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RESEARCH ARTICLE

Green-site Practices and Environmental Performance: How Project Complexity Moderates the Relationship

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Abstract

The characteristics of a project that make it hard to understand, predict, and manage its general behaviour despite the availability of required information relating to the project dynamics is referred to as project complexity. Good knowledge of project complexity at the construction phase of a project, as well as a well-developed plan to manage complexity will determine how proficiently construction projects are planned, managed, and executed in an environmentally friendly manner. The level of complexity of construction projects, to a large extent, determines the performance or otherwise of the projects with regards to achieving specific environmental standards. At construction sites, the effects of adopting green-site practices on environmental performance, are largely dependent on the level of complexity inherent in the project's construction processes. This study investigates the moderating effects of project complexity on the relationship between various green construction site practices and environmental performance of construction projects. A survey was conducted on class A contractors in Nigeria and 168 usable responses were received. The data were analysed using the partial least squares structural equation modelling technique. The results show that project complexity moderates the relationship between waste management and environmental

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performance, and the relationship between materials management and environmental performance. But project complexity does not moderate the relationship between energy management and environmental performance. The study provides important theoretical and practical information for construction managers in understanding the dynamics involved in managing projects with different degrees of complexity while adopting certain green-site practices with the aim of delivering projects with a high degree of environmental performance.

Keywords

Waste management; Materials management; Energy management; Environmental performance; Project complexity; Green-site practices.

Introduction

There have been efforts made over time by construction organizations to ensure their activities are carried out in a manner that is not harmful to the natural environment. These efforts are mostly borne out of a desire to preserve the natural environment, or in a bid to meet the minimum acceptable standards of environmental performance, as spelt out in both local and international regulations (Mwelu et al., 2018). The efforts of these construction organizations have yielded mixed results. Some organizations were able to achieve high environmental performance in some projects and low environmental performance in others. The mixed results achieved with regard to environmental performance have been attributed to differing degrees of complexity in construction projects and the application of the same approach by construction managers in managing them (He et al., 2015). In its simplest term, project complexity refers to the multi-dimension of project characteristics that exhibit uncertainties, risks and difficulties in understanding, planning, managing, operating, monitoring and controlling of projects (Hartono, Wijaya and Arini, 2019; Nguyen et al., 2019). The limited attention given to the complexity of projects and the lack of understanding of the concept of "project complexity" prior to its execution has therefore hindered the ability of contractors to construct projects with high degrees of environmental performance. The understanding of project complexity and its effects on environmental performance by scholars and stakeholders in the construction industry is shallow (Dao et al., 2016). It is therefore imperative that every participant in a project should be able to comprehend, what project complexity is and be able to ascertain the degree of effects it has on the environmental performance of projects, taking into account various site practices to be adopted. As such, project complexity needs to be studied to guarantee the environmental performance of construction projects.

Luo et al. (2017) opined that construction projects have complexity in its nature since it is associated with many factors such as quality, safety, and resource management. The rising complexities in the management of construction projects around the globe have led to increase in research on project complexity in the past 20 years (Luo et al., 2017). Based on Project Management Institute (PMI) understanding of complexity, they opined that ultimately how organizations prepare for, understand, and navigate complexity determines the performance or otherwise of their projects (PMI, 2013). This implies that it is now necessary to understand project complexity if a project is to be successfully managed. The speed with which most towns and cities in Nigeria are becoming urbanized has resulted in the emergence of construction projects with varying degrees of complexity. This is so even as huge financial investments are been made, running into billions of naira in the provision of houses and other infrastructure

(Mudi, Lowe and Manase, 2015). Good comprehension and analysis of the effects of project complexity is necessary to guarantee sound project management (Luo et al., 2017).

The absence or shortage of the requisite knowledge by project managers on the interacting role project complexity plays in the adoption of green-site practices such as waste management, construction materials management and energy management affects the outcome of environmental performance (Kennedy, McComb and Vozdolska, 2011). The overall aim of project managers and site managers is to achieve performance, be it economic, environmental, health and safety, or other factors. The choice of site practice is strongly linked with the performance outcome intended, and it is determined in the planning, design and construction phases of projects (Loganathan, Forsythe and Kalidindi, 2018; Parfitt and Sanvido, 1993). It is noteworthy that not all the relationships between green-site practices (waste management, construction materials management and energy management) and environmental performance may be influenced by project complexity. However, it is important that project managers get acquainted with the role project complexity plays in the relationship between various aspects of green-site practices and environmental performance of their projects.

In the Nigerian context, due to the need to protect the environment, the federal government of Nigeria created the Federal Environment Protection Agency (FEPA) in 1988. FEPA is responsible for producing environmental guidelines and minimum acceptable environmental performance standards (FEPA, 1991). This is with respect to air quality, water quality, discharge and control of hazardous substances, and waste management. Other environmental laws and standards in Nigeria were subsequently enacted to protect the environment. These laws and standards include National Policy on the Environment in 1989, Environmental Impact Assessment Act (EIA Act) 1992, National Environmental Standards and Regulations Enforcement Agency (Establishment) Act 2007 and National Building Energy Efficiency Code 2017. Environmental laws in Nigeria are enforced and administered by the Federal Ministry of Environment directly and through its complementary agencies.

Assessing the effect of project complexity on specific projects, in relation to the green-site practices adopted, can be a source of reference for top management and other professionals involved in site operations. Botchkarev and Finnigan (2015) believe complexity in construction projects is linked to structural and dynamic factors and the interface of these factors across the extensive categories of technical, organizational and environmental domains. Project complexity has been largely studied in several literatures due to its role in the non-performance of projects with regard to cost and time overruns (Qazi et al., 2016). Even though past studies and construction industry stakeholders have come to a consensus that project complexity may most likely result in the poor general performance of construction projects, very little empirical evidence is provided to support this claim. Also, past research hasn't singled out environmental performance for analysis with project complexity. This study aims to bridge this gap by empirically investigating the effects of project complexity on the relationship between construction waste management, energy management, construction materials management and environmental performance.

The significance of this study lies in the fact that it helps project managers and other professionals in the construction industry in Nigeria better understand the role project complexity plays in attaining environmental performance when various environmentally friendly practices are been adopted on site. This study will also assist construction stakeholders in decision-making based on the varying complexities and peculiarities of their projects. Lastly, the study is significant in the sense that it will assist government agencies in policy formulation, taking into consideration different scenarios of project complexity, since it is practically impossible for a single criterion to be applicable in all situations.

