it is often hard to obtain an impeccably, processing-ready data. Such data can be categorized into structured, semi-structured or unstructured data. This classification of data is derived from the existence of the social network, sensors, mobile devices, GPS and other technological appliances (Portela et al., 2016).

2.2 Current Big Data application in other sectors

In recent times, big data has been discussed across various sectors and is considered as a game changer in major industries (Gaitho, 2017). For this reason, many organizations have taken steps to change their plan of action in utilizing the big data value effectively (Akbar, 2017). A survey made by Gartner in 2015 proved that companies have incrementally increased their investment in big data to 75% from 58% recorded by the same survey in 2012. The extensive scope of big data has provided a massive scale of potential and value that can be generated across different sectors such as retail sector, manufacturing as well as the upstream industry.

Retail sector is among the earliest to recognise the potential of big data. This follows from the upsurge of e-commerce during the big data 1.0 era (Laney, 2001). During that time retail businesses leveraged the power of basic internet technologies to establish a strong web presence followed by building their capacity to process a large data which was conducive to their efficiency improvements (Provost & Fawcett, 2013). The potential was further extended in analysing the vast amount of data to support decision to expand businesses, improve cost efficiency and revenue forecasting (Meneer, 2015).

Manufacturing is another leading sector that has moved towards big data exploration in enhancing their product quality, and at the same time reducing the operational costs (Oracle, 2015). External data especially from social networks and suppliers' data combined with data from sensors and machines has given valuable insights to the existing information. In this respect, big data was utilized to analyse varieties in enhancing the efficiency of manufacturing and the operational process by providing the bird's eye view of the processes which led to a better decision making. Apart from that, big data technologies also assist in improving the product quality and reducing the overall cost through production and quality data analysis along with customers' returning data, capacity consumption as well as machinery efficiency (Oracle, 2015).

The oil and gas industry has also gained a lot from big data. According to B. Mathew (2016), in the current situation, data collected particularly in the operational process is used mainly for detection and control purposes. Big data's advanced analytics assisted in the decision making where big data insights were used to plan for predictive maintenance. In this case, it was reported that the technology has managed to bring the maintenance cost down to about 13% (Choudhry, Mohammad, Tan, & Ward, 2016). The benefits of digital monitoring and predictive maintenance extends towards detecting errors on equipment and performing maintenance before they are entirely damaged. It was reported by analytics firm, Kimberlite that an approximately $49 million annually were wasted due to an unplanned downtime (Choudhry et al., 2016). Hence, big data in this respect helped to enhance production and addressed the financial impacts before it eventually occurs.

2.3 Big Data and the Construction Industry

Construction is one of the major industry that is responsible towards a country development. The construction works to be carried out in a project is dynamic (Wood, 2016) and involve a high volume of data exchange from various stakeholders to be gathered and processed (Shrestha, 2013). Shrestha (2013) added that data is generated throughout the various phases of construction projects from planning phase to completion. As shown in Table 1, the stream of data includes design and financial data, sensors and equipment data, photos and videos and others. This data is often large in volume, highly diverse in format and dynamic. The multi faceted data reflects the multitude characteristics of data streaming from construction activities thus sits in comformity with the 3V's concept of big data.

Table 1 *Big Data context in Construction Industry*

Characteristics	Contributors	Examples
Volume	Large volume of data from different sources	Design data, cost data, financial data, contractual data, Enterprise Resource Planning (ERP) system, etc
Variety	Diversity in the content format	DWG (drawing), DXF (drawing exchange format), DGN (design), RVT (revit), ifcXML, ifcOWL, DOC/XLS/PPT (Microsoft format), RM/MPG (videos), JPEG (images)
Velocity	Dynamic nature of data sources	Sensors, RFIDs, Building Management System (BMS)

Source : Aouad, Kagioglou, Cooper, Hinks, and Sexton (1999); Bilal, Oyedele, Qadir, et al. (2016)

Further, Table 1 shows that the advancement of construction processes through the widespread utilization of these data shall be the next frontier of construction industry innovation and productivity. This is supported by Harenberg (2017) who mentioned real-time data processing as the future booster of productivity in construction.

2.4 Triggering Constituents of Big Data in the Construction Industry

The digitalized revolution has impacted the construction industry rather significantly as the industry is dealing with heterogeneous amount of data (Bilal, Oyedele, Qadir, et al., 2016). These triggering contituents to big data are identified and discussed as the following:

2.4.1 Building Information Modelling (BIM)

BIM is anticipated to capture the multi-dimensional CAD data to deliberately support the multidisciplinary and coordinated working environment among the stakeholders involved in a project (Eadie, Browne, Odeyinka, McKeown, & McNiff, 2013). As BIM involves with capturing the additional layers of information throughout the entire building lifecycle, BIM is perceived to transform the construction industry across various perspectives (Azhar, 2011). Though data volume has been the characteristic of BIM, yet Humphreys (2016) argued that this data are not precisely big data. This follows as the huge files of BIM with the combination of the numerous models is still promptly prepared only to be processed by BIM applications. Likewise, the arrival of built-in devices and sensors has increased the amount of data generated where it eventually leads to the wellsprings of Big BIM Data (Bilal, Oyedele, Qadir, et al., 2016). Thus, this triggers the construction industry to penetrate the big data era.

2.4.2 Cloud Computing

Cloud computing is an internet computing trend which on request, give access to the merge of configurable resources (Bughin, Chui, & Manyika, 2010). The main purpose is to provide multiple users with access to data storage and computation without each having to resort for an individual license. The acceleration of cloud computing technology has contributed to the evolution of big data (Qubole, 2017). As cloud computing is supporting the coordination of errands in the BIM-based application, it has been broadly applied in the construction industry and big data performance in this revolution is astounding (Bilal, Oyedele, Qadir, et al., 2016). In addition, cloud computing and big data are said to be an ideal combo that contributes to the cost efficiency and extensible infrastructure in supporting Big Data and Business Analytics (Ferkoun, 2014).

2.4.3 Internet of Things (IoT)

The Internet of Things (IoT) has been the main pillar that triggers the big data 3.0 era. Basically, IoT is a system of Internet-connected devices that gather and transfer data through installed sensors (Meola, 2016). IoT application frequently conveyed a substantial number of sensors devices for data accumulation. As the industry presents boundless big data utilization cases for IoT, big data is inalienably the subject of intrigue (Bilal, Oyedele, Qadir, et al., 2016). Among the prominent areas of IoT applications includes logistics, transport, asset recording, intelligent homes and buildings, energy and agriculture. Bilal, Oyedele, Qadir, et al. (2016) claimed that IoT and big data are interdependent trends where a huge amount of data is created, accessed and analysed in real-time in construction applications. Additionally, Pal (2015) suggested that during the selection of big data processing technology, huge flood of information produced by IoT triggers big data on a reciprocal basis following the selection of big data processing technology.

2.4.4 Smart Buildings

Smart Building technology assimilates the contemporary technologies with existing building systems to attract the economical trade-off between comfort maximization and energy reduction (Khan & Hornbæk, 2011). Often, these systems will produce an enormous volume of data and the greater part of this information often stay undiscovered and eventually disposed of. According to Bilal, Oyedele, Qadir, et al. (2016), this data needs to be interpreted to truly reflect smart buildings hence gives big data analytics a significant role to play. The information and communication technology (ICT)-based integration and development systems, particularly Internet of Things is an important catalyst for various applications, both industry and the general population in realizing the smart buildings (Perera, Zaslavsky, Christen, & Georgakopoulos, 2014). In this sense, Moreno et al. (2016) opined that big data and IoT are an impeccable combination in enhancing energy efficiency for Smart Buildings.

2.4.5 Augmented Reality (AR)

Augmented Reality is a technology that coordinates virtual object images into real-world images. These images can be taken from the camera or, by using a live view, the audience can be added directly to the world (Reiners, Stricker, Klinker, & Müller, 1998). According to Jiao, Zhang, Li, Wang, and Yang (2013) AR comes from 'Virtual Reality' (VR) and provides a half-depth environment that highlights the exact alignment between actual scenes and virtual world images in real time. It is also broadly recognized as an assuring technology to improve human viewpoint. Additionally, the means to enhance prevailing big data visualization techniques is correlated with AR and VR where it is relevant for human limited perception capabilities (Olshannikova, Ometov, Koucheryavy, & Olsson, 2015). Consequently, AR and big data are certainly unavoidable where the complexity related with big data in construction is tremendous and must be overcome by advanced visualization methods, specifically AR and VR (Bilal, Oyedele, Qadir, et al., 2016).

2.4.6 Social Networking Services

Social media is one of the exciting trends that could assist the construction industry to improve the communication among project teams (Jiao, Wang, et al., 2013). Yet, one of the main challenge is to accede the value and exploring ways of analysing it (H. Chen, Chiang, & Storey, 2012). This follows from the enormous volume of heterogeneous data produced by the social networks. Hence, to properly analyse data from social media, the analytical techniques of data analysis need to be modified and incorporated into the new enormous data for enormous information processing (Bello-Orgaz, Jung, & Camacho, 2016). In relation to this, big data can be utilized in developing appealing domain applications through the high volume, velocity, and variety of social network data to improve stakeholders' productivity.

