STRUCTURAL EQUATION MODELLING FOR ESTABLISHING EMPIRICAL RELATIONSHIP BETWEEN ORGANISATIONAL INNOVATIVENESS AND SUSTAINABILITY OF CONSTRUCTION FIRMS IN NIGERIA

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Abstract. The quest to implement innovative practices that will lead to a high level of sustainability at the firm level within the construction sector cannot be overemphasised. The aim of this study is to establish the empirical relationship between organisational innovativeness and sustainability of construction firms using a structural equation modelling approach. The study has adopted a survey approach and 1179 copies of structured questionnaire have been administered to construction firm representatives. A total of valid 980 copies of questionnaire have been received giving a response rate of 83.2 %. Data collected have been analysed using descriptive statistics and structural equation modelling. The correlation coefficient ($\beta = 0.81$) shows that organisational innovativeness positively influences the sustainability of construction firms. The study reveals that 66.1 % of the variability in the overall sustainability of construction firms operating in the Niger Delta region of Nigeria is accounted for by the implementation of innovative practices by the construction firms. It is concluded that 67.1 %, 83.8 % and 45.7 % of the variability in the construction firm's social, environmental and economic sustainability, respectively, are explained by the implementation level of innovative practices by the top management teams of the firms. In line with the findings, this study concludes that efficient implementation of innovative practices at the firm level has a significant and positive influence on the overall sustainability of construction firms.

Keywords: *Empirical relationship; Nigeria; Organisational innovativeness; Structural equation modelling; Sustainability of construction firms.*

INTRODUCTION

The quest to implement innovative practices that will lead to a high level of sustainability at the firm level within the construction sector cannot be overemphasised. Having a good knowledge of the dimensionality of firm sustainability enables the construction firms to make better decisions about which indicators to include or leave out, and the potential consequences of these choices. Firm performance measurement is of great importance in effective management of the firms and in the enhancement of the processes. Love and Roper (2015) posited that many corporate organisations introduced innovation into their business operations in order to increase their productivity, competitiveness, market share

which would lead to higher profit. Organisations that have greater capacity to implement innovative practices respond to environmental challenges faster and better than the organisations that are not innovative (Rukundo, 2017).

Innovation is defined as the introduction of new products, services, or processes to the external market or the introduction of new devices, systems, programs, or practices in one or more internal units (Walker *et al.*, 2011). Most studies carried out on innovation emphasised technology-based products and process innovations (Evangelista and Vezzani, 2010). Product innovations are usually defined as new products or services introduced to meet an external user need, while process innovations are defined as new elements introduced into a firm's production or service operation to produce a product or render a service (Damanpour, 2010; Schilling, 2013, Yusof *et al.*, 2014). There are some other dimensions of innovation, which include paradigm innovation, technical/technological innovation, information technology innovation, and administrative innovation (Moohammad *et al.*, 2014).

Singh, Murty, Gupta and Dikshit (2009) state that there is an inadequate effort to measure firms' commitment to sustainability with an integral approach that encompasses environmental, economic and social aspects. Hence, there is a need to evaluate the level of corporate commitment to the three pillars of sustainability in Niger Delta, Nigeria. Many studies were carried out to determine key performance indicators (KPIs) but most of them were project specific. Existing research that evaluated the sustainability of construction firms is limited in the literature (Ali, Al-Sulaihi and Al-Gahtani, 2013). Combs, Crook and Shook (2005) stated that firm sustainability suffers from the lack of consensus and proper consideration of its dimensionality. Financial measures are often used alone regardless of the growing importance of other social and environmental aspects. Many studies represented firm sustainability as unidimensional despite the acknowledgement of its multidimensionality (Glick, Washburn & Miller, 2005). Shen *et al.* (2010) state that a greater emphasis is placed on economic and social sustainability. In contrast, Tam (2008) and Lilja (2009) maintain that in the construction industry, sustainability is generally interpreted as environment oriented. In view of this consideration, the present study considers the environmental, social and economic sustainability of the construction firms operating in the Niger Delta region of Nigeria.