Project Complexity and its Moderating Role

Construction projects that are characterized by elements of high uncertainty and interdependent units can be referred to as complex projects (Sridarran, Keraminiyage and Herszon, 2017). They further opined that a project referred to as large size (that is, spanning over several years, or involving billions of dollars) does not necessarily imply that it is complex - it may just be resource intensive. But many researchers have discovered that there is a positive correlation between project size and the extent of project complexity (Patanakul et al., 2016). Some construction projects may be accomplished or delivered within a shorter duration or low budget but still be complex. The degree of sophistication required in a project may lead to it being categorized as complex (Cho, Hong and Hyun, 2009). Magent et al. (2009) opined that the quest for a highly environmentally sustainable construction process usually comes with an increase in the extent of complexity of the construction project and increase in the level with which professionals of different trades interact while carrying out the different aspects of the construction process. Project complexity undoubtedly is a very important factor in construction project management and project performance as it brings forth extra hindrances in the quest for achieving project objectives (Dao et al., 2016).

Dao et al. (2016) stated that complexity is frequently used interchangeably with two concepts: project difficulty and project risk. Complex projects focus on obstacles that make realizing the objectives of the project difficult. On the other hand, project complexity focuses on uncertainties associated with unknowns and unpredictable actions (Kermanshachi et al., 2016). Xia and Chan (2012) identified six key measures of project complexity, namely building structure and function, construction method, the urgency of the project schedule, project size/scale, geological condition, and neighbouring environment. Construction projects in Nigeria are characterized by different degrees of complexity, but the level of complexity is on the rise (Ogunde et al., 2017). The rise in complexity has been attributed partly to increased urbanization, increased construction task dependencies, and limited land available to meet the housing and infrastructure needs of the ever-growing urban population.

Additionally, project complexity can be classified into different types. He et al. (2015) classified complexity into technological complexity, organizational complexity, goal complexity, environmental complexity, and cultural complexity while Lu et al. (2015) categorized project complexity into organizational and task complexity. Also, Nguyen et al. (2015) identified the types of project complexity as organizational complexity, technological, socio-political complexity, environmental complexity, infrastructural complexity, and scope complexity. In all, the various studies conducted on the complexity of construction projects are unanimous in agreeing that project complexity influences performance (Luo et al., 2016). That notwithstanding, very little empirical evidence is available regarding the effect of project complexity on the relationship between green-site practices and environmental performance.

The above discussion points out the possible moderating effects of project complexity on the relationship between green construction site practices and environmental performance of construction projects. Moderating role refers to the changes brought about by a third variable (moderator) in the relationship between the independent variable and the dependent variable (Ramayah et al., 2018). The performance or otherwise of a construction project delivery process is determined by the manner in which site activities are carried out (Bekale Mba and

Agumba, 2018). In addition, the ease or difficulty with which these activities are carried out is determined by the level of complexity, be it high or low complexity. In the presence of high complexity, construction projects are very difficult to manage, but the reverse is the case with low complexity projects (Liu, 2015). Project complexity obviously plays a moderating role in achieving project performance, be it schedule performance, health and safety performance, or environmental performance (Yang, Huang and Wu, 2011). Yang, Huang and Wu (2011) further affirmed that project complexity moderates the relationship between project activities and the ability of the projects to be successful.

With reference to this current study, it is believed that the nature of the relationship between each of the green-site practices studied and the environmental performance will differ (in strength or direction) depending on the level of complexity (low or high) in the projects. Next, the development of each hypothesis will be discussed.

Hypothesis Development

Environmental performance of a project can be defined as the outcome of construction projects' planned activities aimed at managing the environmental effects of construction site processes (Walls, Berrone and Phan, 2012). This could be achieved through compliance with relevant standards and engaging in certain environmentally friendly practices. Additionally, green construction site practices entail the construction of buildings and infrastructure using best practices, environmentally sustainable, and resource-efficient measures from the sourcing of construction materials to the end of the entire construction process (Hand et al., 2015; Siew, Balatbat and Carmichael, 2013). Examples of some of the green construction site practices, as contained in various green building rating tools and literature are waste management, energy management, construction materials management, stormwater management, transportation management, noise prevention, visual/dust management, and site layout planning and development. However, the dominant green practices in Nigeria are waste management, construction materials management and energy management (Atanda and Olukoya, 2019). All construction projects in Nigeria are mandated (by the various environmental laws) to comply with these green practices during the construction process. Therefore, the green-site practices considered in this study are waste management, material management and energy management.

The process of managing these site practices in construction projects is a complex one which demands systematic reasoning and analysis (Ding et al., 2016). Recently, there has been an increase in complexity experienced in the management of these green practices due to the involvement of many stakeholders and new technologies, and because it is also composed of many components (Ding et al., 2018). Also, the size of construction projects is becoming larger, involving higher cost and more construction activities and thereby increasing the complexity of projects (Garg and Rajput, 2017). Several researchers have revealed that the complexity of construction projects influences its environmental performance (Luo et al., 2016). The larger and more complex projects (the more suppliers, project stakeholders, site workers, engineers and activities inherent in the project) the more the likelihood of failure (Collins, Parrish and Gibson, 2017; Luo et al., 2016), subsequently highlighting the moderating effects of project complexity. In other words, green construction site practices, when implemented in a construction project (with diverse suppliers, project stakeholders, site workers, engineers, and activities) further poses the challenge of achieving projects' environmental performances.

Construction waste management is a term used to refer to waste generated during construction, renovation and demolition activities (Ajayi et al., 2016; Bhardwaj, 2016). Waste management entails eliminating waste where possible, reducing waste where feasible and reusing construction materials which ordinarily would be considered as waste (Nandhinipriya, Janagan and Soundhirarajan, 2016). A typical example of complexity is in the case of waste management where there are separate teams responsible for waste sorting and others for the recycling plant, and all these teams are interdependent (Fortunato et al., 2012). This induces some level of complexity into the already complex construction project. As highlighted earlier, projects with high complexity have a higher likelihood of failure compared with those with low complexity. Thus, it can be said that the level of project complexity influences the environmental performance of green construction projects. Therefore, the following hypothesis generated;

> **H1:** The effect of construction waste management practices on environmental performance is moderated by project complexity.

Material management refers to the planning, selection, storage, identification, procurement, reception and distribution of construction materials in a sustainable and energy efficient manner (Gulghane and Khandve, 2015; Sandanayake et al., 2016). These activities require the efforts of multiple stakeholders and workers from different professional backgrounds such as suppliers, storekeepers, quantity surveyors and so on. This makes the project complex since their jobs are interdependent. The number of these stakeholders present in the project for managing construction materials determines the level of complexity in the project and also affects the ease with which environmental performance can be achieved. Also, the number of these stakeholders present in a project is a function of the project size which in this study is used as a proxy for measuring complexity as suggested by Franz and Messner (2019). Therefore, we hypothesize as follows:

> **H2:** The effect of materials management practices on environmental performance is moderated by project complexity.