2.5 Current Big Data research in the Construction Industry

Big data has begun to set foot in the construction industry in sync with other sectors that have long benefited from big data. In this regard, the construction industry could exploit big data in the same manner as anticipated by the other sectors or industries. As discussed earlier, this includes enhancing efficiency, decision making, and sensors monitoring. Bilal, Oyedele, Qadir, et al. (2016) maintained that the outlook on the applicability of big data in construction could be magnified as the triggering contituents discussed in section 2.4 advanced. Thus, the surge of these contituents and trends could be the factors to propel the construction industry to the next level of data driven initiatives.

The current big data research or application excerpted from various literature is summarized in Table 2 with the important concepts identified from the review process are aggregated and accentuated in brackets. The findings will become the basis to map the orientation of big data research in construction and subsequently suggesting the probable direction for research to ensue.

3. Research Methodology

The qualitative research design was adopted for this study. According to Bryman (2008), qualitative research is a research strategy that typically emphasizes on words rather than the computation of data. In this regard, the aim is to provide a thick explanation about a phenomena following the specific issue identified from the the literature (Elo & Kyngas, 2008; Fellows & Liu, 2008). The decision for adopting to the strategy was also guided by the objectives of the study. As the research objectives include analysing the current extent of big data research and mapping out its orientation and potential application, these are better achieved by going deep through an analytical explanation of the existing research (Creswell, 2005).

Desk study method was used to collect the data required for attaining the first and the second objectives. According to Travis (2016) desk study relied on the researcher's skill to review the previous research findings in order to obtain an expansive comprehension of the study area. This method was adopted as it provides the fastest and inexpensive method in understanding the realm of the research, where a thorough review was made to obtain a cross sectional insights on big data in the construction industry.

As the study is currently on going, a series of interviews are planned to consolidate and validate the insights that are to be gained from the desk study. The interviews are planned to be administered with personnel who have experienced big data and is aimed to identify the potential application of big data in construction. According to Rubin and Rubin (2011), the qualitative interview is a discussion where the researcher aides a conversational accomplice in a broadened exchange. The interviews will allow the researcher to expand the questions to the extent that they are willing to share. Accordingly, the desk study is important in this regard as it gives the researcher a gist of the previous research findings before the interviews are carried out. For this reason, this paper is organised to highlight the analytical method employed in the desk study and the findings derived therein. These are concurently presented and discussed in the ensuing sections.

4. Findings and Discussion

The important concepts on big data excerpted from the review were structurally analysed by following the steps in the framework known as *SALSA*. The acronym stands for **S**earch, **A**ppraisa**l**, **S**ynthesis, and **A**nalysis and was introduced by Booth, Sutton, and Papaioannou (2016). A complete application of the *SALSA* framework was illustrated in a study by Shamsulhadi, Fadhlin, and Hamimah (2015) and was further methodologically discussed by Shamsulhadi and Fadhlin (2016) and Zafira, Shamsulhadi, and Roslan (2018). In the studies mentioned, it was observed that the Nvivo software was predominantly deployed to assist in the analytical process. Part of the analytical outcomes as presented in Table 2 had followed the processes as outlined by the previous studies and include the usage of the Nvivo software as well. This approach was intentional to maintain the rigour as justified in the illustrated research. Details of the processes carried out for the study are further explained in the following sections.

4.1 Searching

The exploratory nature of this study had naturally required the

Table 2 *Big Data research from various literature*

No	Big Data research area from the literature review	Authors
1	BD with Visual Analytics used for (**building performance)** comparison that leads to renovation and construction with low (**energy**) consumption.	(Ioannidis et al., 2015)
2	LEED uses actual data to verify the (**building performance**)	(Davis, 2015)
3	Improve **(project management)** by using technologies or sensors for (**performance**) monitoring and tracking	(Wood, 2016), (Bleby, 2015), (Yang, Park, Vela, & Golparvar-Fard, 2015)
4	Cost efficiency (**design**) through a real-time, data-focused predictive model.	(Sadhu, 2016)
5	BD assist in (**project management)** to ensure the project is delivered on (**time**) and (**minimize delays)**	(Sadhu, 2016), (Rijmenam, 2015), (Faure, 2016), (Augur, 2016), (Akbar, 2017)
6	Real-time data sharing to improve (**communication)** between stakeholders	(Rijmenam, 2015), (Augur, 2016)
7	Resource tracking through sensors-equipped assets or machineries. (**resource management**)	(Rijmenam, 2015), (Augur, 2016), (Azzeddine Oudjehane & Moeini, 2017), Akhavian and Behzadan
8	Deriving information from stakeholders to improve the (**planning**) process and (**project management**)	(Caron, 2015)
9	Integration of information technologies with data handling in facilitating (**decision-making**) for (**project management**)	(Martínez-Rojas, Marín, & Vila, 2015)
10	BD generate (**prediction**) system for construction businesses bankruptcy	(Hafiz et al., 2015)
11	Drones use for construction progress monitoring for (**project management**)	(Azzeddine Oudjehane & Moeini, 2017), Knight (2015)
12	Geospatial/geo-location data for (**resources optimization**) and (**resource management**)	(Akbar, 2017)
13	Data simulation tool in reducing project (**risk**).	(Akbar, 2017)
14	BD for construction (**cost management**) through tender price assessment system (**project management**)	(Y. Zhang, Luo, & He, 2015)
15	Visual BD to improve (**communication**) among project stakeholders.	(K. K. Han & Golparvar-Fard, 2017)
16	Assess (**Construction waste management**) performance using BD	(Lu, Chen, Ho, & Wang, 2016), (Lu, Chen, Peng, & Shen, 2015)
17	Developing (**waste**) simulation tool using BD for (**Construction waste management**)	(Bilal, Oyedele, Akinade, et al., 2016)
18	Social network analysis and (**energy**) usage analyses as sources in establishing an integrated green building (**design**) model	Redmond, El-Diraby, and Papagelis (2015)
19	BD algorithms to accurately reduce the design space and enabled generative (**design**) tool	(Bilal, Oyedele, Qadir, et al., 2016)
20	BD and VR for better building (**design**) decision	(Bernstein, 2017), (Barista, 2014)
21	BD helps in generating a predictive model for (**energy)** consumption	(Moreno et al., 2016)
22	BD algorithm for (**building performance**) in terms of (**energy)** consumption	(P. A. Mathew et al., 2015)
23	Implementing prototype software called Project Dasher for (**energy**) data visualization and real-time monitoring.	(Khan & Hornbæk, 2011)
24	BD analysis used to understand energy consumption behavior thus help to improve (**energy efficiency**) in building	(Koseleva & Ropaite, 2017), (Janda et al., 2015)
25	Real-time (**energy**) consumption data monitoring and control to improve energy efficiency	(Wei & Li, 2011)
26	BD-based platform to visualize workers' unsafe (**safety**) act in real-time	(SY Guo, Ding, Luo, & Jiang, 2016), (Shengyu Guo, Luo, & Yong, 2015)
27	Use wearable to track worker proximity to rolling (**safety**) exclusionary zones	(Wood, 2016)
28	Use drones to check on site (**safety**)	(Oudjehane & Moeini, 2017)
29	Real-time (**safety**) tracking and data visualization technologies improve (**safety**) understanding.	(Teizer, Cheng, & Fang, 2013) (Hampton, 2015)
30	Application of BD-driven BIM system in improving construction (**safety**)	(S. Zhang, Teizer, Lee, Eastman, & Venugopal, 2013)
31	Integrating BIM data with external data such as Linked Open Data (LOD) for better (**project management**) and reduce project (**risk**)	(Curry et al., 2013)
32	Sensor based fire-fighting system for skyscraper building in associate with the authorities help in fire detecting as well as evacuation process (**safety**)	(Stankovic, 2014)
33	Predicting site injury and workers' behavior towards (**safety**) through 3D skeleton motion model from videos.	(S. Han, Lee, & Peña-Mora, 2012)
34	Data from robotics and automated equipment has the potential to improve job (**safety**) and enhance construction (**productivity**).	(Skibniewski & Golparvar-Fard, 2016)
35	Capturing (**safety**), quality and performance data for real-time analysis in improving site (**safety**) and construction work (**productivity**).	(Bleby, 2015)
36	Big Data from mobile apps for contractor to track **(resource)** and document schedule changes to enhance **(resource management)**.	(Sadhu, 2016)
37	**(Energy**) consumption prediction through computational models developed based on user behavior for better (**energy management**).	(C. Chen & Cook, 2012)
38	BD in (**design)** model comprises of architectural, structural, and building services data to enhance (**design)** efficiency	(Porwal & Hewage, 2013)
39	Past project data-driven (**design)** to improve (**design)** decision and efficiency.	(Barista, 2014)

Source: As shown

researcher to search the relevant literature concerning big data in construction. For this purpose, the researcher had first established the search parameter and subsequently drawn the relevant keywords from the aim and objectives of the study. A snowballing technique was then exercised where literatures were identified through the backward and forward approaches (Webster & Watson, 2002).

