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RESEARCH ARTICLE

Risks of Implementing Sustainable Construction Practices in the Nigerian Building Industry

Peter Uchenna Okoye[1,*], Kevin Chuks Okolie[1], Isaac Abiodun Odesola[2]

[1] Department of Building, Nnamdi Azikiwe University, Awka, Nigeria
[2] Department of Building, University of Uyo, Uyo, Nigeria

Corresponding author: Peter Uchenna Okoye, Department of Building, Nnamdi Azikiwe University, Awka, Nigeria, pu.okoye@unizik.edu.ng

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Abstract

This study assessed the risks level associated with implementation of sustainable construction practices through a questionnaire survey distributed to 256 building professionals in Nigeria. It identified 47 risk factors with different likelihood of occurrence and magnitude of impacts. A quantitative risk analysis result based on mean value method and risk prioritisation number showed that the three top-ranked risk factors with highest likelihood of occurrence were unavailability of sustainable materials and equipment, more complex and unfamiliar construction techniques and processes, and high initial sustainable construction costs; whereas the three top-ranked risk factors with highest magnitude of impacts were high initial sustainable construction costs, poor and inefficient communication among project participants, and high cost of sustainable materials and equipment. The criticality index result identified 23 critical risk factors which mostly related to knowledge and awareness, cost, regulatory framework, building materials and socioeconomic issues. However, the Wilcoxon Signed-rank test result indicated that there is significant difference (z = -3.207, p<0.001) between the likelihood of occurrence and magnitude of impacts of the risks factors associated with implementation of sustainable construction practices in Nigeria of which the effect was moderate (r = 0.468). Furthermore, the study revealed that there is no significance difference in the risk level of the risk factors associated with implementation of sustainable construction practices based on the respondents' roles (p>0.05). The study, therefore, recommended for training

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of construction practitioners in the multi-risk management approaches and increasing awareness through education on sustainable construction concept for building industry stakeholders. It further recommended for developing of new sustainable and affordable building materials through research institutes like Nigerian Building and Road Research Institute (NBRRI) with appropriate regulatory and policy frameworks for successful sustainable building projects.

Keywords

Building Industry; Building Professionals; Implementation; Risk; Sustainable Construction

Introduction

Construction practice is inherently risky. The construction industry is widely known as one of the riskiest industries in the world (Mhetre, Konnur and Landage, 2016; Mohamed, 2017), due to its complexity, magnitude and time-consuming characteristics (Kang et al., 2015). The consequences of construction products and activities also come with huge environmental, social and economic burdens (Taroun, 2014; Xiahuo et al., 2018). In other words, the construction industry directly affects the society, environment and economy (Agyekum-Mensah, Knight and Coffey, 2012; Xia et al., 2015; Aghimien, Aigbavboa and Thwala, 2019), as a result, has the greatest impact on sustainability compared to any other industry (Willar et al., 2021). For example, the construction industry is responsible for 50% of global energy usage, 50% of global solid waste generation, 50% of global CO_2 emitted into the atmosphere, 20-50% of global natural resources consumption, (Thomas, Costa and Guimarães, 2013; Reddy, 2016), and 40% of global extracted raw materials consumption (Bribian, Capilla and Uson, 2011). Construction activities increase the air and noise pollution, induce removal of vegetative cover, unsustainable water and energy consumption patterns, resource depletion, and sometimes altering or destroying the natural ecosystem (Cotgrave and Riley, 2013; Kibert, 2016; Reddy, 2016; Pearce, Ahn and HanmiGlobal., 2017; Wu et al., 2019a); in the course of meeting the population increase and rapid urbanisation demand (Kibert, 2016). Socio-economically, it consumes a huge amount of country's annual budgets, usurps socioecological balance, and upsurges social cost and social risks (Liu et al., 2016; Danku et al., 2020).

However, the evolution of sustainable development concept and its application into the construction industry has led to the concept of sustainable construction. Sustainable construction is a novel approach adopted by the construction industry towards achieving sustainability (Koko and Bello, 2020). It represents the construction industry's response to man's concern over increasing consumption pattern in the mist of earth's limited carrying capacity to sustain lives (Dania, 2016). Practically, sustainable construction deals with how the construction projects preserve the environment and affect the social and economic welfare of the people living around them (Willar et al., 2021). A sustainable construction uses less water, optimises energy efficiency, conserves natural resources, generates less waste, provides healthier spaces for occupants as well as reduces the impact of construction activities on human health and environment during the construction project's lifecycle (U.S. Green Building Council (USGBC), 2010; Kanika et al., 2016). Contrarily, the conventional construction practices overlook the interrelationships between the construction facility, its components, surroundings, and users (Atombo, Dzantor and Agbo, 2015).

Sustainable construction practices, therefore, are the optimal utilisation of sustainable materials and technologies in the design, construction and operation of construction projects for social and economic wellbeing of the people without injury to the environment, now and in the future. Succinctly, sustainable construction practices are those activities, actions, processes, methods and policies adopted during construction processes so as to ensure a balance between environment, economy and society throughout the life cycle of a construction project both now and in the future. It entails following a suitable practice in choosing and sourcing materials, and construction methodologies, as well as design philosophy to improve performance, decrease environmental burden of the project, minimise waste, and become ecologically friendlier; while taking into consideration environmental, economic and socio-cultural values (Mohamed and El-Meligy, 2013).

Unfortunately, the implementation of sustainable construction practices is not an easy task (Willar et al., 2021), especially in the developing countries like Nigeria where construction processes are structured within the traditional construction framework (Kibert, 2016). Sustainable construction projects require the use of advanced construction techniques (Murtagh, Scott and Fan, 2020), complex design and materials (Olawumi and Chan, 2018), and greater communication network among construction project stakeholders (Wuni and Shen, 2020). Just as with the traditional construction projects, sustainable construction projects face many risks (Hwang et al., 2017; Qazi, et al., 2021). Construction risk is, therefore, multifaceted (Wang, Dulami and Agar, 2004) and uncertain event or condition (Hilson and Simon, 2020). It is the likelihood of the occurrence of combination of events/factors or a definite event/factor, which occur during the whole process of construction to the detriment of the project (Kasapoğlu, 2018).

Meanwhile, risk in the construction project may result to substantial cost and time overruns that are detrimental to the project objectives, and inherent in any construction project. Adverse effect of risks in the construction project could lead to losses not only to the project owners, contractors or society, but also to the professionals who are engaged in the project (Kasapoğlu, 2018). However, sustainability specific risks are unique because they are generally not reflected on the risk checklists and risk matrices, unlike traditional risks related to the short-term project performance measures (Qazi, et al., 2021). Furthermore, sustainability-related risks are associated with a wide range of probability and impact ratings due to the evolving and complex nature of these risks (Guan, Abbasi and Ryan, 2020).