Hassan, Shaukat, Nawaz and Naz (2013) assessed the influence of innovation on firm Performance in the Pakistan's manufacturing sector, and the study revealed that there was a positive influence of innovation types on firm performance. Karabulut (2015) evaluated the influence of innovation on performance of manufacturing firms in Turkey and the result showed that product, process and organisational innovation had a direct and positive influence on organisational performance. Bowen *et al.* (2010) revealed a positive relationship between innovativeness and firm performance. Mafini (2015) also predicted organisational performance through innovation, quality and inter-organisational systems in the public sector. The findings of the study indicated that there was a strong positive relationship between innovation and organisational performance. Chan and Liu (2012) showed that organisational innovativeness influenced productivity, profitability and competitiveness, sustainability adoption in an organisation.

Furthermore, Gauthier and Wooldridge (2012) also found that innovation addressed sustainability issues in the construction sector. However, there are limited studies on the relationship between organisational innovativeness and sustainability of construction firms in Nigeria in general and Niger Delta in particular. Hence, the aim of this study is to establish the empirical relationship between organisational innovativeness and sustainability of construction firms using a structural equation modelling approach.

1. RESEARCH METHODOLOGY

Structured questionnaire was used as a research instrument for data collection in this study. The questionnaire consists of three parts. The first part comprises the educational qualification, work experience and professional affiliations of the firm representatives. The second part comprises the constructs and dimensions used to assess the level of implementation of innovation in the construction firms, while the third part contains the construct and dimensions used to assess the firm sustainability. The 1179 copies of questionnaire were administered to the construction representatives comprising project managers, architects, builders and civil engineers working at the construction firms operating in the Niger Delta region of Nigeria. The result of descriptive statistics showed that the construction professionals (project managers, architects, builders, civil engineers) possessed the minimum qualification of Higher National Diploma (HND).

Fig. 1. Educational qualification, work experience and professional affiliation of the firm representatives (developed by the authors).

Figure 1 shows that 20 %, 30 %, and 50 % of the firm representatives possessed HND, BSc and MSc, respectively. In the same way, 50 %, 20 %, 10 % and 20 % of the firm representatives are project managers, architects, builders and civil engineers, respectively. The work experience of the firm representatives ranged between the intervals of 5–10, 11–15, 16–20 and above 20 years. Furthermore, 50 % of the firm representatives had work experience above 10 years. The educational qualification and work experience of the respondents were adequate and their responses could be relied on. A five-point (1–5) Likert scale was used for data collection. Scale 1 implies a very low level of implementation of organisational innovativeness/very low level of firm sustainability, while scale 5 implies a very high level of implementation of organisational innovativeness/very high level of firm sustainability (Kazaz *et al.*, 2008; Santos & Brito, 2012). Structural equation modelling (SEM) was used to establish the empirical relationship between organisational innovativeness and sustainability of construction firms.

2. RESULT ANALYSIS AND DISCUSSION

This section contains the descriptive results of the questionnaire distributed to the firms as well as the response rate. It also provides the results of the structural equation model establishing the empirical relationship between organisational innovativeness and the sustainability of construction firms.

2.1. Questionnaire Administration and Response Rate

The structured questionnaire was used as a research tool for data collection in this study. Figure 2 shows the number of questionnaires administered to construction companies through their representatives, the number of questionnaires returned, and the response rate. Figure 2 indicates that the response rate ranged between 76.10 % and 94.7 %. According to Fig. 2, construction firms operating in Delta state recorded the highest response rate (94.7 %), while the construction firms operating in Abia state had the least response rate (76.10 %).

Fig. 2. Questionnaire administration and response rate (developed by the authors).

The study shows that the overall response rate is 83.2 %. In agreement with Groves (2006), the response rate is considered very good and adequate in the study.