Energy management refers to all activities and processes involved in ensuring energy utilized on site is obtained from sustainable sources, and that energy is utilized in an efficient manner during the entire construction process. Also, energy management involves curtailing the wasteful use of electricity where practicable, and efficiency in the use of machinery and equipment during construction site activities and processes that require transportation of materials and wastes, erection of buildings and general infrastructure on construction sites (Xiong and Liu, 2012). Typically, the services of an electrician, services engineer and other professionals in the construction industry are required (Fortunato et al., 2012). For energy to be managed sustainably, there needs to be synergy between these professionals from different backgrounds. In small projects which are typically low in complexity due to very little task interdependencies, it is easier to manage these professionals, than it is in large and highly complex projects. As such, the following hypothesis is generated:

> **H3:** The effect of energy management practices on environmental performance is moderated by project complexity.

These hypotheses are represented by the model in Figure 1.

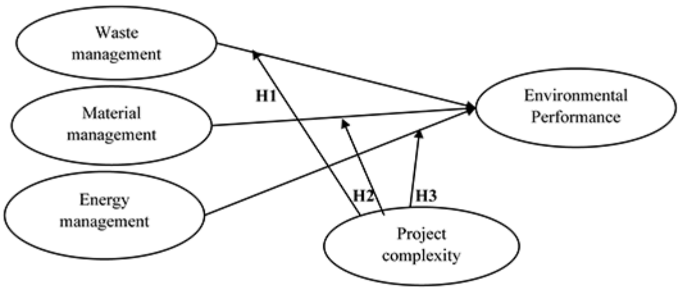

Figure 1 Model showing Research Hypotheses

Research method

DEVELOPMENT OF RESEARCH INSTRUMENT

This study is quantitative in nature and a questionnaire was utilized for collecting data. The choice of quantitative methods in this study is because it uses numerical values with the aim of inferring, explaining, and predicting the constructs in the study and the research findings, to form generalisations (Mills and Gay, 2016). The questionnaire items were adapted from questionnaires used in past research that are similar to this study. The items measured in this study are presented in table 1 below.

Table 1 Items Measured and Source

Waste Management (WM)	Source
Recycling construction site materials & demolition debris (WM1)	Ajayi et al. (2016)
Reuse of construction materials (WM2)	Ajayi et al. (2016) and Bhardwaj (2016)
Reduction in amount of waste generated on site (WM3)	Bhardwaj (2016)
Off-site production of building elements (WM4)	Ajayi et al. (2016)
Adopting a just-in-time delivery strategy (WM5)	Ajayi et al. (2016)
Material Management (MM)	
Sourcing construction materials locally (MM1)	Sandanayake et al. (2016)
Specifying low environmental impact materials (MM2)	Sandanayake et al. (2016)
Use of renewable construction materials (MM3)	Sandanayake et al. (2016) and Sinha, Gupta and Kutnar (2013)
Use of recyclable materials (MM4)	Sinha, Gupta and Kutnar (2013)

Table 1 continued

Waste Management (WM)	Source
Energy Management (EM)	
Saved energy by improving construction processes (EM1)	Collins, Parrish and Gibson (2017)
Use of renewable energy (EM2)	Collins, Parrish and Gibson (2017)
Use of energy efficient lamps and appliances (EM3)	Collins, Parrish and Gibson (2017)
Use of electricity control systems (EM4).	Collins, Parrish and Gibson (2017)
Environmental Performance (EP)	
Conformed with environmental laws (EP1)	Yusof, Awang and Iranmanesh (2017)
The project had low adverse effect on the environment (EP2)	Yusof, Awang and Iranmanesh (2017)
Very low depletion of non-renewable resources (EP3)	Yusof, Awang and Iranmanesh (2017)
Reduction in energy consumption (EP4)	Yusof, Awang and Iranmanesh (2017)

Waste management was measured using five items adopted from Ajayi et al. (2016) and Bhardwaj (2016), materials management was measured using four items from Sandanayake et al. (2016) and Sinha, Gupta and Kutnar (2013), energy management was measured using four items from Collins, Parrish and Gibson (2017), while environmental performance was measured using four items adopted from Yusof, Awang and Iranmanesh (2017). The options for answers to the questionnaire items were graded on a 5-point Likert scale for the three latent variables (waste management practices, materials management practices, energy management practices) that were conceptualized as independent variables. Scale 1 refers to very low extent of practice while 5 represents very high extent of adopting these green-site practices. On the other hand, the dependent variable (environmental performance) was measured on a 7-point Likert scale with scale 1 meaning strongly disagree and scale 7 referring to strongly agree. An additional question is asked for each of the latent variables to collect data for the "global" item as recommended by Hair et al. (2017). The "global item" is an overall response to the questions in a latent variable. This is a requirement in redundancy analysis for formative measurements. The use of different Likert scales (5-point for independent variables and 7-points for dependent variables) is meant to reduce the occurrence of single source bias since all the data will be obtained from a single respondent. Item ambiguity was also taken care of through the pilot tests conducted (Jakobsen and Jensen, 2015; Podsakoff et al., 2003). For project complexity, which is the moderator in this study, the respondents were simply asked to answer if the project they supervised has either "high" or "low" complexity.

Complexity is difficult to operationalize in quantitative studies (Franz and Messner, 2019). As such, most studies choose either building use or project unit cost as a proxy to measure project complexity. This study adopted the unit cost method as recommended by Franz and Messner (2019). Project unit cost is an estimation of the overall cost per gross squaremeter area of a building, where the overall cost refers to the summation of the cost of design and construction contract awards, based on the assumption that construction projects with comparable unit costs will have similar levels of complexity (Franz and Messner, 2019). Since the questionnaires were self-administered, every respondent was briefed prior to completing the questionnaire on what constitutes complexity in projects, the different levels of complexity, and the link each has with green-site practices, so that they had a good understanding of what was intended to be measured.

Prior to data collection, a pilot survey was conducted where project managers, site managers, and lecturers in the field of construction management and project management in Nigeria were consulted. This was done for the purpose of content and construct validity. From the results of the pilot survey, a few items were removed, some wordings in parts of the questions were reworded and some sentences were reversed in the final draft of the questionnaire. The constructs examined in this research were all formative. The questionnaire was prepared in English, which is the official language in Nigeria.

METHOD OF DATA COLLECTION

The data for this research was collected face-to-face through a survey conducted within a period of five months. The survey method is most suitable since it is best in ascertaining the extent or impact of constant and stable types of behaviour. Two hundred and six questionnaires were distributed, and 168 usable responses were received. The "inverse square root" method suggested by Kock and Hadaya (2018) was adopted to determine the sample size for the study. The inverse square root method proposed a minimum sample size of 160 samples. Therefore, the 168 valid responses collected for this study is adequate.