The unpredictability of construction site conditions, multiple stakeholders' involvement and volatile demand of construction projects make the sustainable construction process riskier (Kasapoğlu, 2018). Apine and Valdés (2017) opine that risks in sustainable construction practices are growing with increasing utilisation of new materials and technology in the field. This has even grown to the extent that it is raising health and safety concerns (Fortunate III et al., 2012; Onubi, Yusof and Hassan, 2020) and thereby, constituting an additional risk to the project. Davies and Davies (2017) reveal that risk is one of the barriers of implementing sustainable construction practices in the construction projects. It was also acknowledged that the implementation of sustainable construction practices is bedevilled with a lot of challenges and risks; especially to those who are new to sustainable construction operational system (Apine and Valdés, 2017; Ismael and Shealy, 2018). To this end, sustainable construction project requires a high level of collaboration between the construction stakeholders more than the traditional construction project due to increased number of uncertainty and risk (Klotz and Horman, 2010).

Since the construction managers are still learning and adapting to embrace sustainable practices (Qazi, et al., 2021) and also sustainability-related risks in the construction projects are quite different from the traditional risks (Mahdiyar et al., 2020), it is very germane to assess the risks of implementing sustainable construction practices. It is against this backdrop that this study was aimed at assessing the risks associated with the implementation of sustainable construction practices in Nigeria with a view to increasing the construction managers' understanding and successes of implementing the dynamics of sustainable construction principles. This would allow for appropriate risk response planning and control (El-Sayegh et al., 2018), and minimises the probability of occurrence of unexpected events in executing sustainable building projects (Javed et al., 2020). Based on the foregoing, two hypotheses were postulated to direct the path of this study.

Hypothesis 1:

H_o: There is no significant difference between the likelihood of risks occurrence and magnitude of risks impact of risks associated with the implementation of sustainable construction practices.

H_1: There is significant difference between the likelihood of risks occurrence and magnitude of risks impact of risks associated with the implementation of sustainable construction practices.

Hypothesis 2:

H_o: There is no significance difference in the perceived risk level based on the respondents' roles in the implementation of sustainable construction practices.

H_1: There is significance difference in the perceived risk level based on the respondents' roles in the implementation of sustainable construction practices.

The remainder of the paper is organised as follows: a brief overview of the relevant literature, the methodology applied in the study, the result of the study, the discussion and implications of the study, and the conclusions, recommendations and future research directions.

Literature Review

Currently, there is an increasing awareness over the benefits of implementing sustainable construction principles in all facets of building project delivery process. There is also fear of inherent risks associated with sustainable construction projects and limiting effectiveness of efforts toward sustainable construction objectives (Chan, Darko and Ameyaw, 2017). Construction projects often fail due to unforeseen risks (Górecki and Díaz-Madroñero, 2020). Undoubtedly, different studies (Rafindadi et al., 2014; Ismael and Shealy, 2018) have affirmed that sustainable construction projects are engrossed with enormous risks. Hwang, Shan and Supa'at (2017) even revealed that adoption of sustainable construction presents additional risks to the building projects. Study by Ranaweera and Crawford (2010) found that sustainable building projects incur a higher financial risk compared to the conventional building projects due to a higher investment resulting from the adoption of environmental strategies as requirements for sustainable buildings. Hwang et al. (2017) also found that sustainable buildings projects are facing risks at a more critical level than the conventional building projects. However, from the 42 identified risks, Hwang et al. (2017) revealed that complex procedures to obtain approvals, overlooked high initial cost, unclear requirements of owners, employment constraint, and lack of availability of green materials and equipment were top five critical risks in sustainable building construction projects.

Similarly, Apine and Valdés (2017) found higher operating expenses, unachievable project requirements, failure to meet green code or green certification requirements, construction schedule and cost impacts, damage to environmental and professional reputation, materials and equipment with reduced life cycles or immediate aesthetic or performance failure as risks associated with the sustainable buildings projects. El-Sayegh et al. (2018) categorised 30 identified risks into five groups: management, technical, green team, green materials and regulatory/economic, and found the top five risks associated with sustainable construction projects to include: shortage of clients' funding, insufficient or incorrect sustainable design information, design changes, unreasonable tight schedule for sustainable construction and poor scope definition in sustainable construction.

From the list of 52 risk elements developed, Ismael and Shealy (2018) found that lack of public awareness was the risk that occurs most, whereas designers' and contractors' inexperience has the greatest negative impact on the implementation of sustainable construction in Kuwaiti construction industry. However, the study found high cost of sustainable materials and equipment, contractors' inexperience with sustainable construction, lack of practical experience, lack of public awareness and high initial sustainable construction costs as top five risks of sustainable construction. It recommended for educational interventions, changes in risk allocation, and behavioural science to reframe upfront costs and long-term saving as possible solutions. Qin, Mo and Jing (2016) surveyed different risk factors (including political risks, social risks, quality/technological risks, certification risks, financial/cost risks and managerial risks) associated with green buildings and found 56 risk factors, among which 36 were perceived as key risk factors affecting the success of sustainable buildings. Likewise, Zhao, Hwang and Gao (2016) identified 28 risk factors which they grouped into 11 groups. They found that inaccurate cost estimation was the top risk factor, while cost overrun risk was the most critical risk group. However, the study found that the overall risk criticality was high, signifying the importance of risk management in green construction projects. An in-depth summary of risks associated with implementing sustainable construction practices from the forgoing literature and other sources is presented in Table 1. These would form the basis for further analysis.

In the developing countries, these risks are more pronounced than in the developed ones due to the low level of awareness and understanding of sustainable construction concept (Abolore, 2012; Afolayan and Tunde, 2014). Wang et al. (2016) argued that low level of awareness leads to limited knowledge and in turn irrational behaviour. Consequently, construction practitioners are reluctant to change and tend to be risk averse (Kibert, 2016; Hammond et al., 2019). Aghimien, Aigbavboa and Thwala (2019) and Susanti, Filestre and Juliantina (2019) also revealed that fear of increased cost of investment, inadequate knowledge and understanding of the concept of sustainability, limited number of trained and/or certified workers and lack of communication between parties are some of the major challenges of implementing sustainable construction in the developing countries. Therefore, sustainable construction creation depends on the awareness, understanding of the consequences of individual actions, quest for knowledge and absolute involvement and commitment to the principle (Abidin, 2010; Abolore, 2012). Awareness then includes revealing the risks of implementing sustainable construction practices. According to Kibert (2016), lack of knowledge and/or experience prevents practitioners from identifying all the risks related to sustainable construction practices. Notwithstanding, risk management literature on sustainable construction practices is still insufficient to allow professionals and practitioners to understand and identify the risks involved in implementing sustainable construction practices (Apine and Valdés, 2017).