2.2. Structural Equation Modelling (SEM) for Establishing the Empirical Relationship between Organisational Innovativeness and Sustainability of Construction Firms

Structural equation modelling was used to establish the empirical relationship between organisational innovativeness and the sustainability of construction firms. These processes include model estimation, verification and validation of the final model.

2.2.1. Model Estimation

Maximum likelihood estimate (MLE) was applied to determine the unique contrast between the constructs and dimensions in the study. The Promax rotation method was used to show the principal dimensions that formed contrast patterns between the variables. Furthermore, the promax rotation method was used due to the large data involved and it also accounted for the correlation between variables. The result showed that KMO was 0.744, and p -value = 0.001 at 0.05 level of significance, which confirmed the appropriateness and adequacy for conducting a factor analysis for the data set. The computed value of the KMO was greater than the bench mark of 0.5 for KMO and Bartlett's test < 0.05 . This confirmed the appropriateness and adequacy for conducting a factor analysis for the data set.

The study was not about grouping data because the breakdown of organisational innovativeness and sustainability of construction firms into constructs and dimensions from the literature was carried out at the preliminary stage. Principal component analysis (PCA) was used in this study to reduce the variables and find the smallest components that explained most of the variations in the data set. The result of the rotated matrix of components indicated that no component had less than three variables. The result also indicated that the correlation coefficient (R) was greater than 0.3 for each variable. It also satisfied the condition stated in the literature by Tabachnick and Fidell (2007), who posited that the correlation coefficient (R) had to be 0.30 or greater, because anything below suggested a very weak relationship between the variables.

2.2.2. Verification and Validation of the Final Model

The final model was validated using the model fit indices. The results in Table 1 show that the model fit indices of the final model satisfied the bench marks stipulated in the literature. The results show that the estimates were within the expected limits. The values of chi-square / degree of freedom, goodness of fit, root mean square, error of approximation, comparative fit index, Tucker Lewis index, normed fit index, incremental fit index and relative index were 1.9677, 0.9547, 0.0748, 0.9579, 0.9564, 0.9632, 0.9523 and 0.9657, respectively. The values of these model fit indices showed a satisfactory model fit. This study agrees with other studies in the literature that used many model fit indices to determine the overall fitness of the model (Schumacker and Lomax, 2004; Zulu, 2007; Hair *et al.*, 2010; and Byrne, 2016).

Table 1. Model Fit Indices (developed by the authors)

Model Fit Indices	Recommended	Source(s)	Final Model	Remark
X ² /Degree of freedom	< 2	Byrne, 2016	1.9677	satisfactory
Goodness of Fit (GFI)	0–1	Bagozzi and Yi, 2012	0.9547	satisfactory
Root Mean Square Error of Approximation (RMSEA)	≤ 0.10	Tabachnick and Fidell (2007)	0.0748	satisfactory
Comparative Fit Index (CFI)	> 0.9	Kline, 2004	0.9579	satisfactory
Tucker Lewis Index (TLI)	≥ 0.90	Bagozzi and Yi, 2012	0.9564	satisfactory
Normed Fit Index (NFI)	0–1	Doloi <i>et al.</i> , 2011	0.9632	satisfactory
Incremental Fit Index (IFI)	0–1	Molenaar <i>et al.</i> , 2000	0.9523	satisfactory
Relative Fit Index (RFI)	0–1	Doloi <i>et al.</i> , 2011	0.9657	satisfactory

Table 2 shows the estimates of the standardised regression weight, the standard errors (S.E), and the *p*-values. Furthermore, the feasibility of parameter estimates, the appropriateness of standard errors, and the statistical significance of parameter estimates were assessed for the adequacy of the model. The parameters were checked to ensure that the estimates were correct in order to avoid estimates that had the correlation coefficient greater than one (1). The correctness of the estimates implies that each of the estimates has the correct values and sign. The appropriateness of the standard error is also a key parameter for evaluating the adequacy of the model. Table 2 indicates that the values of standard errors are small, which implies a good model fit. Table 2 also shows that all the *p*-values are less than 0.05 level of significance set for the test. It means that the estimates are significant at the confidence level of 95 %. These criteria and checks showed that the model fit was good.