DATA ANALYSIS APPROACH

In testing the various hypotheses of this study, multiple regression was undertaken using the partial least squares structural equation modelling (PLS-SEM) technique with the WarpPLS 6.0 software. The choice of the PLS-SEM technique is because it has the ability of optimizing predictions through explained variances and test theoretical relationships between variables in a model. WarpPLS software takes into account non-linear functions linking a couple of latent variables in SEM models and calculates multivariate coefficients of interactions accordingly (Kock, 2017a). In estimating the measurement model, "factor-based PLS algorithm" was used and the "Stable 3" method was used for the P-values calculation as recommended by Kock (2017b). Kock (2015) opined that the factor-based PLS algorithm generates estimates of both true composites and factors, and totally accounts for measurement error. The Warp 3 algorithm contained on the WarpPLS 6.0 inner model testing was used to analyse the structural model. This estimates parameters like the path coefficient and associated p-values by way of identifying and taking into account relationships that are nonlinear in the model (Kock, 2011). For the moderator analysis, the inner model analysis algorithm is set to 'linear' because the nonlinearity intrinsic in moderation is taken care of by the nonlinear algorithm selected, which in many instances causes the moderation effect to be insignificant (Kock and Gaskins, 2016).

Data analysis, results and discussion

RESPONDENTS PROFILE

Table 2 shows that 10.7% of the respondents had an Ordinary National Diploma as their highest qualification, 16.1% were Higher National Diploma (HND) holders, 26.2% had a bachelor's degree, 12.5% had postgraduate diploma (PGD), 29.2% had a Master's degree (MSc) and 5.4% possessed a doctorate degree (Ph.D.). This indicates that the respondents are well educated and possessed the requisite knowledge to respond to the questions as contained in the questionnaire.

Table 2 Demographic Profile

Characteristics	Categories	Frequency	Percentage (%)
	Ordinary National Diploma	18	10.7
	Higher National Diploma (HND)	27	16.1
Academic Qualification	Bachelor's Degree (BSc)	44	26.2
	Postgraduate Diploma (PGD)	21	12.5
	Master's degree (MSc)	49	29.2
	Doctorate Degree (Ph.D.)	9	5.4
	0-5	19	11.3
	6-10	31	18.5
Years of working experience	11-15	48	28.6
	16-20	42	25.0
	Over 20	28	16.7
	Construction project manager	47	28.0
Job Designation	General manager	15	8.9
	Site manager	81	48.2
	Senior manager	25	14.9
	0-9	10	6.0
Number of Company Employees	10-99	45	26.8
	100-200	49	29.2
	Over 200	61	36.3

Also, in terms of working experience, 11.3% had 0-5years working experience, 18.5%(6-10years), 28.6% (11-15), 25.0% had 16-20years working experience, and 16.7% (over 20years). Most of the respondents were site managers who constituted 48.2% of the total study population, followed by project managers who constituted 28.0% of the respondents, senior managers, and general managers were 3rd and 4th respectively in the number of respondents in this study with percentages of 14.9% and 8.9% in that order. Most of the contracting organizations considered for this study had over 200 employees which are 36.3% of the entire respondents, followed by 100-200 employees (29.2%), 10-99 employees (26.8%) and 0-9 employees (6%).

ASSESSMENT OF THE MEASUREMENT MODEL

All the latent variables in this study were measured as formative. In assessing the measurement model for formative constructs, convergent validity, indicator collinearity, and statistical significance and relevance of the indicator weights were assessed. Convergent validity for formative models is obtained using redundancy analysis as advocated by Chin (1998). The formative construct for waste management produced a path coefficient of 0.721, material management had a path coefficient of 0.812, energy management yielded a path confident of 0.801, while environmental performance had a path coefficient of 0.765 as shown in table 3, when the redundancy test was conducted for each of them with their respective global items. The values of path coefficient obtained after the redundancy tests yielded values that exceed the 0.70 thresholds recommended by Klassen and Whybark (1999). This suggests that the convergent validity of the various latent variables are adequate. Collinearity between the various indicators in the model also needs to be examined by assessing the VIF values. Kock (2014) suggested that for formative latent variable's measurement, the VIF values should not be above 3.3. From the results presented in table 3, none of the VIF values obtained for the indicators exceeds the 3.3 thresholds. This indicates that collinearity is not an issue in this model. Lastly, in assessing the measurement model, the significance and relevance of outer weights were examined.

Table 3 Assessment of Results of the Measurement Model

Construct	Convergent Validity	Weights	VIF	P-value
Waste Management (WM)	0.721			
Recycling construction site materials & demolition debris (WM1)		0.467	1.499	<0.001
Reuse of construction materials (WM2)		0.203	1.511	<0.003
Reduction in amount of waste generated on site (WM3)		0.237	2.597	<0.001
Off-site production of building elements (WM4)		0.170	1.464	0.012
Adopting a just-in-time delivery strategy (WM5)		0.088	1.490	0.124
Material Management (MM)	0.812			
Sourcing construction materials locally (MM1)		0.181	1.145	0.008

Table 3 continued

Construct	Convergent Validity	Weights	VIF	P-value
Specifying low environmental impact materials (MM2)		0.207	1.225	0.003
Use of renewable construction materials (MM3)		-0.031	1.463	0.344
Use of recyclable materials (MM4)		0.433	1.766	<0.001
Energy Management (EM)	0.801			
Saved energy by improving construction processes (EM1)		0.223	1.294	0.001
Use of renewable energy (EM2)		-0.198	1.745	0.004
Use of energy efficient lamps and appliances (EM3)		0.044	1.280	0.281
Use of electricity control systems (EM4).		0.381	1.199	<0.001
Environmental Performance (EP)	0.765			
Conformed with environmental laws (EP1)		0.290	1.109	<0.001
The project had low adverse effect on the environment (EP2)		0.079	1.058	0.150
Very low depletion of non-renewable resources (EP3)		0.123	1.156	0.052
Reduction in energy consumption (EP4)		0.222	1.207	0.002

The results as presented in Table 3 shows that all indicator weights are significant with the exception of WM5, MM3, EM3, EP2, and EP3. Figure 2 shows the structural model results prior to the introduction of the moderator. Hair et al. (2017) recommends that if the indicator weights are not significant, the decision to keep or delete the indicator is dependent on the value of its outer loading. The outer loading should be higher than 0.5 for the indicator to be retained. The outer loadings for WM5, MM3, EM3, EP2, and EP3 are 0.546, 0.880, 0.876, 0.928 and 0.671 respectively. All the indicators are retained since the values of their outer loadings are all > 0.5.

ASSESSMENT OF THE STRUCTURAL MODEL

In assessing the structural model in PLS-SEM, six steps need to be taken (Ramayah et al., 2018). These six steps according to Hair et al. (2017) are; Assessment of Structural model for collinearity issues, assessment of the significance and relevance of the structural model relationships, assessment of the level of R^2, assessment of the Effect size (*f2)*, and assessment of predictive relevance Q^2.