The complexity and potency of sustainability-related risks indicated the importance of effective management of these risks so as to achieve the desired sustainability goals, allocate budgets, and target certification levels (Gurgun, Arditi and Casals Vilar, 2016). Sequel to this, Durmus-Pedini and Ashuri (2010) recommended for hiring professionals who are experienced in green buildings and engaging consultants to minimise the impacts of risks related to green construction. Likewise, Zou and Couani (2012) recommended for the utilisation of expertise of green building professionals in managing green construction risks. However, implementation of new or untested green technologies and products can be challenging, particularly if, the professionals using them have limited knowledge (Gurgun, Arditi and Casals Vilar, 2016).

Juxtaposing the level of awareness and understanding of sustainable construction concept vis-à-vis the structure of the building construction industry and current construction practices in Nigeria, it could be argued that construction practitioners are not yet very conversant with the risks related to implementation of sustainable construction practices. This therefore, has resulted to the low level of implementation of sustainable construction principles in the Nigerian construction industry (Chukwu, 2018; Otali and Oladokun, 2018). Although Hwang et al. (2017) and El-Sayegh et al. (2018) claimed that sustainable construction projects are riskier than the traditional projects due to greater complexity and uncertainty inherent in the sustainable construction projects, Wu et al. (2019b) revealed that sustainability like other project performance measures such as time, cost and quality, has also been assessed through the risk management perspective to prioritise the associated risks. Notwithstanding, research efforts on the risks associated with sustainable construction projects are still very limited (Qin, Mo and Jing, 2016; Hwang, Shan and Supa'at, 2017; Guan, Abbasi and Ryan, 2020). In Nigeria, there is no clear evidence of research directed towards assessing the risk of implementing sustainable construction practices in the literature.

Available literature has focused on the risk management in construction projects (Wang, Dulami and Agar, 2004; Banaitiene and Banaitis, 2012; Kasapoğlu, 2018; Bahamid, Doh and Al-Sharaf, 2019), risk assessment and prioritisation techniques (Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016;

Table 1. Summary of Risks Associated with Implementing Sustainable Construction Practices

Code	Risk Factors	Sources
SCR1	Uncertain government policies	Ismael and Shealy, 2018; Zou, Zhang and Wang, 2007
SCR2	Cost estimation inaccuracy	Ismael and Shealy, 2018; Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016; Zou and Couani, 2012
SCR3	Payback period is too long	Durmus-Pedini and Ashuri, 2010; Gurgun, Arditi and Casals Vilar, 2016; Ismael and Shealy, 2018
SCR4	Uncertainty in the performance of sustainable buildings projects	Apine and Valdés, 2017; Yin et al., 2018
SCR5	High cost of sustainable materials and equipment	Hwang and Ng, 2013; Ismael and Shealy, 2018
SCR6	Cost and time overrun due to lack of sustainable building knowledge	Gurgun, Arditi and Casals Vilar, 2016; Gurgun, et al., 2018; Ismael and Shealy, 2018
SCR7	Lack of sustainable construction management experts	Zhao, Hwang and Gao, 2016
SCR8	Unattainable expectations or requirements	Hwang et al., 2015; Gurgun, Arditi and Casals Vilar, 2016
SCR9	Culture issues	Kasapoğlu, 2018
SCR10	Poor and inefficient communication among project participants	Zou and Couani, 2012; Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016
SCR11	Liable to undue claims	Durmus-Pedini and Ashuri, 2010; Tollin, 2011
SCR12	Complex approval process due to sustainability specifications	Zou and Couani, 2012; Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016; Gurgun, Arditi and Casals Vilar, 2016; Hwang et al., 2017
SCR13	Lack of practical experience	Qin, Mo and Jing, 2016; Ismael and Shealy, 2018; Kasapoğlu, 2018
SCR14	Unavailability of sustainable materials and equipment	Zou and Couani, 2012; Hwang et al., 2017; Ismael and Shealy, 2018
SCR15	Uncertainty in the quality and performance of sustainable materials	Apine and Valdés, 2017
SCR16	Change in material types and specifications during construction	Apine and Valdés, 2017
SCR17	Lack of sustainable technical experts	Zou and Couani, 2012; Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016

Table 1. continued

Code	Risk Factors	Sources
SCR18	Unforeseen sustainable projects requirements	Durmus-Pedini and Ashuri, 2010; Qin, Mo and Jing, 2016
SCR19	Lack of public awareness and knowledge	Ismael and Shealy, 2018
SCR20	Unclear contract conditions for claims, litigations and dispute resolution	Durmus-Pedini and Ashuri, 2010; Zhao, Hwang and Gao, 2016
SCR21	Safety and health issues	Fortunate et al., 2012; Zou and Couani, 2012; Paradis and Tran, 2016; Zhao, Hwang and Gao, 2016; Kasapoğlu, 2018; Cardoso et al., 2019
SCR22	Fluctuations in labour and material rate	Qin, Mo and Jing, 2016; Kasapoğlu, 2018
SCR23	Lack of market demand	Durmus-Pedini and Ashuri, 2010; Kasapoğlu, 2018
SCR24	Lack of political support	Ismael and Shealy, 2018
SCR25	High initial sustainable construction costs	Zou and Couani, 2012; Qin, Mo and Jing, 2016; Hwang et al., 2017; Ismael and Shealy, 2018
SCR26	Cost of investment in skills development and shortage of skills	Qin, Mo and Jing, 2016; Hwang et al., 2017
SCR27	High sustainable construction premiums	Robichaud and Anantatmula, 2011; Gurgun, Arditi and Casals Vilar, 2016
SCR28	Additional responsibilities for construction maintenance	Zhao, Hwang and Gao, 2016; Apine and Valdés, 2017
SCR29	Project delay due to incremental time caused by sustainable construction	Apine and Valdés, 2017; Yin et al., 2018
SCR30	More complex and unfamiliar construction techniques and processes	Zou and Couani, 2012; Zou and Zhao, 2014; Yang, Zou and Wang, 2016
SCR31	Undue interventions of clients	Zhao, Hwang and Gao, 2016
SCR32	Changing sustainable building certification procedures and policies	Qin, Mo and Jing, 2016
SCR33	Disputes arising from additional requirements	Zou and Couani, 2012; Zhao, Hwang and Gao, 2016
SCR34	Lack of planning and early consideration of sustainability measures by stakeholders	Bal et al., 2013
SCR35	Failure to meet sustainable construction certification requirements	Gurgun et al., 2016; Apine and Valdés, 2017; Qazi, et al., 2021
SCR36	Lack of qualified professionals with requite sustainable building expertise	Zou and Couani, 2012; Gurgun, Arditi and Casals Vilar, 2016; Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016