To achieve this, the UTM Library Online Database which contained access to academic journals from Emerald, Science Direct, IEEE Xplore Digital Library, and Springerlink was searched. The main keywords used in searching the literature were "big data" and "construction industry". Additionally, the Boolean operators, truncation characters and wildcards were also used in selecting the relatable journal articles. Based on the search results, a large numbers of big data articles were displayed from both construction as well as other domains. However, the results were again filtered where only the content that portrays the presence of big data in the construction industry was of particular interest.

4.2 *Mapping Ideas and Analysis*

Mapping involves putting together different strands that make up the topic to enable analysis and synthesis to be undertaken. The process involves accumulating the literature content from the review and sorting the list into categories for the purpose of establishing connections (Hart, 1998). According to Hart (1998), the aim of this process is to dynamically reduce the huge amount of information extracted from the review with due emphasized given to extract the main points of the argument. For this study, a featured map, in a form of a table proposed by Hart (1998) was developed and showed in Table 2. The table showed the results of the analysis which has taken place by reflecting the words (or terms) derived from the extracted data. These were reflected as the features which had characterised the literature and a structural form of recognition of the leading concepts. Despite, at this stage, it appears that the concepts derived were rather disjointed and had followed the individual reflection from the sources. This necessitates the next step in the process - synthesis.

4.3 *Synthesis, Mapping and Discussion of the Outcomes*

Concepts that arised from the analysis were synthesized through the aggregative approach in which the concepts were grouped into relatable themes or area. This process was carried out by using the Nvivo software where apart from its ability in mapping out the outcome, proved to be useful in espousing the weightage which could exaggerated certain number of concepts. The frequently mentioned concepts were mapped out through the word frequency command. It counts the frequency of a particular word or phrase or a set of alternative words fed from the analysis. In relation to this study, the 'Word Frequency Query' in Nvivo was used to reveal a specified concepts of big data that have been mentioned the most. Hence, the predilections of big data in construction were obtained thus attaining the second objective.

A model which was developed from the synthesis is presented in Figure 1. It shows that prior research on big data in construction had centered around 'management' especially 'project' management, 'energy' management and 'resource' management. In this context, big data in 'project management' involves those linked-construction data in cloud base that provides broad understanding on complex project. It was submitted that big data leads to a better 'project management', especially in ensuring that cost efficiency was achieved as well as minimizing delays. Likewise, big data initiated by the IoT devices such as drones, sensors or smartphones aid in recording construction work progress and monitoring work performance. It was postulated that a real -time data was able to be provided so that actionable actions could be taken in enhancing the project productivity. Additionally, the IoT devices also generates data on the 'safety' aspect such as workers' safety behaviour on site and site safety conditions through sensors, automated equipments, tracking devices as well as visualization technologies.

Big data also contribute to a better project management through data wise enhancing 'decision-making' process especially in predicting the project orientation that leads to lower project risk.

On the other hand, 'energy management' encompasses the integration of IoT or BIM with big data analytics in understanding the building energy consumption to increase energy efficiency and add to building performance. Energy analyses further assist in decision making 'design' framework where the results could be the determinant in generating integrated models for building design. Also, big data provide an aerial view on all aspects of the built environment that facilitates a better decision-making design framework.

Correspondingly, resources tracking and monitoring through sensors or mobile apps helped to enhance the decision-making for 'resources management' and ensure resource optimization. Other big data potential application reviewed from the literature includes construction waste management as well as data-sharing efficiency to improve communication.

Based on the discussion, the theoretical orientations obtain from the analytical processes could be summarised as: (1) project management; (2) safety; (3) energy management; (4) decision making design framework and (5) resource management. Table 3 recapitulates the interpretative context of the most frequent big data research area in relation to the findings previously presented in Table 2.

The findings from this study had revealed five current directions of construction big data research. Despite being bounded with the number of articles that were obtainable from the search, the findings nevertheless had shed some lights on the areas currently being pursued by researchers in construction domain. This information could be harnessed by the current and future researcher in charting their path and further justifying the significance of their research.

5. Conclusion and Recommendation

The study has managed to draw important insights on the specific areas in construction big data research. These were achieved through the accomplishment of the following objectives: (1) to analyse the current extent of construction big data research; (2) to map out the orientation

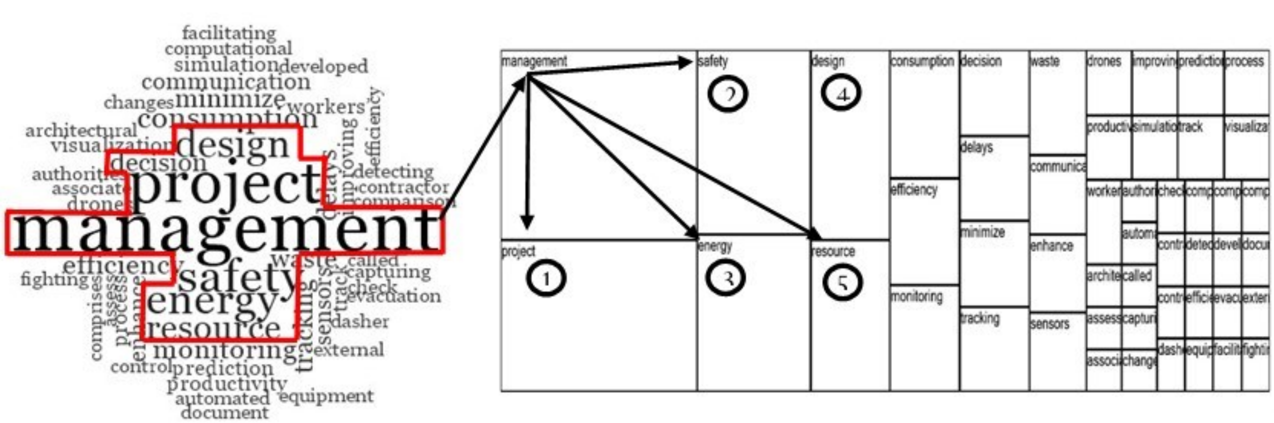

***Figure 1**: Generated model representing the frequency of big data research area*

Table 3 *The context of big data research area and details*

Context of big data research	Important keywords	Detail of research area
Construction Project Management	monitoring	Progress/performance monitoring through IoT devices
	time, cost	Better time and cost management
	Decision-making	Making decision using predictive data that leads to lower project risk and
Safety	Site safety, workers' safety behaviour	Big data generated through IoT devices in tracking and visualize site safety conditions as well as workers' behaviour towards safety
Energy management	Consumption, building performance	Enhancing energy efficiency and building performance through an understanding of building energy consumption
Decision-making design framework	Decision-making	Big data for prompt and informed decision-making
Resource management	Resources tracking	Resources tracking through IoT devices to improve resources utilization efficiency

Source : Researcher

of the current construction big data research; and (3) to suggest the current directions of construction big data research. As the foregoing discussions have shown, a structured analytical framework has been employed to analyse the resources obtained, assisted by the used of NVivo. This has permitted a wider inclusion of resources, thus had broadened the base for the qualitative analysis to take place.

As the study has shown, the current extent and orientation of the present construction big data research covers a diverse research area. It reflects from the analysis that big data research on monitoring, tracking and decision making are intensively being pursued by researcher in construction. Apparently, this suggests the rapid pace of big data development in construction and the on-going interest to harness the technology for common good.

Besides, the study had also suggested that the current directions of construction big data research could be translated into five specific areas. This covers construction project management; safety; energy management; decision making design framework and resource management. Of the five areas mentioned, big data for construction project management was identified as the area which research is really intensified. This follows as the construction industry is a data-dependent industry hence data must be managed efficiently with the right tool to ensure the success of a project.

As the study has shown, construction big data research offers a potentially good prospect to improve the industry. It is a step ahead of the current digitalisation effort and bring a new wave in obtaining insights from the voluminous amount of data. As the study reported in this paper is still on-going, it is interesting to contemplate the industry's views on the findings discussed here. This shall include what and how would the industry profit from the adoption of big data. The authors recommend a study to be conducted on the challenges impeding the adoption of big data in construction as well as readiness in embracing to big data. This effort shall increase the depth and breadth of the current knowledge which could further bolster the industry's understanding on big data.

Acknowledgements:

The authors wish to thank the anonymous reviewers for their constructive comments and effort to review this paper.

References

Addo-Tenkorang, R., & Helo, P. T. (2016). Big data applications in operations/supply-chain management: A literature review. *Computers & Industrial Engineering, 101*, 528-543.

Akbar, S. (2017). Is Big Data The Most Trending Thing In Construction Now. Retrieved from https://geniebelt.com/blog/big-data-in-construction

Akhavian, R., & Behzadan, A. H. (2015). Construction Equipment Activity Recognition for Simulation Input Modeling using Mobile Sensors and Machine Learning Classifiers. *Advanced Engineering Informatics, 29*(4), 867-877. doi:10.1016/j.aei.2015.03.001

Aouad, G., Kagioglou, M., Cooper, R., Hinks, J., & Sexton, M. (1999). Technology management of IT in construction: a driver or an enabler? *Logistics Information Management, 12*(1/2), 130-137.