Table 2. Standardised Regression Weights, Standard Errors and Level of Significance (developed by the authors)

			Estimate	S.E.	P-value
CFS	<---	OI	0.813		
ECP	<---	CFS	0.676		
SP	<---	CFS	0.819		
EP	<---	CFS	0.916		
OIESAD	<---	OI	0.731		
OITSAD	<---	OI	0.579		
OIKSAD	<---	OI	0.965		
OIRSAD	<---	OI	0.815		

			Estimate	S.E.	P-value
ECP1	<---	ECP	0.515		
ECP2	<---	ECP	0.321	0.092	***
ECP3	<---	ECP	0.425	0.098	***
OIES4AD	<---	OIESAD	0.559		
OIES3AD	<---	OIESAD	0.545	0.086	***
OIES2AD	<---	OIESAD	0.836	0.105	***
OIES1AD	<---	OIESAD	0.761	0.108	***
OITS4AD	<---	OITSAD	0.656		
OITS3AD	<---	OITSAD	0.789	0.081	***
OITS2AD	<---	OITSAD	0.800	0.080	***
OITS1AD	<---	OITSAD	0.834	0.082	***
OIKS4AD	<---	OIKSAD	0.492		
OIKS3AD	<---	OIKSAD	0.689	0.119	***
OIKS1AD	<---	OIKSAD	0.565	0.111	***
OIRS4AD	<---	OIRSAD	0.549		
OIRS3AD	<---	OIRSAD	0.701	0.106	***
OIRS2AD	<---	OIRSAD	0.781	0.098	***
OIRS1AD	<---	OIRSAD	0.724	0.098	***
EP5	<---	EP	0.615		
EP6	<---	EP	0.806	0.093	***
EP7	<---	EP	0.899	0.089	***
EP8	<---	EP	0.809	0.087	***
EP9	<---	EP	0.703	0.097	***
SP2	<---	SP	0.667		
SP3	<---	SP	0.729	0.066	***
SP4	<---	SP	0.820	0.067	***
SP5	<---	SP	0.888	0.070	***
SP6	<---	SP	0.869	0.071	***
SP7	<---	SP	0.878	0.066	***
SP8	<---	SP	0.854	0.074	***
SP9	<---	SP	0.886	0.079	***

Table 3 shows the total effect of organisational innovativeness on the sustainability of construction firms. The correlation coefficient of 0.813 indicates that organisational innovativeness has a direct and positive relationship with the sustainability of construction firms. Table 3 also demonstrates the squared multiple correlations of each variable in the model. The squared multiple correlations reveal the proportion of variability in sustainability of construction firms as explained by the level of implementation of innovative practices. Table 3 shows that 66.1 % of the variability in the overall sustainability of construction firms is explained by the level of implementation of innovative practices by the top management of the construction firms.

Table 3. Standardised Total Effects and Squared Multiple Correlation (developed by the authors)