Table 1. continued

Code	Risk Factors	Sources
SCR37	Insufficient or incorrect sustainable design information	Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016; El-Sayegh et al., 2018
SCR38	Unreasonable tight schedule for sustainable construction	Apine and Valdés, 2017; El-Sayegh et al., 2018
SCR39	Exposed to litigation for not achieving client expectations	Tollin, 2011; Qin, Mo and Jing, 2016; Kasapoğlu, 2018
SCR40	Shortage of clients' funding	Qin, Mo and Jing, 2016; Zhao, Hwang and Gao, 2016; El-Sayegh et al., 2018
SCR41	Project team inexperience in providing sustainable construction services	Gurgun, Arditi and Casals Vilar, 2016; Ismael and Shealy, 2018
SCR42	Insecurity	Paradis and Tran, 2016; Kasapoğlu, 2018
SCR43	Corruption and high crime rate	Zhao, Hwang and Gao, 2016
SCR44	Uncertainty in energy saving and renewable energy	Gurgun, Arditi and Casals Vilar, 2016
SCR45	Poor scope definition and unclear allocation of roles in sustainable construction	Gurgun, Arditi and Casals Vilar, 2016; Qin, Mo and Jing, 2016; Hwang et al., 2017; El-Sayegh et al., 2018
SCR46	Inflation and fluctuation of exchange rate	Zhao, Hwang and Gao, 2016; Kasapoğlu, 2018; Qazi, et al., 2021
SCR47	Design changes during construction	El-Sayegh et al., 2018

Tong et al., 2018; Yuan et al., 2018; Ribas et al., 2019; Guan, Abbasi and Ryan, 2020; Qazi, et al., 2021), managing risks in green building (Zou and Couani, 2012), risks in green building projects (Durmus-Pedini and Ashuri, 2010; Xiang and Shu, 2018), impact of green building (Gurgun, Arditi and Casals Vilar, 2016), risk perception (Wu et al., 2019b). Most of these studies were also conducted outside the shores of Nigeria. Although Qazi et al. (2021) dealt with prioritising the risks in sustainable construction projects in United Arab Emirates, Qin et al. (2016) investigated the risks associated with the life cycle of green buildings in China. This study would focus on the risks associated with the implementation processes of sustainable construction practices in South-East Nigeria. It should be noted that the management and administration of construction project is key to achieving its objectives. Unarguably, sustainable construction projects cannot be effectively implemented without first identifying and assessing the risks therein. Besides, construction professionals who are not familiar with the sustainable construction concepts and approaches may perceive it as risky (Ismael and Shealy, 2018). This study, therefore, narrows the gap of risks of implementing sustainable construction practices in the literature.

Methodology

RESEARCH DESIGN

The study adopted a descriptive survey research design because, the study was only interested in determining the type of risks associated with the process of implementation of sustainable construction projects.

Additionally, a survey approach was adopted because it is efficient, flexible, has ethical advantage, internal and external validity, and can be used to cover geographically spread samples such as in this study (Mathers, Fox and Hunn, 2009). However, it depends on the accuracy of the sampling frame. In this case, it involved the collection of information on the level of risk associated with the implementation of sustainable construction practices (exposure and impact of risk factors) as they exist on the building construction sites in South-East Nigeria. Although the South-East Nigeria is just one region in Nigeria, it was chosen because it is the fastest growing region among the six regional blocks in Nigeria with very high volume of ongoing building projects. Moreover, construction operational system is the same in all parts of Nigeria. The study area is the most densely populated region in Nigeria with an average density of 442 persons per square kilometre (Federal Government of Nigeria (FGN), 2012).

The study made use of structured questionnaire administered to the selected building construction professionals in the study area. Although, other methods such as interview, observation and Delphi, can also be used, questionnaire is the most efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest (Sekaran and Bougie, 2016). Since the study was only interested in the risk level of different risk factors affecting implementation of sustainable construction practices and not 'why', questionnaire is the most appropriate tool that ensures minimal bias and wider spread. The questionnaire was designed to measure the perceived risk level of sustainable construction practices in Nigeria. It was also designed to investigate the perceived likelihood of occurrence and the impact of risk factors affecting the implementation of sustainable construction practices in Nigeria. Considering the frequency and severity simultaneous indicates a broader result than evaluating risk based on frequency or on severity only (Baradan and Usmen, 2006). Meanwhile, the questionnaire consisted of two parts. Part 1 captured the respondents' demographic data. Part 2 contained 47 risk factors for sustainable construction practices extracted from the literature and on which perceived likelihood of occurrence and magnitude of impacts were assessed. The respondents were asked to express their opinion based on their perception on the frequency of occurrence and severity of impact of identified risk factors affecting the implementation of sustainable construction practices on a 5-point Likert scale. Where, 1 = very unlikely, 2 = unlikely, 3 = fairly unlikely, 4 = likely, 5 = very likely (for likelihood of risk occurrence); and 1 = very insignificant, 2 = insignificant, 3 = fairly significant, 4 = significant, 5 = very significant (for severity of risk impact).

SAMPLING AND SAMPLING TECHNIQUE

The population of this study constituted all relevant registered building industry professionals as obtained from the register of various professional associations in South-East Nigeria and have practised for at least 10 years. In this kind of research, experience of the respondents on the subject matter is very important to avoid any suspicion of bias. It is also believed that those professionals with sufficient practical experience of at least 10 years could be able to provide the desired information about the risks inherent in the process of implementation of sustainable construction practices, because they may have handled varieties of building projects that should have given them enough insights about the risks associated with sustainable construction projects. According to Ismael and Shealy (2018), lack of experience of designers and contractors is the risk element with the highest possible negative impact on future sustainable construction projects. The importance of using experienced construction professionals in identifying and assessing the risks inherent in sustainable construction projects before implementation has also been stressed by Durmus-Pedini and Ashuri (2010), Zou and Couani (2012) and Kibert (2016). Specifically, Wu et al. (2019b) revealed that professionals' experience in the sustainable construction projects affected their risk perceptions. Thus, a total of 728 professionals was involved. To determine the appropriate sample size for this study, Cochran's sample size calculation procedure for large population was used as shown in Equation 1 (Cochran, 1977).

$$n_0 = \frac{(t)^2 \times (p)(q)}{(d)^2} \quad (1)$$

Where n_0 is the sample size, t = value for selected alpha level of .025 in each tail = 1.96 (the alpha level of .05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error), (p)(q) = estimate of variance = 0.25 (maximum possible proportion (0.5) x 1-maximum possible proportion (0.5) produces maximum possible sample size), d = acceptable margin of error for proportion being estimated = 0.05 (error estimate).