Augur, H. (2016). Big Data is Transforming Commercial Construction. Retrieved from http://dataconomy.com/2016/07/big-data-is-transforming-commercial-construction/

Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and management in engineering, 11*(3), 241-252.

Azzeddine Oudjehane, & Moeini, S. (2017). Big Data in Construction Projects Risk and Opportunity Management.

Barista, D. (2014). The Big Data revolution: How data-driven design is transforming project planning. *Building Design+Construction*.

Bello-Orgaz, G., Jung, J. J., & Camacho, D. (2016). Social big data: Recent achievements and new challenges. *Information Fusion, 28*, 45-59.

Bernstein, P. (2017). How Big Data and VR in Architecture Will Greatly Improve Design. Retrieved from https://www.autodesk.com/redshift/big-data-vr-in-architecture/

Bilal, M., Oyedele, L. O., Akinade, O. O., Ajayi, S. O., Alaka, H. A., Owolabi, H. A., . . . Bello, S. A. (2016). Big data architecture for construction waste analytics (CWA): A conceptual framework. *Journal of Building Engineering, 6*, 144-156.

Bilal, M., Oyedele, L. O., Qadir, J., Munir, K., Ajayi, S. O., Akinade, O. O., . . . Pasha, M. (2016). Big Data in the construction industry: A review of present status, opportunities, and future trends. *Advanced Engineering Informatics, 30*(3), 500-521. doi:10.1016/j.aei.2016.07.001

Bleby, M. (2015). Big Data boosts construction. Retrieved from http://www.afr.com/real-estate/commercial/big-data-boosts-constrcution-20150109-12l8xx

Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review*: Sage.

Bryman, A. (2008). Mixed methods research: combining quantitative and qualitative research. *Social research methods, 3*, 608-626.

Bughin, J., Chui, M., & Manyika, J. (2010). Clouds, big data, and smart assets: Ten tech-enabled business trends to watch. *McKinsey Quarterly, 56*(1), 75-86.

Burger, R. (2017). How the Construction Industry is Using Big Data. Retrieved from https://www.thebalance.com/how-the-construction-industry-is-using-big-data-845322

Caron, F. (2015). Data management in project planning and control. *International Journal of Data Science, 1*(1), 42-57.

Chen, C., & Cook, D. J. (2012). Behavior-Based Home Energy Prediction. *IEEE Internet of Things Journal*.

Chen, C. P., & Zhang, C.-Y. (2014). Data-intensive applications, challenges, techniques and technologies: A survey on Big Data. *Information Sciences, 275*, 314-347.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS quarterly, 36*(4).

Choudhry, H., Mohammad, A., Tan, K. T., & Ward, R. (2016). The next frontier for digital technologies in oil and gas. Retrieved from https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-next-frontier-for-digital-technologies-in-oil-and-gas

Creswell, J. (2005). Planning, conducting, and evaluating quantitative and qualitative research: Educational research: Prentice Hall: Upper Saddle River, NJ Creswell, JW (2007). Research method: Qualitative, quantitative and mixed methods approaches (2nd ed.). Thousand Oaks, CA: Sage.

Cukier, K. (2010). *Data, data everywhere: A special report on managing information*: Economist Newspaper.

Curry, E., O'Donnell, J., Corry, E., Hasan, S., Keane, M., & O'Riain, S. (2013). Linking building data in the cloud: Integrating cross-domain building data using linked data. *ADVANCED ENGINEERING INFORMATICS, 27*(2), 206-219.

Davis, D. (2015). How Big Data is Transforming Architecture.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2013). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction, 36*, 145-151.

Elo, S., & Kyngas, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115.

Faure, A. (2016). Big data is revolutionizing business: the construction industry in general and building sites in particular. Retrieved from https://blog.serenacapital.com/big-data-is-revolutionizing-business-the-construction-industry-in-general-and-building-sites-in-de7a53a20516

Fellows, R., & Liu, A. (2008). *Research Methods for Construction* (3rd. ed.). Oxford: Wiley-Blackwell.

Ferkoun, M. (2014). Cloud Computing and Big Data: An ideal combination. Retrieved from https://www.ibm.com/blogs/cloud-computing/2014/02/cloud-computing-and-big-data-an-ideal-combination/

Gaitho, M. (2017). How Applications of Big Data Drive Industries. Retrieved from https://www.simplilearn.com/big-data-applications-in-industries-article

Gartner. (2014). Glossary.(2013). *Big Data*.

Gartner. (2015). 6.4 billion connected "Things" will be in use in 2016, up 30 percent from 2015. *Gart. Inc*.

Guo, S., Ding, L., Luo, H., & Jiang, X. (2016). A Big-Data-based platform of workers' behavior: Observations from the field. *Accident Analysis & Prevention, 93*, 299-309.

Guo, S., Luo, H., & Yong, L. (2015). A big data-based workers behavior observation in China metro construction. *Procedia Engineering, 123*, 190-197.

Hafiz, A., Lukumon, O., Muhammad, B., Olugbenga, A., Hakeem, O., & Saheed, A. (2015). *Bankruptcy prediction of construction businesses: towards a big data analytics approach.* Paper presented at the Big Data Computing Service and Applications (BigDataService), 2015 IEEE First International Conference on.

Hammer, C., Kostroch, D. C., & Quiros, G. (2017). *Big Data; Potential, Challenges and Statistical Implications*. Retrieved from

Hampton, T. V. (2015). Big Data Boosts Safety in Brazil. Retrieved from https://www.enr.com/articles/9640-big-data-boosts-safety-in-brazil?v=preview

Han, K. K., & Golparvar-Fard, M. (2017). Potential of big visual data and building information modeling for construction performance analytics: An exploratory study. *Automation in Construction, 73*, 184-198.

Han, S., Lee, S., & Peña-Mora, F. (2012). A machine-learning classification approach to automatic detection of workers' actions for behavior-based safety analysis *Computing in Civil Engineering (2012)* (pp. 65-72).

Harenberg, M. (2017). 5 ways to boost construction productivity. Retrieved from https://www.planradar.com/construction-productivity/

Hart, C. (1998). *Doing a literature review: Releasing the social science research imagination*: Sage.

Humphreys, R. (2016). How Big Data Complements Information Management. Retrieved from https://sourceable.net/how-big-data-complements-information-management/

Ioannidis, D., Fotiadou, A., Krinidis, S., Stavropoulos, G., Tzovaras, D., & Likothanassis, S. (2015). *Big Data and Visual Analytics for Building Performance Comparison.* Paper presented at the IFIP International Conference on Artificial Intelligence Applications and Innovations.

Janda, K. B., Patrick, J., Granell, R., Bright, S., Wallom, D., & Layberry, R. (2015). *A WICKED approach to retail sector energy management.* Paper presented at the Proceedings of ECEEE Summer Study.

Jiao, Y., Wang, Y., Zhang, S., Li, Y., Yang, B., & Yuan, L. (2013). A cloud approach to unified lifecycle data management in architecture, engineering, construction and facilities management: Integrating BIMs and SNS. *Advanced Engineering Informatics, 27*(2), 173-188.

Jiao, Y., Zhang, S., Li, Y., Wang, Y., & Yang, B. (2013). Towards cloud augmented reality for construction application by BIM and SNS integration. *Automation in Construction, 33*, 37-47.

Khan, A., & Hornbæk, K. (2011). *Big data from the built environment.* Paper presented at the Proceedings of the 2nd international workshop on Research in the large.

Knight, W. (2015). New boss on construction sites is a drone: MIT Technology review.

Koseleva, N., & Ropaite, G. (2017). Big Data in Building Energy Efficiency: Understanding of Big Data and Main Challenges. *Procedia Engineering, 172*, 544-549.

Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. *META Group Research Note, 6*, 70.

Lee, I. (2017). Big data: Dimensions, evolution, impacts, and challenges. *Business Horizons, 60*(3), 293-303.

Lu, W., Chen, X., Ho, D. C., & Wang, H. (2016). Analysis of the construction waste management performance in Hong Kong: the public and private sectors compared using big data. *Journal of Cleaner Production, 112*, 521-531.

Lu, W., Chen, X., Peng, Y., & Shen, L. (2015). Benchmarking construction waste management performance using big data. *Resources, Conservation and Recycling, 105*, 49-58.

Martínez-Rojas, M., Marín, N., & Vila, M. A. (2015). The role of information technologies to address data handling in construction project management. *Journal of Computing in Civil Engineering, 30*(4), 04015064.

Mathew, B. (2016). How Big Data is reducing costs and improving performance in the upstream industry. Retrieved from http://www.worldoil.com/news/2016/12/13/how-big-data-is-reducing-costs-and-improving-performance-in-the-upstream-industry

Mathew, P. A., Dunn, L. N., Sohn, M. D., Mercado, A., Custudio, C., & Walter, T. (2015). Big-data for building energy performance: Lessons from assembling a very large national database of building energy use. *Applied Energy, 140*, 85-93.