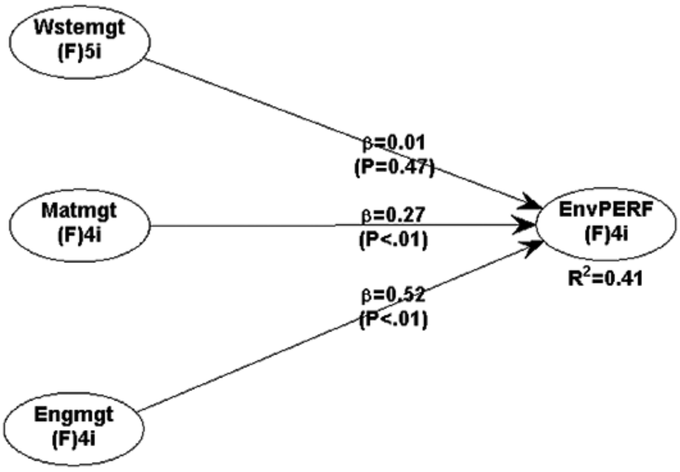

Figure 2 Structural model results (without moderating variable)

Figure 2 shows the results of the structural model excluding the interaction effect of the moderator (project complexity). While figure 3 presents the structural model results when the moderator is introduced.

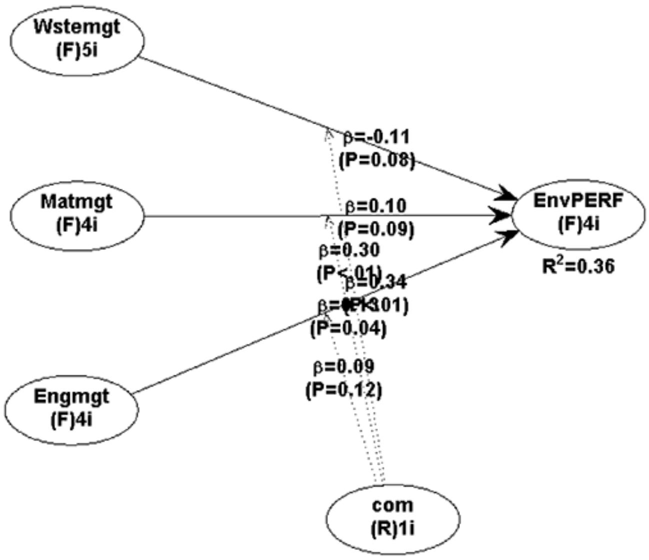

Figure 3 Structural model results with moderation effect

All the path coefficients are positive and statistically significant ($p < 0.05$) except for waste management ($p > 0.05$). In the absence of the moderator (project complexity), the explained variance (R^2) is 0.41 and the Stone-Geisser Q^2 is 0.214, while in the presence of the moderator, the R^2 is 0.36 and the Stone-Geise Q^2 is 0.378. R^2 values of 0.19, 0.33 and 0.67 can be interpreted to be weak, moderate and substantial (Chin, 1998) and the Stone-Geisser Q^2 value of larger than zero is desirable (Ramayah et al., 2018). Thus, the R^2 and Stone-Geisser Q^2 in the two models are within the acceptable limit. It is noticeable from the comparison of the two models (with and without moderating effects), that there is a decline in the explained variance (R^2) by 5% (from 0.41 to 0.36) and an increase in predictive relevance of the model by 16.4% (from 0.214 to 0.378) with the introduction of the moderator. This implies the presence of a moderating effect. The path coefficient and hypotheses will be examined subsequently. Table 4 presents the results obtained for hypotheses testing.

Table 4 Result of Hypothesis Testing

Hypothesis	Relationship	Path Coefficient(β)	P-value	Effect Size	Decision
H1	WM*com → EP	0.303	<0.001	0.122	Supported
H2	MM*com → EP	0.131	0.041	0.057	Supported
H3	EM*com → EP	0.091	0.116	0.022	Not Supported

(WM =Waste Management, com = project complexity, MM = Materials management, EM = Energy management, EP = Environmental performance)

The results as presented in table 4 shows that H1 ($\beta = 0.303$, $P < 0.001$) which is the effect of project complexity on the relationship between waste management practices and environmental performance is significant with an effect size of 0.122. Therefore, hypothesis 1 is accepted. This indicates that project complexity has a large effect on the relationship by virtue of its effect size > 0.025 according to Kenny (2016) rules. The nature of this relationship across both high and low complexity projects is shown in figure 4.

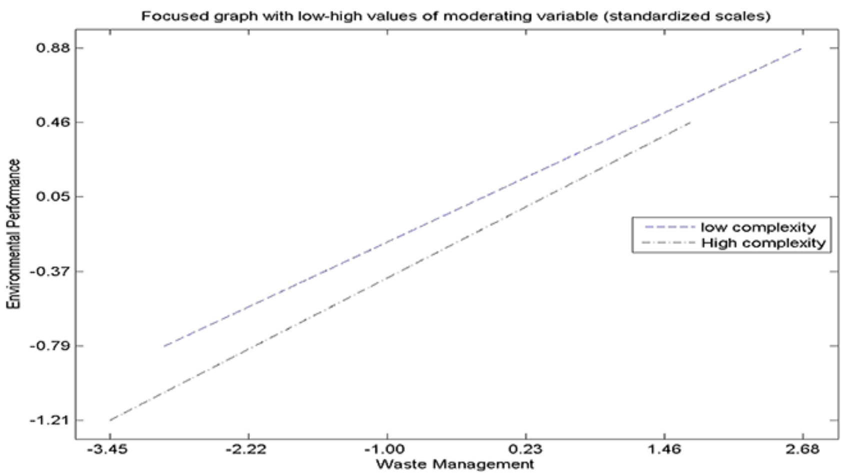

Figure 4 Moderating effect of project complexity on the relationship between waste management and environmental performance

From figure 4, it is observed that the adoption of waste management practice leads to increased environmental performance in both high and low complexity projects. Be that as it may, environmental performance is higher in projects with low complexity. From the findings of past studies, high complexity leads to poor project performance (Luo et al., 2016). According to them, the studies they referred to treated project performance as a whole and not the individual components of project performance. In the present study, it was revealed that the high complexity of construction projects leads to high environmental performance of projects executed by adopting waste management practices. When waste management practices are been adopted, it requires the engagement of other professionals for that purpose, it also involves a lot of interdependent tasks and also the application of technology. This leads to a situation where there is an increase in complexity with regards to managing the workforce and also technological complexity since waste management at times requires sophisticated technology. This could be the possible reason why environmental performance increases with increased project complexity.