	OI	CFS	SP	EP	OIRS AD	OIKSAD	OITSAD	OIESAD	ECP	Squared Multiple Correlation
CFS	0.813	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.661
SP	0.666	0.819	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.671
EP	0.744	0.916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.838
OIRSAD	0.815	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.665
OIKSAD	0.965	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.931
OITSAD	0.579	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.335
OIESAD	0.731	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.534
ECP	0.549	0.676	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.457
SP9	0.590	0.726	0.886	0.000	0.000	0.000	0.000	0.000	0.000	0.786
SP8	0.568	0.699	0.854	0.000	0.000	0.000	0.000	0.000	0.000	0.729
SP7	0.584	0.719	0.878	0.000	0.000	0.000	0.000	0.000	0.000	0.770
SP6	0.578	0.711	0.869	0.000	0.000	0.000	0.000	0.000	0.000	0.755
SP5	0.591	0.727	0.888	0.000	0.000	0.000	0.000	0.000	0.000	0.788
SP4	0.546	0.672	0.820	0.000	0.000	0.000	0.000	0.000	0.000	0.673
SP3	0.485	0.597	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.531
SP2	0.444	0.546	0.667	0.000	0.000	0.000	0.000	0.000	0.000	0.445
EP9	0.523	0.644	0.000	0.703	0.000	0.000	0.000	0.000	0.000	0.495
EP8	0.602	0.741	0.000	0.809	0.000	0.000	0.000	0.000	0.000	0.654
EP7	0.669	0.823	0.000	0.899	0.000	0.000	0.000	0.000	0.000	0.807
EP6	0.600	0.738	0.000	0.806	0.000	0.000	0.000	0.000	0.000	0.650
EP5	0.457	0.563	0.000	0.615	0.000	0.000	0.000	0.000	0.000	0.378
OIRS1AD	0.590	0.000	0.000	0.000	0.724	0.000	0.000	0.000	0.000	0.524
OIRS2AD	0.637	0.000	0.000	0.000	0.781	0.000	0.000	0.000	0.000	0.611
OIRS3AD	0.571	0.000	0.000	0.000	0.701	0.000	0.000	0.000	0.000	0.491
OIRS4AD	0.448	0.000	0.000	0.000	0.549	0.000	0.000	0.000	0.000	0.301
OIKS1AD	0.546	0.000	0.000	0.000	0.000	0.565	0.000	0.000	0.000	0.320
OIKS3AD	0.665	0.000	0.000	0.000	0.000	0.689	0.000	0.000	0.000	0.474
OIKS4AD	0.475	0.000	0.000	0.000	0.000	0.492	0.000	0.000	0.000	0.242
OITS1AD	0.482	0.000	0.000	0.000	0.000	0.000	0.834	0.000	0.000	0.695
OITS2AD	0.463	0.000	0.000	0.000	0.000	0.000	0.800	0.000	0.000	0.640
OITS3AD	0.457	0.000	0.000	0.000	0.000	0.000	0.789	0.000	0.000	0.623
OITS4AD	0.380	0.000	0.000	0.000	0.000	0.000	0.656	0.000	0.000	0.431
OIES1AD	0.557	0.000	0.000	0.000	0.000	0.000	0.000	0.761	0.000	0.580
OIES2AD	0.611	0.000	0.000	0.000	0.000	0.000	0.000	0.836	0.000	0.699
OIES3AD	0.398	0.000	0.000	0.000	0.000	0.000	0.000	0.545	0.000	0.297
OIES4AD	0.409	0.000	0.000	0.000	0.000	0.000	0.000	0.559	0.000	0.313
ECP3	0.234	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.425	0.181
ECP2	0.176	0.217	0.000	0.000	0.000	0.000	0.000	0.000	0.321	0.103
ECP1	0.283	0.348	0.000	0.000	0.000	0.000	0.000	0.000	0.515	0.266

2.3. Relationship between Organisational Innovativeness and Sustainability of Construction Firms

The results in Tables 1–3 indicate a satisfactory model fit because all output values are within acceptable limits. Statistical significance of parameter estimates was assessed and the results revealed that all the p -values were less than 0.05. It means that all the estimates are significant at the confidence level of 95 %. The model fit indices showed a satisfactory model fit. The present research is in consonance with studies performed by Schumacker and Lomax (2004), Zulu

(2007), Hair *et al.* (2010) and Byrne (2016) that used many model fit indices to determine the overall fitness of the model.