Meneer, D. (2015). How Big Data is Transforming Construction Businesses. Retrieved from https://www.constructionmonitor.com/blog/2015/06/26/how-big-data-is-transforming-construction-businesses/

Meola, A. (2016). What is the Internet of Things (IoT)? Retrieved from http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8/?IR=T

Moreno, M. V., Dufour, L., Skarmeta, A. F., Jara, A. J., Genoud, D., Ladevie, B., & Bezian, J.-J. (2016). Big data: the key to energy efficiency in smart buildings. *Soft Computing, 20*(5), 1749-1762.

O'Reilly. (2014). *Big data now: 2014 Edition*: O'Reilly Media, Incorporated.

Olshannikova, E., Ometov, A., Koucheryavy, Y., & Olsson, T. (2015). Visualizing Big Data with augmented and virtual reality: challenges and research agenda. *Journal of Big Data, 2*(1), 22.

Oracle. (2015). Improving Manufacturing Performance with Big Data: Architect's Guide and Reference Architecture Introduction. Retrieved from http://www.oracle.com/us/technologies/big-data/big-data-manufacturing-2511058.pdf

Oudjehane, A., & Moeini, S. (2017). Big data in construction projects: Risk and opportunity management.

Özköse, H., Arı, E. S., & Gencer, C. (2015). Yesterday, today and tomorrow of big data. *Procedia-Social and Behavioral Sciences, 195*, 1042-1050.

Pal, K. (2015). The Impact of the Internet of Things on Big Data. Retrieved from http://data-informed.com/the-impact-of-internet-of-things-on-big-data/

Peiffer, E. (2016). 3 concepts that will shape the future of construction. Retrieved from https://www.constructiondive.com/news/3-concepts-that-will-shape-the-future-of-construction/417049/

Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. (2014). Sensing as a service model for smart cities supported by internet of things. *Transactions on Emerging Telecommunications Technologies, 25*(1), 81-93.

Portela, F., Lima, L., & Santos, M. F. (2016). Why Big Data? Towards a Project Assessment Framework. *Procedia Computer Science, 98*, 604-609.

Porwal, A., & Hewage, K. N. (2013). Building Information Modeling (BIM) partnering framework for public construction projects. *Automation in Construction, 31*, 204-214.

Provost, F., & Fawcett, T. (2013). Data science and its relationship to big data and data-driven decision making. *Big Data, 1*(1), 51-59.

Qubole. (2017). Big Data Cloud Database & Computing. Retrieved from https://www.qubole.com/resources/big-data-cloud-database-and-computing/

Redmond, A., El-Diraby, T., & Papagelis, M. (2015). Employing an Exploratory Research Stage to Evaluate Green Building Technologies for Sustainable Systems. *Submitted to international journal; under review*.

Reiners, D., Stricker, D., Klinker, G., & Müller, S. (1998). Augmented reality for construction tasks: Doorlock assembly. *Proc. IEEE and ACM IWAR, 98*(1), 31-46.

Rijmenam, M. v. (2015). Big Data Can Help Construction Companies Deliver Projects On Time. Retrieved from https://datafloq.com/read/big-data-construction-companies-deliver-projects-t/143

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data*: Sage.

Sadhu, R. (2016). Big Data For Construction: How It Can Help You Deliver Your Project On Time. Retrieved from https://www.planacademy.com/big-data-construction/

Santiago Castagnino, Christoph Rothballer, & Gerbert, P. (2016). What's the future of the construction industry? Retrieved from https://www.weforum.org/agenda/2016/04/building-in-the-fourth-industrial-revolution/

Shamsulhadi, B., & Fadhlin, A. (2016). Documenting its application in Quantity Surveying research: A Review. *International Journal of Built Environment and Sustainability, 3*(1), 10-17. doi:10.11113/ijbes.v3.n1.105

Shamsulhadi, B., Fadhlin, A., & Hamimah, A. (2015). Research into the Bills of Quantities: Where can it be focused. *The Malaysian Surveyor Journal, 50*(3), 15-24.

Shrestha, J. (2013). Big Data, Predictive Analytics, and Data Visualization in The Construction Engineering. *CCEE Graduate Student Research Showcase and Poster Competition*.

Skibniewski, M., & Golparvar-Fard, M. (2016). Toward a Science of Autonomy for Physical Systems: Construction. *arXiv preprint arXiv:1604.03563*.

Stankovic, J. A. (2014). Research directions for the internet of things. *IEEE Internet of Things Journal, 1*(1), 3-9.

Teizer, J., Cheng, T., & Fang, Y. (2013). Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity. *Automation in Construction, 35*, 53-68.

Travis, D. (2016). Desk research: the what, why and how. *Dostupno na http://www. userfocus. co. uk/articles/desk-research-the-what-why-and-how. html, pristupljeno, 10*, 2017.

Viktor, M.-S., & Kenneth, C. (2013). Big data: A revolution that will transform how we live, work, and think. *Houghton Mifflin Harcourt*.

Waal-Montgomery, M. d. (2015). World's data volume to grow 40% per year & 50 times by 2020: Aureus. *Retrieved Syyskuu, 28*, 2016.

Webster, J., & Watson, R. T. (2002). Analysing the past to prepare for the future: writing a literature review. *MIS Quarterly, 26*(2), 1-11.

Wei, C., & Li, Y. (2011). *Design of energy consumption monitoring and energy-saving management system of intelligent building based on the Internet of things.* Paper presented at the Electronics, Communications and Control (ICECC), 2011 International Conference on.

Wood, C. (2016). Betting on big data: How construction firms are leveraging digitized job sites. Retrieved from https://www.constructiondive.com/news/betting-on-big-data-how-construction-firms-are-leveraging-digitized-job-si/431047/

Yang, J., Park, M.-W., Vela, P. A., & Golparvar-Fard, M. (2015). Construction performance monitoring via still images, time-lapse photos, and video streams: Now, tomorrow, and the future. *ADVANCED ENGINEERING INFORMATICS, 29*(2), 211-224.

Zafira, N. M., Shamsulhadi, B., & Roslan, A. (2018). *Potential opportunities and future directions of big data in the construction industry.* Paper presented at the The 12th SEATUC Symposium 2018, Universitas Gadjah Mada, Yogyakarta.

Zhang, S., Teizer, J., Lee, J.-K., Eastman, C. M., & Venugopal, M. (2013). Building information modeling (BIM) and safety: Automatic safety checking of construction models and schedules. *Automation in Construction, 29*, 183-195.

Zhang, Y., Luo, H., & He, Y. (2015). A system for tender price evaluation of construction project based on big data. *Procedia Engineering, 123*, 606-614.

Zikopoulos, P., Parasuraman, K., Deutsch, T., Giles, J., & Corrigan, D. (2012). *Harness the power of big data The IBM big data platform*: McGraw Hill Professional.

INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 5(2)/2018, 155-162

Investigation of the Use of Energy Efficient Bulbs in Residential Buildings in Ile-Ife, Osun State, Nigeria

Wahab Akeem Bolaji
Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria
Email: wahabak2002@yahoo.com

History:

Received: 15 March 2018
Accepted: 08 May 2018
Available Online: 30 May 2018

Keywords:

Buildings, Electrical supply, Energy, Lighting bulbs, Management, Occupants, Spaces

DOI:

10.11113/ijbes.v5.n2.269

ABSTRACT

The use of incandescent bulbs by the majority of building occupants in Nigeria has complemented high cost of electrical energy consumption and this has informed prevalence of different types of energy efficient lighting bulbs. The study, therefore, identified and examined types of lighting bulbs used, assessed the rate of use of energy efficient bulbs in selected residential buildings and examined factors influencing its use. The study was carried out in Ife Central Local Government Area of Osun State, Nigeria. Residential settlements in core wards in the study area were considered and four wards in the core zone of the Local Government were randomly selected from the total of eleven while data collection was done with the use of primary and secondary data techniques. Simple random sampling technique was used to select 5% sample size from the entire population and systematic sampling procedure was further employed by selecting every 10th building in the direction of movement which indicated selection of 123 houses. A total of 123 structured questionnaires were administered on the respondents on issues associated with the use of lighting bulbs. Data collected were analysed by both descriptive and inferential statistical techniques. The study found that 90.53% and 72.63% of the respondents used incandescent and energy saving bulbs respectively; variation existed in the wattages of different brands of energy saving and non-energy saving bulbs used in the selected buildings: A major proportion of the respondents used an average number of 1-5 lighting bulbs in buildings and its spaces therein; while quality and cost-saving benefit, energy saving benefit and durability of bulb influenced the choice of fluorescent tubes, compact fluorescent bulbs and light emitting diodes with a mean score value of 2.20, 2.29 and 2.85 respectively. In view of the need to enhance visual performance and comfort of buildings and its occupants respectively, efforts must be made by government to ensure that consumers awareness and enlightenment be increased on the types of lighting bulbs to procure and there is also need to strengthen mechanisms through the importation and sales of energy efficient bulbs only so as to enhance its cost-saving and environment–related benefits amongst others.

1. Introduction

Energy is an essential ingredient for socio-economic development and economic growth and its central objective is to provide energy services that are needed for lighting and other benefits in an environment (Sambo, 2005). According to Oyedepo (2012), energy is an important production factor that should be managed in parallel with factors like land, labour and capital. In order to achieve energy efficiency, the modes of utilizing sustainable energy resources play an important role. The industrial revolution heralded the unprecedented use of energy which has brought about massive increases in productivity and changes in lifestyles (Nag, 2004). This involves the practice of energy efficiency through the services and components used in buildings. Energy efficiency does not necessarily mean that we should not use energy, but it should be used in a way that it will minimize the amount needed to provide services and comfort of building occupants (Johnson, Odekoya and Umeh, 2012).