The second hypothesis (H2) is also supported since there is a significant positive effect of project complexity on the relationship between materials management practices and environmental performance ($\beta = 0.131$, $P = 0.041$). The effect size of the moderating effect is 0.057 which is > 0.025, indicative of large effect size. This can be interpreted as project complexity having a large effect on the relationship between materials management practices and environmental performance. The nature of this relationship across both high and low complexity projects is shown in figure 5. It shows that low complexity projects that adopt material management practices on site perform considerably better compared to characteristically high complexity projects. However, from figure 5, it is observed that when the extent of adoption of materials management practices reaches its peak, they tend to be convergence for both lines of the graphs for high and low complexity. This implies that if the rate of the practice of materials management is very high, there is likely to be a point where there will be no difference in the environmental performance outcome. Put differently, there will be a point where the environmental performance will be the same for both highly complex and low complexity projects if the rate of adoption of materials management is at its peak.

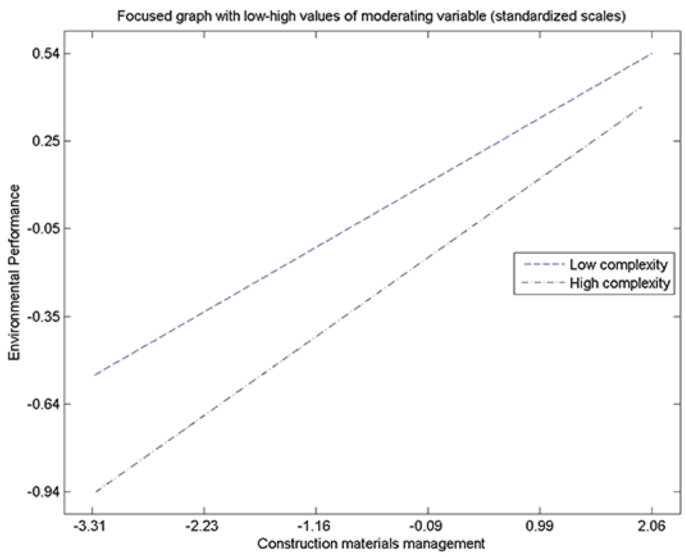

Figure 5 Effect of project complexity on the relationship between construction materials management and environmental performance

The third hypothesis (H3), is rejected since it has an insignificant p-value of 0.116 ($p > 0.05$). Its associated path coefficient is 0.091. As such, there is no need for further discussions on it due to its insignificance.

The results obtained show that project complexity moderates the relationship between waste management and environmental performance, and also moderates the relationship between material management and environmental performance. This conforms to the results of the study by Luo et al. (2016) who opined that project complexity undoubtedly determines whether or not a project meets certain minimum environmental performance thresholds. Also, Dao et al. (2016) acknowledged the importance of project complexity in various construction project management activities and its role in the attainment of project performance. They affirmed that the complexity of projects plays a moderating role in relationships between site practice and performance outcomes as also evidenced in the results of this study.

The reasons for such findings in this study are not far-fetched since construction processes and site practices are enormously susceptible to constant changes, they are unique and flexible (Bajjou, Chafi and En-Nadi, 2017). This is so because each project has peculiar tasks which require diverse construction methods with fluctuating requirements which determines the level of complexity inherent in the project. In the case of waste management, the management process involves activities such as waste sorting, recycling and so on. This requires several processes and the involvement of many participants from different areas of specialization. The involvement of several participants and processes in itself results in the complexity of the waste management process and this can negatively affect the environmental performance of the project if not properly managed. The same scenario is applicable to materials management. A construction project has various suppliers providing different construction materials at varying times, these materials have to be stored differently depending on their characteristics. The management of these categories of project participants and the storage of these materials introduces some complexity in the project which impacts its environmental performance if not managed well. This differs from one project to another. The adaptive capacity of construction managers to manage changes in the project, and manage the various stakeholders involved in the project, is essential in managing project complexity (Giezen, Bertolini and Salet, 2015). Brady and Davies (2014) also acknowledged that the capacity of project stakeholders to adapt and respond to varying structural and dynamic project conditions is one of the ways to effectively manage complexity. The level of complexity can be included in project planning, taking into consideration the weather and site conditions, and management capability of the project participants. Therefore, the highpoint of the study findings is the importance of tailoring project management practices to the level of project complexity at hand.

Conclusion

It has been observed in this study that the level of complexity of construction projects is a very important factor to be considered in the decision to adopt environmentally friendly practices such as waste management and construction materials management. Project complexity also shapes the level of environmental performance of the project. Construction managers and project managers need to take into account, and study the impact of project complexity, before attempting to adopt any of the green practices on site. Failure to do this could negatively impact the expected environmental performance outcome of their projects. It should be noted that the mode of adoption of these practices should be dependent on the peculiarities of the individual projects since no two projects share the same level of organizational, goal, and technological characteristics which are the major sources of complexities in construction projects.

This study has both practical and theoretical implications for construction industry professionals. The findings of this study will assist site managers, project managers and other professionals at the top management level of construction firms to better plan and manage projects to achieve environmental performance and other desirable performance outcomes for their projects. The study also contributes to the body of existing knowledge by elaborating on the various interacting effects of variables in the quest to achieve sustainability on the construction site. Good knowledge of complexity is very important to contactors, project managers and site managers in Nigeria due to the variances connected with the decision-making processes that are linked to complex construction projects. Also, as soon as project complexity is well understood by project stakeholders, it should be explored during the planning stages of projects so as to better fit in green-site practices with different levels of project complexity, as is the case in Nigeria, with a view to improving project environmental performance.

Limitations of the study and suggestions for future research

This research covers only projects executed by class A contractors in Nigeria, and is limited to three green construction site practices. It is suggested that further research be conducted on projects executed by classes of contractors other than class A to ascertain if similar results will be obtained. Also, further research should be conducted on the same dependent and independent variables but with a different moderating variable to see the effects on the relationship. Furthermore, other green-site practices can be tested to ascertain if they will have similar effects on environmental performance taking into consideration project complexity. Finally, similar studies can also be conducted in other developing countries around the world for the purpose of comparing the results with those obtained in Nigeria.

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References

Ajayi, S.O., Oyedele, L.O., Akinade, O.O., Bilal, M., Owolabi, H.A., Alaka, H.A. and Kadiri, K.O., 2016. Reducing waste to landfill: A need for cultural change in the UK construction industry. *Journal of Building Engineering*, 5, pp.185-93. https://doi.org/10.1016/j.jobe.2015.12.007

Atanda, J.O. and Olukoya, O.A., 2019. Green building standards: Opportunities for Nigeria. *Journal of Cleaner Production*, 227, pp.366-77. https://doi.org/10.1016/j.jclepro.2019.04.189

Bajjou, M.S., Chafi, A. and En-Nadi, A., 2017: Trans Tech Publ.

Bekale Mba, M.F. and Agumba, J.N., 2018. Critical success factors influencing performance outcome of joint venture construction projects in South Africa: Comparison of first and second order models. *Construction Economics and Building*, 18(3), p.74. https://doi.org/10.5130/ajceb.v18i3.5885

Bhardwaj, B.R., 2016. Role of green policy on sustainable supply chain management: A model for implementing corporate social responsibility (CSR). *Benchmarking: An International Journal*, 23(2), pp.456-68.