Figure 3 reveals that organisational innovativeness has a direct and positive influence on the sustainability of construction firms in the Niger Delta region of Nigeria ($\beta = 0.81$). The study shows that recruitment of experienced employees by the firms, use of multi-skilled teams to execute their projects, recruitment and development of new graduates as well as participation in apprenticeship programmes enhance the sustainability of construction firms. Furthermore, enhancement of firm's technical capabilities, investment in research and development (R&D) by construction firms, protection of firm's intellectual property, and participation in the development of industry standards and practices significantly improve sustainability of construction firms. This study also shows that actively monitoring international best practices, measuring how well the changes made by the firms have worked, and actively monitoring advances in related industries that might be applicable to construction firms contribute immensely to the sustainability of the firms. In addition, rewarding staff for maintaining networking linkages with strategically useful industry participants, pursuing partnering on projects, and maintaining long-term collaborative arrangements with other businesses greatly improve the sustainability of construction firms. This study is in tandem with the research conducted by Hassan, Shaukat, Nawaz and Naz (2013) who revealed that there are positive effects of innovation on firm performance.

Empirically, Table 3 shows that 66.1 % of the variability in the overall sustainability of construction firms operating in the Niger Delta region of Nigeria is accounted for by the implementation of innovative practices by the construction firms. It also shows that 67.1 % of the variability in the social sustainability of the firms is explained by the implementation of innovative practices by the construction firms. In the same manner, 83.8 % of the variability in environmental sustainability of the construction firms is accounted for by the implementation of innovative practices by the firms, while 45.7 % of the economic sustainability of the firms is accounted for by the level of implementation of innovative practices in the organisational processes by the construction firms.

Specifically, the study shows that 44.5 %, 53.1 %, 67.3 %, 78.8 %, 75.5 %, 77 %, 72.9 % and 78.6 % of the variability in the employment level of the firms, infrastructural development, standard of living of the stakeholders, public and private sector investment, peace and security within the organisation, bio-diversity and eco-system stability, poverty reduction, and human health standard, respectively, are explained by the level of implementation of innovative practices by the top management teams of the construction companies. In addition, 37.8 %, 65 %, 80.7 %, 65.4 % and 49.5 % of the variability in effective communication of sustainability and other environmental management issues among contractors, suppliers and other professionals engaged by the construction firms, standardised management systems such as ISO 14001 or environmental management system in the organisation, implementation of environmental management programmes and the use of certified professionals, the inclusion of sustainability and other environmental management measures in tendering requirement, and the use of

innovative features and renewable energy, respectively, are explained by the level of implementation of innovative practices by the top management teams of the construction companies. This study also demonstrates that the implementation of innovative practices by the construction firms accounts for 26.6 %, 10.3 % and 18.1 % of the annual financial turnover, annual employment growth, and net income (profitability), respectively, of the construction firms operating in the Niger Delta region of Nigeria. This study is in agreement with the research conducted by Chan and Liu (2012) who posited that innovativeness influenced organisational productivity, profitability, competitiveness and sustainability at an organisation. This study is also in tandem with the research carried out by Gauthier and Wooldridge (2012) who revealed that innovations at the firm level helped address sustainability issues in the construction sector.

Fig. 3. Structural equation model for establishing the relationship between organisational innovativeness and sustainability of construction firms in Nigeria.

CONCLUSION

This study has established an empirical relationship between organisational innovativeness and sustainability of construction firms using a structural equation modelling approach. The model estimation and modification, verification and validation have been carried out. The result of the model fit indices shows a satisfactory and good model fit. The correlation coefficient ($\beta = 0.81$) shows that organisational innovativeness positively influences the sustainability of construction firms. The study reveals that 66.1 % of the variability in the overall sustainability of the construction firms operating in the Niger Delta region of Nigeria is accounted for by the implementation of innovative practices by the construction firms. It is concluded that 67.1 %, 83.8 % and 45.7 % of the variability in the social, environmental and economic sustainability, respectively, are explained by the level of implementation of innovative practices by the top management teams of the construction firms. In line with the findings, this study concludes that the implementation of innovative practices at the firm level has a significant and positive influence on the overall sustainability of construction firms.

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