Impact Assessment of Change Management Capability Maturity Level of Contractors' on Time Performance of Building Projects in Nigeria

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Abstract

Changes are generally inevitable in all stages of design and construction of building projects and are commonly associated with some consequences such as time overrun, cost overrun, conflicts and reworks. All these risks contribute to project failure if change implementation is inconsistently managed. In construction, project failure has become a common concern of all parties hence, assessing the impact of capability of contractors to manage project changes in order to improve project performance is critical. Therefore, this research assesses the relationship between the change management capability maturity level (CMCML) of contractors and time performance of building projects. Data collected from respondents via questionnaire survey were analyzed using spearman's rank correlation, fuzzy synthetic evaluation and multiple regression. The research findings reveal that the project time overrun is negatively related to change management capability maturity level of contractor as evidenced by the co-efficient of determination $R^2 = -0.385$ (i. e as CMCML increases, project time overrun decreases). In addition, the result further indicates a strong negative correlation between CMCML and project time overrun going by the spearman's rank correlation coefficient value of - 0.621 [7]. The established model is capable of predicting contractors' CMCML thus making it possible to forecast contractor's likelihood of performance in terms of time.

Keywords. Contractors; Capability; Nigeria; Time; Fuzzy synthetic; Change management; Project change

1 Introduction

Project changes are inevitable and highly common in all stages of both design and construction during the project life cycle. However, they always results in some consequences such as time overrun, cost overrun, disputes, and rework. Reviewed previous studies had it that construction projects are one-off in nature and are affected by varying site conditions and unpredictable climate [23]. Many of the studies have established negative impact of changes on project performance and the need for managing project change effectively via project change management system. From the project management perspective, effective management of project changes enhances proper execution of project and helps in urgent delivery of project [25]. Change management is a critical problem faced by the construction industry, it is a nightmare which industry people wished they never have to face [28]. In recent years, several generic change management tools or models have been developed for process improvement [23]; consequently, these tools have provided valuable process support for effective management of project change in construction. However, they are not sufficient to assess the change management capability [23]. Moreover, assessing the change management capability of contractor to effectively manage project changes in order to improve performance in terms of time is critical. Therefore, the research presented in this paper adopts to practically examine the relationship between the change management capability maturity level of contractor and time performance of building projects. However, the study shows, improved change management capability maturity level of contractors produce an impact on time performance of building projects.

1.1 Change Management in Construction Projects

Change management is directly related to project planning techniques as well as change management processes hence, the central idea about change management is that it seeks to predict possible changes, identify changes which have occurred, plan corrective measures in order to minimize the occurrence and eventually reduce the disruptive effects of changes.

Researchers have focused more attention on change process approaches which was considered to have been instigated by the report of [10] which placed much emphasis on the need to improve construction processes and the awareness has been embraced by the construction management research community. Several generic models of change management process have been developed. A concept for project change management was established by the construction industry institute [6] in which change is to be considered as an adjustment to a former agreement between project participants. A generic procedure for issuing a change order request after the award of contract was proposed by [8]. Stock and Singh reported in Motawa developed a functional analysis concept design in which designers and owners can come into agreement during design stage of projects in order to mitigate the overall rate of construction change and change orders [21, 25].

Ibbs et al came up with a systematic change management process of managing project change and this was founded on five basic principles of; promote a balance change culture; recognize change; evaluate change; implement change; and continuously improve from lessons learned [12]. All these principles are inter-related and they work hand-in-hand with each other in order to minimize negative change and enhance beneficial change. In the same vein, [25] also developed a systematic change process model that was based on four parts of; pre-change; identify and evaluate; approval and propagation; and post change. Motawa's model was designed to be applied to different change categories of pre- or post-fixity changes.

Similarly, a toolkit for project change management was introduced by [22]. This toolkits supports project team's anticipation of changes and the evaluation of the impacts of these changes. [4] developed a project change management model which strongly emphasis on the need for effective communication and information sharing among the project participants and more importantly the usefulness of information technology for supporting change management.

Furthermore, adopting the software approach, [13] developed a change prediction framework based on the dynamic control methodology (DPM) result of [16] that utilized a system dynamics technique to develop a rework cycle embedded in the project development process and finally developed a tool for the management of events that are not expected on a project. These developments was further enhanced by [26] development of an integrated fuzzy logic- based prediction model and utilizing the system dynamics model of the DPM to manage changes based on information gathered early enough on a project.

Based on the foregoing, it can clearly be said that previous studies mainly focused on the identification of the change process and best practice recommendations for managing change during a project life cycle. However, these developments facilitate change management processes and indeed provide potential benefits to construction participants, nevertheless, they do not provide for the assessment of the relationship between change management capability maturity level (CMCML) of contractors and cost performance of building projects.

1.2 Capability Maturity

Maturity is considered to be a comparative level of advancement which an organization has achieved with regard to any given set of activities or process. In this respect an organization is said to be matured when it engages in a more actively defined policies, standards and practices. According to [18] "maturity is the level of sophistication that indicates organization's current project management practices and processes" As organization's process maturity increases, then it institutionalizes its change management process through good policies, standards and organizational structures. "The more mature an organization's practices are, the more likely the organization meets its project goals successfully" [18].

On the other hand, an organization is considered to be immature when it does not use consistency and defined processes in the management of its projects, [20]. For example, in an immature organization completion dates for similar sized projects are unpredictable and it varies widely. However, in a matured organization, projects of similar nature are expected and delivered within a much smaller range of time. At the highest maturity levels all projects are handled within controlled variables approaching the organization's process capability [17].