However, if the computed sample size is greater than 5% of the population (n_0 > 5% of population), the final and survey sample size would be calculated using Cochran (1977) correction formula in Equation 2. Otherwise n_0 would be adopted as the final and survey sample size for the study.

$$n_1 = \frac{n_0}{1 + \frac{n_0}{population}} \quad (2)$$

From Equation 1,

The sample size $n_0 = \frac{(1.96)^2 \times (0.5)(0.5)}{(0.05)^2} \approx 385$

Since n_0 (385) > 5% of 728 (36),

The survey sample size $n_1 = \frac{385}{1 + \frac{385}{728}} \approx 256$

Prior to the distribution of the questionnaires, the locations and contacts of the prospective respondents were first identified and consent/permission was sought and obtained from the relevant persons. The objectives of the study were clearly stated in the consent/introduction letter and no further permission was necessary for data collection through the questionnaire in this study. The study then employed a multi-stage sampling procedure in selecting the desired respondents. Firstly, cluster sampling technique was employed, where the samples were proportionally divided into five to ensure that the respondents from each of the five states in the study area were adequately represented in the survey (geographical spread). Secondly, a simple random sampling technique was used in choosing the respondents from each state (cluster). Meanwhile, with the initial set out benchmark of ≥ 10 years of experience, it was assumed that any respondent selected through a simple random sampling was appropriate and capable of giving valid information.

Based on this, a total of 256 copies of questionnaire were distributed to the respondents through both self-administration and by online post via established mail contacts. After about one month of the distribution of questionnaires, very few responses were obtained. Consequently, soft reminder was sent to the respondents who had not responded to the questionnaires through phone calls and emails. Two other reminders were sent to the respondents at one-month interval. Unfortunately, COVID-19 pandemic restricted the researchers from making personal contacts to the respondents which later affected the response rate. The distribution and retrieval of questionnaire were conducted from April to July 2020. Thereafter, 162 questionnaires were returned with 117 representing about 45.70% found valid for used in the analysis due to their completeness and meeting other criteria (≥ 10 years of practice). Although the valid response rate was below the sample size, Dörnyei (2007) recommended that in a descriptive survey research design a sample of between 1% and 10% of the population, with a minimum of 100 respondents is acceptable and can produce a valid result. Wiseman (2003) and Archer (2008) also noted that web-based surveys often encounter low response rates. However, the result of this study may suffer from generalisability

(Young, 2016). Since the population of this study is finite (728), the result of this study is reliable and acceptable within a 5% margin of error and at 95% confidence level as recommended by Bartlett, Kotrlick and Higgins (2001); Gilliland and Melfi (2010) and Taherdoost (2017) for survey research.

METHOD OF DATA ANALYSIS

The data generated from the survey were subjected to descriptive analysis. Thereafter, a quantitative risk analysis was carried out to assess the risk factors. Table 2 summarised a modified risk factor likelihood of occurrence and impact rating scales respectively, based on the Royal Institute of Chartered Surveyors (RICS) Professional Guidance for Management of Risk (RICS, 2015).

Table 2. Risk Factor Likelihood of Occurrence and Risk Factor Impact Scales

Risk Factor Likelihood of Occurrence			Risk Factor Impact Scale		
Scale	Rating	Description	Scale	Rating	Description
1	Very unlikely	Extremely unlikely to happen.	1	Very insignificant	Minimal impact that can be easily remedied
2	Unlikely	Low but not impossible.	2	Insignificant	Minor and shot-term impact on the achievement of objectives
3	Fairly likely	Fairly likely to happen.	3	Fairly significant	Reduced viability and medium-term impact on the achievement of objectives.
4	Likely	More likely to occur than not.	4	Significant	Serious or major impact on the achievement of objectives.
5	Very likely	Almost certain to occur.	5	Very significant	Critical impact on the achievement of objectives.

RICS (2015)

However, the likelihood of risk occurrence and severity of risk impact were calculated using the Mean Value Method as shown in Equations 3 and 4.

$$LRO^i = \frac{1}{n}\sum_{j=1}^{n} LRO_j^i \tag{3}$$

$$SRI^i = \frac{1}{n}\sum_{j=1}^{n} SRI_j^i \tag{4}$$

Where LRO^i = the likelihood assessment of risk i; LRO_j^i = the likelihood assessment of risk i by respondents j; SRI^i = the impact assessment of risk i; SRI_j^i = the impact assessment of risk i by respondents j; and n = the total number of respondents.

On the other hand, the degree of risk or rather the risk score is obtained using Risk Criticality Index (RCI) in Equations 5 and 6, which invariably determines the level of risk (risk prioritisation number). The

Risk Criticality Index has been extensively used in the risk management-related studies (Deng, Pheng and Zhao, 2014; Hwang et al., 2017; Hwang, Shan and Supa'at, 2017).

$$RCI_j^i = LRO_j^i \times SRI_j^i \quad (5)$$

$$RCI^i = \frac{1}{n}\sum_{j=1}^{n} RCI_j^i \quad (6)$$

Where RCI^i = the risk criticality of risk *i*; RCI_j^i = the risk criticality of risk *i* by respondents *j*; and *n* = the total number of respondents.

Since the assessment of LRO and SRI were both carried out based on 5-point rating system (5X5 matrix), the RCI is therefore, on a full scale of 25. In this study, a benchmark for critical risks in implementing sustainable construction practices in the study area is presented in Table 3. In this case, any risk factor with score greater than 12 was classified as high-level risk and therefore, considered as critical risk factor (see Table 3).

Table 3. Classification of Risk Level

Risk score scale	Risk level
$1 \leq x \leq 4$	Low
$4 < x \leq 12$	Medium
$12 < x \leq 25$	High

x = Actual risk score for each factor

Workplace Safety and Health Council (2011)

As argued in the introduction, a null and alternative hypothesis of significant difference between the likelihood of risks occurrence and magnitude of risks impact of risks associated with the implementation of sustainable construction practices were tested using Wilcoxon Signed-rank test statistic. Meanwhile, Kruskal-Wallis test statistics was applied to test the differences in the risk level based on the respondents' role

Decision: Reject H_0 if $p<0.05$ otherwise, do not reject H_0 and conclude.

Result

RESPONDENTS BACKGROUND INFORMATION

The respondents composed of more than half (58.97%) working in the private sector organisations, while about (41.03%) work in the public sector organisations. Out of this number, 15.38% were affiliated to building profession, 28.21% to architecture profession, 34.19% belong to engineering, whereas 22.22% belong to quantity surveying profession. Similarly, 11.97% of the respondents were holding either the post of project or construction managers, 36.75% were either project/site engineer, architect, quantity surveyor or builder. 17.95% were holding the post of project consultants, 14.53% were academia, 11.11% supervisors, and 7.69% were directors.

Furthermore, 19.66% of the respondents stated that they had diploma as the highest educational certificate. 40.17% showed that they had first degree certificates, 7.35% had master's degree, 9.40% had PhD as their highest certificate, while 3.42% had other certificates. This showed that all the respondents were lettered and could give account of themselves in terms of response to the questions in this study. In terms of years of experience, the benchmark for consideration was (> 10 years). In this case, 28.21% indicated that they have had between 11-15 years working experience, more than half (58.97%) of the respondents indicated that they have had between 16-20 years working experience, while 12.82% indicated that they have had more than 20 years of working experience. This implied that the respondents are very relevant, well positioned and had requite experience in the construction practice to give vital information and express their perception about the risks associated with implementation of sustainable construction practices.