In any country, energy efficiency practice has become the key driver required to achieve sustainable energy management in buildings. Building design and modes of use equally offer major opportunities for improved energy efficiency (Oyedepo, 2012; Dineen and Gallachoir, 2011). Usually, there are two important ways that can be explored in achieving efficient use of energy in a given environment. According to Community Research and Development Centre (2009), the first is the technological approach while the second is the behavioural approach. The technological approach involves the process of changing the type of technology we use to a more efficient one, while behavioural approach entails the mode of changing the way things are done. The transition in the type, pattern and use of lighting bulbs in buildings has been a global issue and this causes paradigm shift from incandescent to low energy efficient bulbs.

In Nigeria, what are mostly used are the incandescent bulbs (IBs) (IEA, 2006), but there are also energy efficient bulbs. Energy efficient bulbs that we have in Nigeria include halogen incandescent, compact fluorescent lamps (CFLs) and lighting emitting diodes (LEDs) (www.wikipedia.org). One unique thing about all the energy saving lamps mentioned above is that they consume lesser energy compared to incandescent bulbs which upholds the principle of sustainable energy management. In Nigeria, residential buildings account for 65% of the total consumption of electricity, and lighting being one of its major uses, the country stands to make a lot of savings from the use of energy efficient bulbs but there is still high rate of sale and use of incandescent bulbs and this is contrary to what obtains in developed countries (Johnson et al., 2012).

The technical benefits of retrofitting incandescent bulbs have been shown when compared with the energy saving bulbs. Natalie and Yi (2012) opined that by increasing the prevalence of CFLs, it is expected that households will save energy and cut utility bills as CFLs provide significant energy savings over IBs. It further showed that large-scale switch to CFLs can aid in reducing carbon emissions or help in closing the gap between electricity supply and demand which is an issue that is specially crucial in most developing countries. Casillas and Kammen (2011) stipulated that the use of CFLs provided the most attractive financial investment, with an internal rate of return (IRR) of 52.80%. Bertoldi and Atanasiu (2006) also reported that the payback for switching from IBs to CFLs depends on the initial purchasing costs, cost of electricity and the rate of use. Xing, Hewitt and Griffiths, (2011) opined that replacement of inefficient lamps is usually the first choice for low carbon refurbishment due to significant reduction in energy usage with relatively cheaper means. Equally, CFLs, consume 1/4th to 1/5th of the energy used by incandescent light bulbs to provide the same level of light (Kumar, Juain and Bansal, 2003; IEA, 2006; Waide, 2006). CFLs also have much longer lifetimes with rated life spans of 5,000 to 25,000 hours when compared to 1,000 hours on average for incandescent lamps (IEA, 2006).

In developing areas, having access to electricity has become a major challenge and investing in energy saving practices would help to entrench sustainability. In view of the importance attached to the savings attached to energy consumption, a number of past studies have been carried out on the lighting bulbs used in buildings because having access to electricity has been seen as a major challenge (Johnson et al., 2012). Community Research and Development Centre (2009) showed that less than 40% of the population of the country used energy savings bulbs as shown by its rate of sales and usage. Otegbulu, Odekoya and Johnson (2012) showed varying percentages of the use of incandescent bulbs and CFLs in parts of Ikorodu and Magodo areas of Lagos State, Nigeria based on various indices. Lebot (2009) also found that a paltry 29.69% of the respondents in Ikorodu area of Lagos state employed the use of incandescent bulbs exclusively while a higher percentage (56.10%) of the respondents used combinations of CFLs and incandescent bulbs for lighting in their homes. The use of incandescent bulbs by the majority has complimented the high cost of electrical energy supply in various residential buildings in Nigeria. In view of the awareness of the benefits of energy efficient bulbs, there is a rising adoption for its use by building occupants in the study area, hence the need for this study. The study was limited to the perception of respondents on the use of incandescent bulbs and lighting emitting diodes based on the state of development of the study area. The study was therefore carried out to identify and examine types of lighting bulbs used, assess the rate of use of energy efficient bulbs in the selected residential buildings and examine factors influencing its use.

2. Research Methodology

The study was carried out in Ife Central Local Government Area of Osun State, Southwestern Nigeria. It consists of multi-ethnic nationalities predominantly dominated by the

Yorubas. The target population consisted of residential buildings in the core ward of the study area. The selection of the core zone was based on its population density, historic and antecedent backgrounds. Demographically, the core zone of Ife Central Local Government had 11 wards and 4; which were core-based, were selected for this study. Preliminary survey and NPC (2009) showed that there were 482, 506, 635 and 835 residential buildings in each of Ilare III, Iremo IV, Iremo V and Moore/Ojaja ward of the study area respectively and these were adopted for this study.

With regards to this study, the sample frame was the total number of residential buildings in the core zone of Ife Central Local Government Area which were 2,458 houses. According to Richard and Anita (2008), the process of sampling or selection of part of the population from which the characteristics of the larger population can be inferred has long been accepted as a legitimate and important method of research. A simple random sampling technique was used to select 5% sample size from the entire population, which indicated selection of 24, 25, 32 and 42 houses in Ilare III, Iremo IV, Iremo V and Moore/Ojaja ward respectively and thus totaling 123 houses. Also, systematic sampling procedure was employed by selecting every 10th building in the direction of movement along major roads and streets in the study area (Table 1). Assessment of facilities used indoor can be carried out by either or both objective and subjective approach which involve the use of field measurement and questionnaire/ interview respectively. Based on the emerging use of LED lights in the study area, the method of data collection employed was the subjective method to establish and verify perception of the occupants of buildings on the lighting bulbs used. Hence, data for the study was collected by using structured questionnaire administered on the respondents of the selected buildings. It was complemented by conducting interview on the respondents to get information on the type and mode of use of lighting bulbs in the study area and issues associated with the factors that influenced various brands and types of lighting bulbs used by the respondents. Data collected was analysed by using descriptive and inferential statistics.

Table 1: *Number of Buildings Sampled in the Study Area*

Study Area	Wards in the Core Zone	Number of Residential Buildings in the Core Zone	No of Residential Buildings Selected
Ife Cental Local Govern-ment	Ilare III	482	24
	Iremo IV	506	25
	Iremo V	635	32
	Moore/Ojaja	835	42
	Total	2,458	123

Table 2: *Profile of the Respondents*

Sex Category of Respondents Sampled		
Sex	Frequency	%
Male	41	43.20
Female	54	56.80
Total	95	100.00
Age Limits of the Respondents		
Age	Frequency	%
20-25	47	49.50
26-30	21	22.10
31-35	6	6.30
36-40	5	5.30
Above 40	16	16.80
Total	95	100.00
Marital Status of the Respondents		
Marital Status	Frequency	%
Single	48	50.50
Married	47	49.50
Total	95	100.00
Occupational Status of the Respondents		
Occupation Status	Frequency	%
Employed	14	14.70
Self-Employed	56	58.90
Unemployed	6	6.30
Student	14	14.70
Others	5	5.30
Total	95	100.00
Educational Qualifications had by the Respondents		
Education Level	Frequency	%
Primary	8	8.40
Secondary	60	63.20
Tertiary	27	28.40
Total	95	100.00
If Tertiary:		
ND	8	29.60
HND	8	29.60
B.Sc	9	33.30
M.Sc	2	7.40
Total	27	100.00
Occupancy Pattern of the Buildings		
Occupancy Type	Frequency	%
Single room	23	38.30
Room and Parlour	22	36.70
Self-contain	10	16.70
Others	5	8.30
Total	60	100.00
Type of the Building Occupied		
Building Typology	Frequency	%
Bungalow	27	77.14
Multi-Storey building	8	22.86
Total	35	100.00

3. Results

Through the adoption of 5% of the occupants of residential buildings in the study area, a total of 123 questionnaire was administered on them while 95 were returned, and this indicates a response rate of 77.23%. The rate of return of the questionnaire administered ought to be adequate to substantiate results of the study based on Babies (2005) which states that a response rate of 40% ought to be adequate for researches in built environment studies. The profile of respondents sampled in the study area is shown in Table 2. The results show that 56.80% of the respondents were females while 49.50% were males; 49.5% of the respondents' age limit was 20-25 years, 22.10% were 26-30 years and 16.8% were above 40 years old. The respondents have an almost similar proportion of marital status as 49.50% were married and 50.50% were single and a sizeable number, 60 (63.20%) had secondary school education while 28.40% had tertiary education level. The occupancy pattern of respondents of the study area indicated that 63.20% of them occupied rented apartment, 38.30% lived in a room apartment, 36.70% in room and parlour and majority of them (77.14%) were in bungalow buildings.