Botchkarev, A. and Finnigan, P., 2015. Complexity in the context of information systems project management. *Organisational Project Management*, 2(1), pp.15-34. https://doi.org/10.5130/opm.v2i1.4272

Brady, T. and Davies, A., 2014. Managing structural and dynamic complexity: A tale of two projects. *Project Management Journal*, 45(4), pp.21-38. https://doi.org/10.1002/pmj.21434

Chin, W.W., 1998. The partial least squares approach to structural equation modeling. *Modern methods for business research*, 295(2), pp.295-336.

Cho, K., Hong, T. and Hyun, C., 2009. Effect of project characteristics on project performance in construction projects based on structural equation model. *Expert Systems With Applications*, 36(7), pp.10461-70. https://doi.org/10.1016/j.eswa.2009.01.032

Collins, W., Parrish, K. and Gibson, G.E., 2017. Development of a project scope definition and assessment tool for small industrial construction projects. *Journal of Management in Engineering*, 33(4), p.04017015. https://doi.org/10.1061/(asce)me.1943-5479.0000514

Dao, B., Kermanshachi, S., Shane, J., Anderson, S. and Hare, E., 2016. Exploring and Assessing Project Complexity. *Journal of Construction Engineering and Management*, 143(5), p.04016126. https://doi.org/10.1061/(asce)co.1943-7862.0001275

Ding, Z., Yi, G., Tam, V.W. and Huang, T., 2016. A system dynamics-based environmental performance simulation of construction waste reduction management in China. *Waste Management*, 51, pp.130-41. https://doi.org/10.1016/j.wasman.2016.03.001

Ding, Z., Zhu, M., Tam, V.W., Yi, G. and Tran, C.N., 2018. A system dynamics-based environmental benefit assessment model of construction waste reduction management at the design and construction stages. *Journal of Cleaner Production*, 176, pp.676-92. https://doi.org/10.1016/j.jclepro.2017.12.101

FEPA, 1991. National Environmental Protection (Effluent Limitation) Regulations (S.1.8). Lagos, Nigeria.

Fortunato, B.R., Hallowell, M.R., Behm, M. and Dewlaney, K., 2012. Identification of Safety Risks for High-Performance Sustainable Construction Projects. *Journal of Construction Engineering and Management*, 138(4), pp.499-508. https://doi.org/10.1061/(asce)co.1943-7862.0000446

Franz, B. and Messner, J., 2019. Evaluating the impact of building information modeling on project performance. *Journal of Computing in Civil Engineering*, 33(3), p.04019015. https://doi.org/10.1061/(asce)cp.1943-5487.0000832

Garg, S. and Rajput, K., 2017. Performance consequences on complexity in Public-private Partnerships: Evidence from Indian Highway Projects.

Giezen, M., Bertolini, L. and Salet, W., 2015. Adaptive capacity within a mega project: A case study on planning and decision-making in the face of complexity. *European Planning Studies*, 23(5), pp.999-1018. https://doi.org/10.1080/09654313.2014.916254

Gulghane, A. and Khandve, P., 2015. Management for Construction Materials and Control of Construction Waste in Construction Industry: A Review. *Int. Journal of Engineering Research and Applications*, 5(4), pp.59-64.

Hair , J.F., Hult, G.T.M., Ringle, C. and Sarstedt, M., 2017. *A primer on partial least squares structural equation modeling (PLS-SEM)*: Sage Publications.

Hand, A., Zuo, J., Xia, B., Jin, X. and Wu, P., 2015: Springer.

Hartono, B., Wijaya, D.F. and Arini, H.M., 2019. The impact of project risk management maturity on performance: Complexity as a moderating variable. *International Journal of Engineering Business Management*, 11, p.1847979019855504. https://doi.org/10.1177/1847979019855504

He, Q., Luo, L., Hu, Y. and Chan, A.P., 2015. Measuring the complexity of mega construction projects in China—A fuzzy analytic network process analysis. *International journal of project management*, 33(3), pp.549-63. https://doi.org/10.1016/j.ijproman.2014.07.009

Jakobsen, M. and Jensen, R., 2015. Common method bias in public management studies. *International Public Management Journal*, 18(1), pp.3-30. https://doi.org/10.1080/10967494.2014.997906

Kennedy, D.M., McComb, S.A. and Vozdolska, R.R., 2011. An investigation of project complexity's influence on team communication using Monte Carlo simulation. *Journal of Engineering and Technology Management*, 28(3), pp.109-27. https://doi.org/10.1016/j.jengtecman.2011.03.001

Kenny, D.A., 2016. *Moderation* [online]. Available at: davidakenny.net/cm/moderation.htm.

Kermanshachi, S., Dao, B., Shane, J. and Anderson, S., 2016. Project complexity indicators and management strategies–a Delphi study. *Procedia Engineering*, 145, pp.587-94.

Klassen, R.D. and Whybark, D.C., 1999. The impact of environmental technologies on manufacturing performance. *Academy of management journal*, 42(6), pp.599-615. https://doi.org/10.2307/256982

Kock, N., 2011. Using WarpPLS in e-collaboration studies: Descriptive statistics, settings, and key analysis results. *International Journal of e-Collaboration (IJeC)*, 7(2), pp.1-18. https://doi.org/10.4018/jec.2011040101

Kock, N., 2014. Advanced mediating effects tests, multi-group analyses, and measurement model assessments in PLS-based SEM. *International Journal of e-Collaboration (IJeC)*, 10(1), pp.1-13. https://doi.org/10.4018/ijec.2014010101

Kock, N., 2015. One-tailed or two-tailed P values in PLS-SEM? *International Journal of e-Collaboration (IJeC)*, 11(2), pp.1-7. https://doi.org/10.4018/ijec.2015040101

Kock, N., 2017a. Structural equation modeling with factors and composites: A comparison of four methods. *International Journal of e-Collaboration (IJeC)*, 13(1), pp.1-9. https://doi.org/10.4018/ijec.2017010101

Kock, N., 2017b. WarpPLS user manual: Version 6.0. *ScriptWarp Systems: Laredo, TX, USA*.