LIKELIHOOD, IMPACT AND CRITICALITY OF RISKS ASSOCIATED WITH IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION PRACTICES

Table 4 showed the result of analysis of risk associated with implementation of sustainable construction practices in South-East Nigeria. The result revealed that out of the 47 identified risk factors from the literature, only one risk factor (i.e., unavailability of sustainable materials and equipment) with mean score value of 4.58 occurred very likely, 26 factors with mean scores ranging from 4.48-3.51 occur likely, whereas 20 factors with mean scores ranging from 3.47-2.62 fairly likely or occasionally occurred. Likewise, only one risk factor with mean score value of 4.67 (i.e., high initial sustainable construction costs) had very significant impact on the implementation of sustainable construction practices. 21 risk factors had significant impact with mean scores ranging from 4.43-3.68, 18 risk factors had fairly significant impact with mean score ranging from 3.42-2.50, while 7 risk factors with mean scores ranging from 2.48-2.26 had insignificant impact.

However, the top five ranked risk factors with the highest likelihood of occurrence in the implementation of sustainable construction practices were unavailability of sustainable materials and equipment (4.58), more complex and unfamiliar construction techniques and processes (4.48), high initial sustainable construction costs (4.37), failure to meet sustainable construction certification requirements (4.35), and uncertain government policies (4.34). Similarly, the top five ranked risk factors with the greatest magnitude of impact were high initial sustainable construction costs (4.37), poor and inefficient communication among project participants (4.43), high cost of sustainable materials and equipment (4.39), lack of public awareness and knowledge (4.39) and lack of sustainable technical experts (4.25).

In terms of risk level, 23 risk factors were classified as high-level risk factors with RCI ranging from 20.41-12.37, while 24 factors with RCI ranging from 11.76-6.79 were medium level risk factors. However, the 23 high level risk factors were also critical risk factors which have overall critical effects on the implementation of sustainable construction practices. As also contained in Table 4, the top five critical risk factors affecting implementation of sustainable construction practices in South-East Nigeria in order of criticality were high initial sustainable construction costs (20.41), unavailability of sustainable materials and equipment (19.34), lack of public awareness and knowledge (18.88), high cost of sustainable materials and equipment (18.75), and failure to meet sustainable construction certification requirements (18.40).

To determine the significant difference between the likelihood of occurrence and magnitude of impact of risk factors affecting implementation of sustainable construction practices, the Wilcoxon Signed-rank test result is showed in Tables 5 and 6. The result rejected the null hypothesis of no significant difference and concluded that there is significant difference ($z = -3.207$, $p<0.001$) between the likelihood of occurrence and magnitude of impact of risk factors affecting implementation of sustainable construction practices in the study area. In this case, the LRO has a larger median (3.76) than SRI median (3.24) which suggested the existence of statistically significant difference. The result also suggested that the overall risk level in the implementation of sustainable construction practices was more likely determined by the likelihood of risk occurrence than the magnitude of risk impact.

Table 4. Assessment of risks associated with implementation of sustainable construction practices

Code	LRO			SRI			RCI	Overall Ranking	Risk Level
	Mean	Rank	Frequency Rating	Mean	Rank	Impact Rating			
SCR1	4.34	5	Likely	4.21	9	Significant	18.27	6	High
SCR2	3.51	27	Likely	2.70	33	Fairly significant	9.48	33	Medium
SCR3	3.91	21	Likely	2.90	30	Fairly significant	11.34	28	Medium
SCR4	3.97	19	Likely	2.91	29	Fairly significant	11.55	27	Medium
SCR5	4.27	8	Likely	4.39	3	Significant	18.75	4	High
SCR6	3.94	20	Likely	3.14	27	Fairly significant	12.37	23	High
SCR7	4.21	10	Likely	2.76	31	Fairly significant	11.62	25	Medium
SCR8	3.08	34	Fairly likely	3.17	26	Fairly significant	9.76	31	Medium
SCR9	3.20	31	Fairly likely	3.01	28	Fairly significant	9.63	32	Medium
SCR10	3.05	35	Fairly likely	4.43	2	Significant	13.51	20	High
SCR11	3.26	30	Fairly likely	4.11	13	Significant	13.40	21	High
SCR12	4.15	14	Likely	4.23	6	Significant	17.55	9	High
SCR13	4.11	16	Likely	3.90	19	Significant	16.03	15	High
SCR14	4.58	1	Very likely	4.22	8	Significant	19.34	2	High
SCR15	4.19	12	Likely	3.92	18	Significant	16.42	13	High
SCR16	4.20	11	Likely	4.15	12	Significant	17.43	10	High
SCR17	4.16	13	Likely	4.25	5	Significant	17.68	7	High
SCR18	2.97	39	Fairly likely	3.96	15	Significant	11.76	24	Medium
SCR19	4.30	6	Likely	4.39	3	Significant	18.88	3	High
SCR20	3.91	21	Likely	3.42	23	Fairly significant	13.37	22	High
SCR21	4.14	15	Likely	3.89	20	Significant	16.10	14	High
SCR22	3.72	26	Likely	3.68	22	Significant	13.69	19	High
SCR23	3.27	29	Fairly likely	2.48	41	Insignificant	8.11	36	Medium
SCR24	3.76	24	Likely	2.69	34	Fairly significant	10.11	29	Medium

Table 4. continued

Code	LRO			SRI			RCI	Overall Ranking	Risk Level
	Mean	Rank	Frequency Rating	Mean	Rank	Impact Rating			
SCR25	4.37	3	Likely	4.67	1	Very significant	20.41	1	High
SCR26	2.97	39	Fairly likely	2.29	46	Insignificant	6.80	46	Medium
SCR27	3.11	33	Fairly likely	2.60	35	Fairly significant	8.09	37	Medium
SCR28	3.47	28	Fairly likely	2.38	44	Insignificant	8.26	35	Medium
SCR29	3.74	25	Likely	2.26	47	Insignificant	8.45	34	Medium
SCR30	4.48	2	Likely	3.24	24	Fairly significant	14.52	18	High
SCR31	2.94	41	Fairly likely	2.38	44	Insignificant	6.99	45	Medium
SCR32	2.90	42	Fairly likely	2.58	37	Fairly significant	7.48	41	Medium
SCR33	3.04	37	Fairly likely	2.50	40	Fairly significant	7.60	40	Medium
SCR34	2.82	44	Fairly likely	2.51	39	Fairly significant	7.08	44	Medium
SCR35	4.35	4	Likely	4.23	6	Significant	18.40	5	High
SCR36	4.30	6	Likely	4.10	14	Significant	17.63	8	High
SCR37	2.78	46	Fairly likely	4.16	11	Significant	11.56	26	Medium
SCR38	2.85	43	Fairly likely	2.55	38	Fairly significant	7.27	43	Medium
SCR39	2.81	45	Fairly likely	2.73	32	Fairly significant	7.67	38	Medium
SCR40	4.23	9	Likely	3.86	21	Significant	16.62	12	High
SCR41	4.04	17	Likely	3.93	17	Significant	15.88	16	High
SCR42	2.62	47	Fairly likely	2.59	36	Fairly significant	6.79	47	Medium
SCR43	3.86	23	Likely	3.96	15	Significant	15.29	17	High
SCR44	2.98	38	Fairly likely	2.45	42	Insignificant	7.30	42	Medium
SCR45	3.05	35	Fairly likely	3.21	25	Fairly significant	9.79	30	Medium
SCR46	4.01	18	Likely	4.20	10	Significant	16.84	11	High
SCR47	3.15	32	Fairly likely	2.42	43	Insignificant	7.62	39	Medium