4. Identify and Examine Lighting Bulbs Used in the Buildings

The study shows that according to past studies examined in the literature review, lighting bulbs used by building occupants can be categorized into either incandescent and energy efficient bulbs. Thus, as shown in Table 3, it was found that a large proportion of the respondents in the selected buildings (90.53%) used incandescent bulbs while a fairly reduced proportion, 72.63% used energy efficient bulbs. Past works of Otegbulu et al., (2012) indicated that awareness on the use of energy efficient bulbs in selected areas of Lagos state accounted for the rate of its adoption by the occupants. The results of this study also indicated further classification of bulbs used in residential buildings sampled classified as energy inefficient and efficient bulbs respectively. Thus, Table 4 shows that a sizeable number of the occupants of the buildings, 57.90% used incandescent bulbs, 10.59% used fluorescent tubes, and 56.47% used compact fluorescent lamps. This indicated that socio-economic characteristics of the occupants and level of availability of the various types of lighting bulbs affected its rate of use by the building occupants.

The study also examined wattage of the types and brands of lighting bulbs used in the buildings sampled. As shown in

Table 3: *Types of Lighting Bulbs Used in Selected Buildings*

Types of Bulbs	Response		Total Frequency/
	Yes Frequency/(%)	No Frequency/ (%)	
Incandescent bulbs	86(90.53%)	9(9.47%)	95(100.00%)
Energy efficient bulbs	69(72.63%)	26(27.36%)	95(100.00%)

Table 4: *Varying Brand of Lighting Bulbs Used by Selected Building Occupants*

Brand of Lighting Bulb	Frequency	%
Energy Inefficient:		
Incandescent	55	57.90
Halogen	10	10.53
Others	30	31.57
Total	95	100.00
Energy Efficient:		
Fluorescent tubes	9	10.59
Compact fluorescent lamps	48	56.47
Light emitting diodes	2	2.35
High intensity discharge	1	1.18
Others	25	29.41
Total	85	100.00

Table 5: *Response on the Wattage of Lighting Bulbs Used in Selected Buildings*

Incandescent Bulbs		
Wattage of Types of Bulbs Used (Watts)	Frequency	%
40	4	7.28
60	22	40.00
100	23	41.82
200	3	5.45
No response	3	5.45
Total	55	100.00
Compact Fluorescent Bulbs		
Wattage of Types of Bulbs Used (Watts)	Frequency	%
8-12	4	8.33
13-18	2	4.17
18-30	7	14.58
30-60	18	37.50
No response	17	35.42
Total	48	100.00
Lighting Emitting Diode (LED) Bulbs		
Wattage of Types of Bulbs Used (Watts)	Frequency	%
4-5	1	50.00
6-8	1	50.00
9-20	0	0.00
25-28	0	0.00
Total	2	100.00

Table 5, it was revealed that amongst the respondents that used incandescent bulbs in the study area, 41.82% used 100 watts, 40.00% of them used 60 watts and 7.28% used 40 watts bulbs. This implied that the use of 100watts incandescent bulbs was most prevalent in the buildings. It was also shown that amongst those that used compact fluorescent bulbs, 30-60 watts was mostly used by 37.50% of the respondents and 14.58% used 18-30 watts bulbs. However, 50.00% of the respondents used 6-8 and 4-5 watts of the lighting emitting diodes bulbs respectively.

5. Assessment of the Rate of Use of Energy Efficient Bulbs

The study equally assessed the distribution and rate of use of incandescent and energy savings bulbs in the building spaces used by respondents in the study area. As shown in Table 6, it was revealed that 1-5 number/range of bulbs was mostly used by the respondents in all the buildings sampled; 1-5 number of 100 watts of incandescent bulbs was used by 91.30% of the respondents; 1-5 number of 8-12 watts and 13-18 watts of compact fluorescent bulbs respectively were mostly used by 100.00% of the respondents while 85.70% used 18-30 watts of 1-5 number of the compact fluorescent bulbs; and 4-5 watts and 6-8 watts of 1-5 number of lighting emitting diodes were mostly used by the occupants of the buildings respectively.

Table 6: *Proportion of Watts of Lighting Bulbs Used in the Selected Buildings*

Watts of Bulbs Used (Watts)	Range of Number of Lighting Bulbs Used				
Incandescent Bulbs					
	1-5 F (%)	6-10 F (%)	11-15 F (%)	>15 F (%)	Total F (%)
40	2(50.00)	2(50.00)	0(0.00)	0(0.00)	4(100)
60	17(77.27)	5(22.73)	0(0.00)	0(0.00)	22(100)
100	21(91.30)	2(8.70)	0(0.00)	0(0.00)	23(100)
200	0(0.00)	3(100.00)	0(0.00)	0(0.00)	3(100)
Compact Fluorescent Bulbs					
	1-5 F (%)	6-10 F (%)	11-15 F (%)	>15 F (%)	Total F (%)
8-12	4(100.00)	0(0.00)	0(0.00)	0(0.00)	4(100)
13-18	2(100.00)	0(0.00)	0(0.00)	0(0.00)	2(100)
18-30	6(85.70)	1(14.30)	0(0.00)	0(0.00)	7(100)
30-60	10(55.55)	5(27.78)	1(5.56)	2(11.11)	18(100)
Lighting Emitting Diodes (LED)					
	1-5 F (%)	6-10 F (%)	11-15 F (%)	>15 F (%)	Total F (%)
4-5	19100.00)	0(0.00)	0(0.00)	0(0.00)	1(100)
6-8	1(100.00)	0(0.00)	0(0.00)	0(0.00)	1(100)
9-20	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0)
25-28	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0)

The study further showed the prevalence and number of either incandescent or energy saving bulbs used in different spaces of the buildings sampled based on their typology which was either personally-owned or self-rented apartment. As shown in Tables 7 and 8, an almost similar pattern of the 1-5 number of lighting bulbs of either incandescent or energy efficient bulbs were used in the various spaces of either personally-owned or self-contained buildings occupied by the respondents in the study area. It further showed that in the living room of personally-owned or self-rented buildings, 86.40% of incandescent bulbs were used while the rate of use of energy saving bulbs was comparably higher (100.00%). The same pattern on the prevalence and pattern of use of both incandescent and energy saving bulbs were found in other spaces of the buildings sampled.

6. Factors Affecting the Use of Lighting Bulbs

The study equally examined factors that influenced the use of different lighting bulbs by the respondents in the study area by taking note of the factors that existed in the body of literature. It is shown in Table 9 that quality of bulb and cost saving benefit of bulb were rated as the most significant factors that influenced the use of fluorescent bulbs with mean score values of 2.20 respectively while durability was rated third with an index value of 2.10. It was shown that energy saving benefit of bulb with a mean value of 2.29 was ranked as the most important factor that influenced the use of compact fluorescent bulb, durability of bulb with value of 2.28 was ranked second and quality of bulb with mean value of 2.24 was ranked third. Equally, durability and quality of bulb mostly influenced the use of light emitting diodes bulbs in the study area with a mean value of 2.85.

7. Discussion of Findings

The profile of the respondents based on their characteristics indicated that the proportion of female respondents (56.80%) that responded to the questionnaire administered was significantly higher than the male (43.20%). This disparity was observed to be due to the fact that the study was carried during the day as most men respondents would have left for their places of work compared with the female that stay more at homes based on their occupational status This was also observed to be a reflection of socio-economic characteristics of the respondents in the core zone of the study area. The result showed that bulk of the respondents (49.50%) were within the age limit of 20-25 years and 22.10% between 26-30years. A fairly large proportion,

Table 7: *Proportion of Number of Lighting Bulbs Used Inside Personally-Owned Buildings*

Building Space	Incandescent Bulbs					Energy Saving Bulbs				
	Range of Number of Bulbs Used					Range of Number of Bulbs Used				
	1-5	6-10	11-15	>15	Total	1-5	6-10	11-15	>15	Total
	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)
Living room	19 (86.40)	3 (13.64)	0 (0.00)	0 (0.00)	22 (100.00)	19 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	19 (100.00)
Bedroom 1	19 (86.40)	3 (13.64)	0 (0.00)	0 (0.00)	22 (100.00)	18 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	18 (100.00)
Bedroom 2	14 (1000.00	0 (0.00)	0 (0.00)	0 (0.00)	14 (100.00)	16 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	16 (100.00)
Dinning	9 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	9 (100.00)	16 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	16 (100.00)
Kitchen	17 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	17 (100.00)	14 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	14 (100.00)
Store	10 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	10 (100.00)	13 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	13 (100.00)
Lobby	11 (1000.00	0 (0.00)	0 (0.00)	0 (0.00)	11 (100.00)	11 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	11 (100.00)
Terrace	10 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	10 (100.00)	9 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	9 (100.00)
Toilet	12 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	12 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	12 (0.00)
Bathroom	11 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	11 (100.00)	10 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	10 (100.00)
Surrounding	12 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	12 (100.00)	17 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	17 (100.00)
Others	3 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	0 (0.000	0 (0.00)

50.50% were married and the occupational status of the respondents revealed that majority of the respondents, 58.90%, were self-employed. It was observed that in view of geographic location of the study area (a core zone), and occupational status of the respondents, a sizeable proportion of them, 63.20%, had up to secondary school education. This characteristic, occupancy pattern and type of building where they lived as 38.30% lived in single-room buildings and 77.14% were in bungalow buildings. Thus, the socio-economic characteristics of the respondents served as the prime issues that affected the type and mode of use of lighting bulbs in the selected buildings of the study area.