Kock, N. and Gaskins, L., 2016. Simpson's paradox, moderation, and the emergence of quadratic relationships in path models: An information systems illustration. *International Journal of Applied Nonlinear Science*, 2(3), pp.200-34. https://doi.org/10.1504/ijans.2016.077025

Kock, N. and Hadaya, P., 2018. Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, 28(1), pp.227-61. https://doi.org/10.1111/isj.12131

Liu, S., 2015. Effects of control on the performance of information systems projects: the moderating role of complexity risk. *Journal of Operations management*, 36, pp.46-62. https://doi.org/10.1016/j.jom.2015.03.003

Loganathan, S., Forsythe, P. and Kalidindi, S.N., 2018. Work practices of onsite construction crews and their influence on productivity. *Construction Economics and Building*, 18(3), p.18. https://doi.org/10.5130/ajceb.v18i3.5973

Lu, Y., Luo, L., Wang, H., Le, Y. and Shi, Q., 2015. Measurement model of project complexity for large-scale projects from task and organization perspective. *International journal of project management*, 33(3), pp.610-22. https://doi.org/10.1016/j.ijproman.2014.12.005

Luo, L., He, Q., Jaselskis, E.J. and Xie, J., 2017. Construction project complexity: research trends and implications. *Journal of Construction Engineering and Management*, 143(7), p.04017019. https://doi.org/10.1061/(asce)co.1943-7862.0001306

Luo, L., He, Q., Xie, J., Yang, D. and Wu, G., 2016. Investigating the relationship between project complexity and success in complex construction projects. *Journal of Management in Engineering*, 33(2), p.04016036. https://doi.org/10.1061/(asce)me.1943-5479.0000471

Magent, C.S., Korkmaz, S., Klotz, L.E. and Riley, D.R., 2009. A design process evaluation method for sustainable buildings. *Architectural Engineering and Design Management*, 5(1-2), pp.62-74. https://doi.org/10.3763/aedm.2009.0907

Mills, G.E. and Gay, L.R., 2016. *Educational Research: Competencies for Analysis and Applications*. NJ: Pearson.

Mondéjar-Jiménez, J., Vargas-Vargas, M., Segarra-Oña, M. and Peiró-Signes, A., 2013. Categorizing Variables Affecting the Proactive Environmental Orientation of Firms. *International Journal of Environmental Research*, 7(2), pp.495-500.

Mudi, A., Lowe, J. and Manase, D., 2015. Conceptual framework for public-private financed road infrastructure development in Nigeria. *International Journal of Engineering Research & Technology*, 4(8), pp.586-90.

Mwelu, N., Davis, P.R., Ke, Y. and Watundu, S., 2018. Compliance within a regulatory framework in implementing public road construction projects. *Construction Economics and Building*, 18(4). https://doi.org/10.5130/ajceb.v18i4.6362

Nandhinipriya, B., Janagan, S. and Soundhirarajan, K., 2016. Construction Waste Management. *International Research Journal of Advanced Engineering and Science*, 1(4), pp.132-35.

Nguyen, A.T., Nguyen, L.D., Le-Hoai, L. and Dang, C.N., 2015. Quantifying the complexity of transportation projects using the fuzzy analytic hierarchy process. *International journal of project management*, 33(6), pp.1364-76. https://doi.org/10.1016/j.ijproman.2015.02.007

Nguyen, L.D., Le-Hoai, L., Tran, D.Q., Dang, C.N. and Nguyen, C.V., 2019. Effect of project complexity on cost and schedule performance in transportation projects. *Construction Management and Economics*, 37(7), pp.384-99. https://doi.org/10.1080/01446193.2018.1532592

Ogunde, A.O., Dafe, O.E., Akinola, G.A., Ogundipe, K.E., Oloke, O.C., Ademola, S.A., Akuete, E. and Olaniran, H.F., 2017. Factors Militating Against Prompt Delivery of Construction Projects in Lagos Megacity, Nigeria: Contractors' Perspective. *Mediterranean Journal of Social Sciences*, 8(3), pp.233-42. https://doi.org/10.5901/mjss.2017.v8n3p233

Parfitt, M. and Sanvido, V., 1993. Checklist of critical success factors for building projects. *Journal of Management in Engineering*, 9(3), pp.243-49. https://doi.org/10.1061/(asce)9742-597x(1993)9:3(243)

Patanakul, P., Kwak, Y.H., Zwikael, O. and Liu, M., 2016. What impacts the performance of large-scale government projects? *International journal of project management*, 34(3), pp.452-66. https://doi.org/10.1016/j.ijproman.2015.12.001

PMI, 2013. PMI's Pulse of the Profession In-Depth Report: navigating complexity: PMI Publishing Division.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y. and Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), p.879. https://doi.org/10.1037/0021-9010.88.5.879

Qazi, A., Quigley, J., Dickson, A. and Kirytopoulos, K., 2016. Project Complexity and Risk Management (ProCRiM): Towards modelling project complexity driven risk paths in construction projects. *International journal of project management*, 34(7), pp.1183-98. https://doi.org/10.1016/j.ijproman.2016.05.008

Ramayah, T., Cheah, J., Chuah, F., Ting, H. and Memon, M.A., 2018. *Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS 3.0: An Updated and Practical Guide to Statistical Analysis*. 2nd Edition ed: Pearson Malaysia Sdn Bhd.

Sandanayake, M., Zhang, G., Setunge, S., Li, C.-Q. and Fang, J., 2016. Models and method for estimation and comparison of direct emissions in building construction in Australia and a case study. *Energy and Buildings*, 126, pp.128-38. https://doi.org/10.1016/j.enbuild.2016.05.007

Siew, R., Balatbat, M. and Carmichael, D., 2013. A review of building/infrastructure sustainability reporting tools (SRTs). *Smart and Sustainable Built Environment*, 2(2), pp.106-39. https://doi.org/10.1108/sasbe-03-2013-0010

Sinha, A., Gupta, R. and Kutnar, A., 2013. Sustainable Development and Green Buildings. *Wood Industry/Drvna Industrija*, 64(1). https://doi.org/10.5552/drind.2013.1205

Sridarran, P., Keraminiyage, K. and Herszon, L., 2017. Improving the cost estimates of complex projects in the project-based industries. *Built Environment Project and Asset Management*, 7(2), pp.173-84. https://doi.org/10.1108/bepam-10-2016-0050

Walls, J.L., Berrone, P. and Phan, P.H., 2012. Corporate governance and environmental performance: Is there really a link? *Strategic Management Journal*, 33(8), pp.885-913. https://doi.org/10.1002/smj.1952

Xia, B. and Chan, A.P., 2012. Measuring complexity for building projects: a Delphi study. *Engineering, Construction and Architectural Management*, 19(1), pp.7-24. https://doi.org/10.1108/09699981211192544

Xiong, H. and Liu, J.-J., 2012. Life cycle energy consumption of residential buildings. *Construction Conserves Energy*, 40(9), pp.59-63.

Yang, L.-R., Huang, C.-F. and Wu, K.-S., 2011. The association among project manager's leadership style, teamwork and project success. *International journal of project management*, 29(3), pp.258-67. https://doi.org/10.1016/j.ijproman.2010.03.006

Yusof, N.A., Awang, H. and Iranmanesh, M., 2017. Determinants and outcomes of environmental practices in Malaysian construction projects. *Journal of Cleaner Production*, 156, pp.345-54. https://doi.org/10.1016/j.jclepro.2017.04.064