Table 5. Result of Mean Rank from Wilcoxon Signed-Ranks Test

Ranks					LRO	SRI
		N	Mean Rank	Sum of Ranks		
SRI - LRO	Negative Ranks	34[a]	25.50	867.00		
	Positive Ranks	13[b]	20.08	261.00		
	Ties	0[c]				
	Median				3.76	3.24
	Total	47				

a. SRI < LRO
b. SRI > LRO
c. SRI = LRO

Table 6. Result of Wilcoxon Signed-Ranks Test

Test Statistics[b]	
	SRI - LRO
Z	-3.207[a]
Asymp. Sig. (2-tailed)	.001
Exact Sig. (2-tailed)	.001
Exact Sig. (1-tailed)	.001
Point Probability	.000

a. Based on positive ranks.
b. Wilcoxon Signed Ranks Test

To further determine the magnitude of the differences, the effect size (r) was computed by dividing the absolute (positive) standardised test statistic (z) by the square root of the number of factors (N) as represented in Equation 7.

$$\text{Therefore, } r = \frac{z}{\sqrt{N}} \tag{7}$$

Where, z = 3.207 and N = 47

$$\text{Thus, } r = \frac{3.207}{\sqrt{47}} = 0.468$$

From the foregoing result, the effect size was 0.468 which is a moderate effect according to Cohen's classification of effect sizes which is 0.1 (small effect), 0.3 (moderate effect) and ≥0.5 (large effect). This result suggested that the differences in the likelihood of occurrence and magnitude of impact of risk factors affecting implementation of sustainable construction practices in the study area could be due to disparities in the tripod of sustainable construction practices.

Furthermore, to determine if there is significance difference in the risk level of the risk factors associated with implementation of sustainable construction practices based on the respondents' roles, the Kruskal-

Table 7. Kruskal Wallis H Test for comparing the risk level based on the respondents' role

	Role of respondent	N	Mean Rank
	Construction manager	14	38.71
	Project/site engineer, architect, quantity surveyor or builder	43	64.44
	Project consultants	21	64.10
	Academia	17	64.35
	Supervisor	13	59.54
	Director	9	41.78
	Total	117	
Test Statistics[a,b]			
			Risk level
Chi-Square			9.335
df			5
Asymp. Sig.			.096

a. Kruskal Wallis Test

b. Grouping Variable: Role of respondents

Wallis test statistics result presented in Table 7 revealed that the computed χ^2 was 9.335 and the p value (0.096) is greater than 0.05 at 5% significant level. This implied that there is no significance difference in the risk level of risk factors associated with the implementation of sustainable construction practices based on the respondents' roles.

Discussion

RISK LEVEL OF SUSTAINABLE CONSTRUCTION PROJECTS

The result of this study has demonstrated that the risks associated with sustainable construction projects are many and varied. The study also indicated that different elements of sustainable construction are associated with different dimensions and magnitudes of risk factors in operationalising sustainability in the building industry. Specifically, the study showed that both high and medium level risk factors are associated with sustainable construction practices. The study further revealed that 23 out of 47 risk factors are high level and critical risk factors, whereas 24 were medium level risk factors. This, therefore, implied that the implementation of sustainable construction practices in Nigeria especially in the study area needs to be cautious. This is because the result indicated that many risk factors are contending with implementation of sustainable construction practices most of which are critical to the success of sustainable construction projects. This result aligned with that of Bahamid, Doh and Al-Sharaf (2019) who identified 111 risk factors with 56 being critical to the success of construction projects in developing countries. The result further implied that the high-level risk factors affecting implementation of sustainable construction practices must be considered, measured and controlled so as to reduce them to an acceptable level before adventuring into sustainable building projects. At the same time, the medium level risk factors have to be tamed to a minimal level of acceptance so as to maximise the full benefit of sustainable construction projects.

However, when the risk level of implementing sustainable construction practices in the study area was compared based on the role of the respondents, the Kruskal-Wallis test statistics result revealed that there is no significance difference in the risk level of the risk factors associated with the implementation of sustainable construction practices based on the respondents' roles. This suggested that the respondents perceived the risks associated with the implementation of sustainable construction practices in the study area as the same regardless of the role they play in the construction project. This result corroborated with Ismael and Shealy (2018) whose result indicated that there were no significant differences in the mean scores for all risk categories in sustainable construction projects between the different titles of the professionals (project manager, site engineer, or architect) in Kuwait. Since all the respondents were professionals in the building industry, the tendency of perceiving any difference in the risk inherent in any construction project is likely to be slim because professionally, they perform near similar roles in the project. The path of their training is also similar, hence the likelihood of non-significance difference in their perception about the risk level in the implementation of sustainable construction practices as indicated by this study. This result is similar to the result of Ribas et al. (2019) who found that different groups in hydroelectric plant construction project have similar risk perceptions, despite having different roles and asymmetric risk sharing caused mainly by the characteristics and provisions contained in the Engineering, Procurement and Construction (EPC) contract. It also agreed with Zou and Couana (2012) whose result suggested that members of green building supply chain invest in green building training and education regarding responsibilities.

CRITICAL RISK FACTORS ASSOCIATED WITH IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION PRACTICES

The study identified 23 critical risk factors associated with the implementation of sustainable construction practices. This study identified seven critical factors relating to knowledge and awareness of sustainable construction, five critical factors relating to cost of sustainable construction projects, and three critical factors relating to sustainable materials and equipment. It also identified five critical factors relating to government policies and regulations for implementation of sustainable construction practices, and three critical factors relating to socioeconomic factors. This result suggested to the importance of sustainable construction knowledge and awareness among the building professionals, operational and suitable regulatory framework, and proper assessment of availability of sustainable construction resources including the prevailing socioeconomic conditions/implications surrounding the implementation of sustainable construction practices. This result is supported by Zhao, Hwang and Gao (2016) who assessed the risk of green projects in Singapore. The high number of critical risk factors suggested that they could be responsible for the low implementation of sustainable construction practices in the execution of building projects in the study area. This implied that those critical risk factors must be considered in the planning and execution of sustainable construction projects. For instance, knowledge and awareness about sustainable construction is a capital issue when it comes to the implementation of sustainable construction practices. At least sustainable construction project involves a huge amount of initial capital outlay and requires sound technical and professional expertise with supporting regulatory frameworks. This result is aligned with the results of Wang et al. (2016), Aghimien, Aigbavboa and Thwala (2019) and Susanti, Filestre and Juliantina (2019).