Responses on the types of lighting bulbs used indicated that 72.63% made use of energy efficient bulbs in the building; most of which are in combination with incandescent bulbs which is 57.90% of use by the respondents. Also, the results showed that compact fluorescent bulbs is the mostly used type of energy efficient bulbs in the study area with a response rate of 56.47% compared to 10.59% and 2.35% that used fluorescent tubes and light emitting diodes respectively. The study has shown that 1-5 number proportion of lighting bulbs was mostly used in the spaces of buildings sampled in the building typologies sampled. Responses on the various factors that affected the use of lighting bulbs used by the building occupants sampled indicated that in the case of fluorescent tubes, quality and cost saving benefit of bulb respectively were the most significantly ranked factors that influenced its use; energy saving benefit was the mostly ranked factor that influenced the choice of compact fluorescent bulbs followed by the durability of bulb while durability and quality of bulb respectively influenced the choice and use of light emitting diodes by the respondents. Variation in the factors that affected the use of different lighting bulbs by the respondents was observed to be due to the awareness on their performance based on the operating factors.

8. Conclusion and Recommendations

The study was carried out to depict information on the awareness and adoption of the types of lighting bulbs used by the occupants of buildings in the core zone of Ife Central Local Government, Osun State, Nigeria in order to foster visual comfort needed to enhance performance of tasks indoor. The varying performance of the types and brands of lighting bulbs has affected the procurement and use of

Table 8: *Proportion of Number of Lighting Bulbs Used Inside Self-Contained Apartments*

Building Space	**Incandescent Bulbs**					**Energy Saving Bulbs**				
	Range of Number of Bulbs Used					**Range of Number of Bulbs Used**				
	1-5	**6-10**	**11-15**	**>15**	**Total**	**1-5**	**6-10**	**11-15**	**>15**	**Total**
	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)	F (%)
Living room	11 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	11 (100.00)	6 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	6 (100.00)
Bedroom 1	10 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	10 (100.00)	6 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	6 (100.00)
Bedroom 2	2 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (100.00)	5 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	5 (100.00)
Dinning	5 (83.33)	1 (16.67)	0 (.00)	0 (0.00)	6 (100.00)	2 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	2 (100.00)
Kitchen	12 (100.00)	0 (0.00)	0 (0.000)	0 (0.00)	12 (100.00)	1 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	1 (100.00)
Store	1 (100.00)	0 (0.000	0 (0.000	0 (0.00)	1 (100.00)	1 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	1 (100.00)
Lobby	3 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	3 (100.00)	1 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	1 (100.00)
Terrace	3 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	3 (100.00)	2 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	2 (100.00)
Toilet	8 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	8 (100.00)	2 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	2 (100.00)
Bathroom	9 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	9 (100.00)	2 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	2 (100.00)
Surrounding	7 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	7 (100.00)	3 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	3 (100.00)
Others	2 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	2 (100.00)	1 (100.00)	0 (0.00)	0 (0.000	0 (0.00)	1 (100.00)

either energy inefficient and efficient bulbs respectively over the years in the country. Thus, the study was carried out to identify and examine types of lighting bulbs assessed rate of use of types of energy efficient bulbs and the factors influencing its use. The study established that amongst energy inefficient bulbs used by the respondents, incandescent type was mostly used while compact fluorescent bulb was the most prevalent type of energy efficient bulb mostly used in the study area. It also showed that different watts of types and brands of lighting bulbs were used by the respondents. This was largely due to different operating factors that informed the choice of the type of either energy inefficient or efficient bulbs used. The study also depicted that there was variation in the wattages and number of the types of lighting bulbs used in the types of buildings and spaces occupied by the respondents sampled. The limitation of the study involved the adoption of subjective approach which allowed the use of questionnaire as the data collection instruments based on the emerging use of LED lights in the study area, and further studies on the assessment of types of lighting bulbs be carried out to depict the comparative energy savings potentials obtainable from the different types and brand of lighting bulbs through the use of appropriate field measurement devices.

In view of the importance attached to the dependence of building occupants on the performance of building occupants on lighting bulbs to give visual comfort, the study recommended that there is need to foster consumers awareness on the types of lighting bulbs to procure and government should also strengthen mechanisms through importation and sales of energy efficient bulbs only so as to enhance its cost-saving and environment–related benefits amongst others.

References

Babies, E. (2005). The Basics of Social Research, 3rd Edition, Belmont, C.A., USA, Thomson Wordsworth Learning.

Bertoldi, P., Atanasiu, B. (2009). Electricity Consumption and Efficiency Trends in the Enlarged European Union. Status Report 2009. European Commission, Directorate-General Joint Research Center. Institute for Environment and Sustainability. Ispra, Italy.

Casillas, C.E., Kammen, D.M, (2011). The Delivery of Low-Cost, Low-Carbon Rural Energy Services. *Energy Policy*, 39(8), 4520-4528.

Table 9: *Factors Affecting the Use of Lighting Bulbs*

Factors	Mean Score	Rank
Fluorescent Tubes		
Factors	**Mean Score**	**Rank**
Quality of bulb	2.20	1
Cost saving benefit of bulb	2.20	1
Durability of bulb	2.10	2
Environmental friendliness of bulb	2.05	4
Energy saving benefit of bulb	2.00	5
Source of electricity	2.00	5
Trust in bulb performance	1.95	7
Awareness of bulb	1.90	8
Availability of bulb	1.65	9
Compact Fluorescent Bulbs		
Factors	**Mean Score**	**Rank**
Energy saving benefit of bulb	2.29	1
Durability of bulbs	2.28	2
Quality of bulbs	2.24	3
Trust in bulb performance	2.21`	4
Cost saving benefit of bulb	2.07	5
Awareness of bulb	2.06	6
Source of electricity	1.85	7
Environmental friendliness of bulb	1.66	8
Availability of bulb	1.54	9
Light Emitting Diodes (LED)		
Factors	**Mean Score**	**Rank**
Durability of bulb	2.85	1
Quality of bulb	2.85	1
Trust in bulb performance	2.54	3
Energy saving benefit of bulb	2.45	4
Awareness of bulb	2.20	5
Source of electricity	2.11	6
Cost saving benefit of bulb	2.09	7
Availability of bulb	2.05	8
Environmental friendliness of bulb	2.03	9

Community Research and Development Centre (2009). Energy Efficiency Survey in Nigeria, A Guide for Developing Policy and Legislation.

Dineen, D., Gallachóir, B.P. (2011). Modelling the Impacts of Building Regulations and a Property Bubble on Residential Space and Water Heating. *Energy and Buildings*, 43(1), 166-178.

IEA (2006). Light's Labour's Lost: Policies for Energy Efficient Lighting, IEA/OECD, Paris.

Johnson, O.O., Odekoya, A.J. and Umeh, O.L. (2012). Factors Influencing Usage of Compact Fluorescent Lamps in Existing Residential Buildings in Lagos, Nigeria, International Journal of Energy and Economics, 2(2), 63-70.

Kumar, A., Jain, S.K., Bansal, N.K. (2003). Disseminating Energy-Efficient Technologies: A Case Study of Compact Fluorescent Lamps in India. Energy Policy. 31, 259-272.

Lebot, B. (2009). Energy Efficiency and Market Transformation: A Short Overview of Best Practices. A paper presented during the Inception Workshop of the UNDP-GEF Project to Promote Energy Efficiency in Residential and Public Building in Nigeria, 14th July 2009.

Natalie, C. and Yi, J. (2012). Adoption of CFLs and Electrical Lighting Usage in Pakistan, ADB Economics Working Paper Series 305, Asian Development Bank.

Nag, P.K. (2004), Power Plant Engineering (2nd Ed.), Tata McGraw Hill.

National Population Commission (2009). Notice on the Publication of 2006 Census for Final Results, Federal Republic of Nigeria.

Otegbulu A, Odekoya A.J., Johnson O. (2012) Determinants of Investments in Energy Efficient Light Bulbs in Lagos Residential Buildings. *Elixir Project Management, 51*, 11159-11163.

Oyedepo, S.O. (2012). Energy Efficiency and Conservation Measures: Tools for Sustainable Energy Development in Nigeria, *International Journal of Energy Engineering*, 2(3), 86-98.

Richard, F and Anita, L. (2008). Research Methods for Construction, 3rd Edition, Wiley-Blackwell Publishing Ltd., USA, 46-183.

Sambo, A.S (2005). Renewable Energy for Rural Development: The Nigerian Perspective, ISESCO Science and Technology Vision, 1, 12 – 22.

Waide, P. (2006). Light's Labour's Lost – Policies for Energy-Efficient Lighting. International Energy Agency: Paris.

Xing, Y., Hewitt, N., Griffiths, P. (2011). Zero Carbon Buildings Refurbishment–A Hierarchical pathway, Renewable and Sustainable Energy Reviews, 15(2011), 3229–3236.

www.wikipedia.org/wiki/Incandescent_light_bulb