More significantly, since the critical risk factors were mostly knowledge and awareness related, cost related, policy and regulation related, material and equipment related, and socioeconomic related, it could be argued that the fundamental issues relating to the implementation of sustainable construction practices in the study area have not been adequately addressed; thus, the perception of construction professionals. Implicitly, lack of awareness and knowledge about sustainable construction concepts could be the reason while construction professionals perceived the implementation of sustainable construction practices as risky. This could also be the source of low interest in sustainable construction on the part of the government, professionals and other relevant stakeholders in terms of development of regulatory and policy frameworks. In addition, the perceived high cost and unavailability of materials and equipment, lack of technical experts, and socioeconomic risks could be reason for the low level of implementation of sustainable construction practices. This view is supported by Kibert (2016) and Ismael and Shealy (2018). Consequently, there is need to raise the bar of training and education of building construction professionals and other relevant stakeholders on issues relating to sustainable construction so as to increase their knowledge and awareness.

Furthermore, the significance of all the 47 identified risk factors was centred on the fact that none was a low-level risk factor. This implied that none of these risk factors should be ignored while planning for implementation of sustainable construction practices in the study area. However, a multiple risk control mechanism should be adopted according to the nature and degree of riskiness of each factor. This is in line with the provision of the Risk Assessment Methodology of the University of Melbourne, Australia (2017) which stated that risks are controlled using a combination of control measures and must be implemented in accordance with the risk control priorities established during the risk assessment. Overall, the result suggested that the level of risk associated with the implementation of sustainable construction practices is more related to the rate of likelihood of occurrence than the magnitude of impact, but in any case careful risk assessment must be undertaken before any consideration for embarking on sustainable construction building project.

RATE OF OCCURRENCE AND IMPACT OF RISK FACTORS ASSOCIATED WITH IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION PRACTICES

Although the result revealed that all the identified risk factors were either classified as high or medium level risk factors, the result of the Wilcoxon Signed-rank test showed that there is significant difference between the likelihood of occurrence and magnitude of impact of risks associated with implementation of sustainable construction practices. This implied that the rate of occurrence and magnitude of impact differed across factors. The result also revealed that some factors have high frequency of occurrence, while some others have high severity of impact and vice versa. The result supported Zou and Couana (2012) who found that the risks in green building development vary and are unequally distributed throughout the supply chain. This could be attributed to the differences and multiplicity of sustainable construction practices, in which environmental, social and economic sustainability criteria must be integrated and considered simultaneously. It also gave credence to the fact that risk management in construction industry is multifaceted, and therefore, requires multiple risk management approaches. This is related to the findings of Apine and Valdés (2017) which suggested that different tools should be applied in managing sustainable building projects and supported by El-Sayegh et al. (2018).

Particularly, the top risk factors with high rate of frequency of occurrence (e.g. unavailability of sustainable materials and equipment, more complex and unfamiliar construction techniques and processes, high initial sustainable construction costs, failure to meet sustainable construction certification requirements, and uncertain government policies), and high severity of impact factors (e.g. high initial sustainable construction costs, poor and inefficient communication among project participants, high cost of sustainable materials and equipment, lack of public awareness and knowledge and lack of sustainable technical experts) respectively, suggested that different approaches need to be applied in the management of risks associated with implementation of sustainable construction practices. This finding is in line with that of Hwang et al. (2017) and Ismael and Shealy (2018). However, since this study indicated that the rate of occurrence of the risks factors contributed slightly more than the magnitude of impacts to the overall risk level, it then suggested that more attention should be focused on such factors that contributed mostly to the overall risk level.

Conclusion

The concept of sustainable construction is still new to the Nigerian construction industry. Its level of implementation in the building industry has also been found to be very low due to numerous barriers including the risks associated with it. Therefore, the need for an insight into the risk level of implementing sustainable construction practices in the Nigeria building industry. The study has therefore, assessed the risk level of implementing sustainable construction practices in South-East Nigeria. It has found that the risks associated with the implementation of sustainable construction practices are many and varied. It has further found that these risks have different likelihoods of occurrence and magnitudes of impacts depending on the variability of the risk factors and elements of sustainability. Furthermore, the study established 23 critical risk factors associated with the implementation of sustainable construction practices in study area. Besides, it has succeeded in prioritising the risk levels and risk factors associated with the implementation of sustainable construction practices in South-East Nigeria. It then argued that these factors must not be overlooked when considering the execution of sustainable construction building projects for optimum sustainability performance and benefits.

Specifically, certain factors related to knowledge and awareness, cost, regulatory framework, construction materials and socioeconomic issues call for special attention, while implementing sustainable construction practices. This suggested that sustainable construction concept has not been deeply rooted in the Nigerian building construction industry. Therefore, there is need for more awareness of sustainable construction among building industry stakeholders. This could be done through education and training, collaboration and knowledge sharing, and other communication channels. This also calls for the need for more research into developing new sustainable building materials and making them available and affordable. Furthermore, the need for appropriate regulatory framework and socioeconomic policies that would guide the implementation of sustainable construction practices is of very essence.

Certainly, this study has provided some positive practical implications. Specifically, it has contributed to both practice and research in risk management of sustainable construction projects and Nigeria construction industry in general. Although the study did not evaluate risk management strategies, it has provided valuable information and basis for developing appropriate guidelines for holistic management of risks associated with sustainable construction projects. In view of this, the study craves for the development of multifaceted strategies for curbing or mitigating the risks associated with implementation of sustainable construction practice, especially the high-level risk factors. Since this study has classified and prioritised the risks associated with implementation of sustainable construction practices, it is a useful asset to the construction industry stakeholders especially the clients, construction managers, professionals and contractors who mostly receive the risk impacts in construction projects. The study is also a valuable tool to regulatory agencies, academia in the built environment and building material research agencies.

On the strength of this result, the study recommended for a multi-risk management approach incorporating element of sustainable construction for construction managers since the frequency of risk occurrence and the magnitude of risk severity differ due to the variability of risk factors and elements of sustainability. It also suggested for a special training on issues relating to risks management of sustainable construction projects and awareness of sustainable construction concept among building industry stakeholders. Finally, it recommended for the development of appropriate regulatory framework for management of sustainable construction projects and intensified efforts towards developing new sustainable and affordable building materials through building material research institutes like Nigerian Building and Road Research Institute (NBRRI).

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