Capability maturity models are used to assess the capability of organization practices to provide a means of identifying improvement areas and pointing out strengths and weaknesses of the organization. Several generic maturity models adopted five level rating system of the capability maturity model (CMM). However, adopted for this research paper is the five levels of maturity, [19, 23] beginning from lower level of maturity, Abstract or Adhoc (level 1) to the highest level of organizational competency (level 5) figure1.1. The maturity of an organization is described with five observable capabilities (attributes) of leadership, application, competency, standardization and socialization which exhibit change management capability maturity. In this respect, organization is assessed based on its performance in these capability areas and an overall capability maturity level rating is produced. Hence, organization with no capability improvement program will fall at the lowest level of maturity which is level 1 and organizations classified in level 3 – 5 have demonstrated process improvement and optimizing capabilities that allow them to meet schedule, cost, quality and functionality targets, [17]

Figure 1.17: Typical Five level Maturity model

2 Research Methodology

A set of well-structured questionnaire was administered to collect data from respondents within the contracting organizations engaged in the construction of institutional buildings in the southwest geopolitical zone of Nigeria. Nigeria is on longitude 10^0 north and latitude 8^0 east. This zone is the most developing economics zone where construction activities are high [9] and it comprises Oyo, Ogun, ondo, Osun, and Ekiti states. Literature review was carried out to compliment the developed questionnaire. However, the developed questionnaire was piloted with couple of project managers and contract managers using the initial draft of the questionnaire. This is to ensure that the research instrument will establish the most productive form of data analysis. The questionnaire was eventually refined based on the input and results generated from the pilot survey. Reliability test for the internal consistency of the instruments adopted was conducted using Cronbach's alpha and the alpha value was found to be 0.725 indicating that the instrument used for the study were reliable. The questionnaire comprises of two sections A and B. Section A was meant to profile the respondents and their organizations. In section B, respondents were asked to rate the states of change management capability maturity of their own organizations based on the 32 sub-attributes classified under five attributes using a five point Likert scale with 1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High [3, 14]. In addition, respondents were further asked to provide details of completed building projects that experienced time overrun in terms of approximate percentage of time overrun attributable to change orders, original contract duration and final contract duration. A total of 65 survey questionnaire was hand distributed to project managers, contract managers, project quantity surveyors and project architect in contractor's organization. However, a total of 40 valid questionnaires out of 65 were returned. The returned questionnaire represents a response rate of 61.54% which is far above the norm of 20 – 30% response rate in questionnaire survey, [1]. Data collected for the study were analyzed using frequency index, importance index, normalization method, fuzzy synthetic evaluation and multiple regression analysis techniques. However, a regression test was conducted between the observed and the predicted values to validate the model. Statistical package for social sciences (SPSS ver.21) was adopted for the analysis of the data collected.

3 Results and Discussion

3.1 Profile of Respondents

Background information on respondents' profile shows that 17.5% of the respondents have the minimum qualification of Higher National Diploma (HND) in their various fields of disciplines in Nigeria, 25% have BSc, 45% have MSc, and 12.5% are PhD holders. However, 60.0% of the respondents are corporate members of their respective professional bodies while about 40.0% of the respondents are fellow members of their professional bodies. In addition, the respondents have an average of 12years of experience in construction. From the foregoing, it can be concluded that the respondents could be relied upon for the information provided for this study for the purpose of analysis.

3.2 Determination of Overall Change Management Capability Maturity Level of Contractors

The first step in doing this is to develop appropriate weightings and membership functions for both the sub-attributes and the principal attributes of the change management capability maturity. However, from the frequency and severity indices computed for this study, importance index of all the sub-attributes were calculated. Hence, the computed importance index were subjected into normalization and only sub-attributes whose normalized value were equal to or greater than 0.5 were selected for the analysis, [5]. Fifteen sub-attributes were finally extracted and used for the study, table 1.2. Taxonomy was developed which classified the selected sub-attributes under five principal attributes of leadership, application, competency, standardization and socialization.

3.3 Developing appropriate weightings for the attributes

In order to determine the overall change management capability level of the contractor's organization, using fuzzy assessment model, appropriate weightings for each of the principal attributes and sub-attributes were determined by adopting the equation below;

$$W_j = \frac{M_j}{\sum_{j=1}^{m} M_j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where;

W_j represents the weightings of a particular sub-attributes or principal groups of attribute.

M_j represents the mean rating of a particular sub-attributes or principal groups of attribute.

$\sum M_j$ represents the summation of mean ratings of all the sub-attributes or principal groups of attribute.

3.4 Developing membership functions for attributes

Similarly, membership functions were determined for the sub-attributes and principal attributes. For instance the result of the survey on; is funding regularly made available for change management? Shows 5% of the respondents opined the maturity of this capability to be very low, 17.5% as low, 45% as moderate, 30% as high and 2.5% as very high. Hence, the membership function can be written as 0.05, 0.18, 0.45, 0.30, and 0.03. Following similar step, the membership functions of all the sub-attributes and principal attributes are determined, table1.

Table1.1: The Membership function of all the CMC attributes

S/N	Attributes and sub-attributes	Weighting	Membership function of level 3	Membership function of level 2
CMC 1	**LEADERSHIP**			
QI.1.1		0.11	(0.10,0.13,0.23,0.35,0.20)	(0.10,0.19,0.27,0.310.20)
QI.1.2		0.12	(0.10,0.18,0.20,0.38,0.15)	
QI.1.3		0.11	(0.15,0.28,0.43,0.10,0.05)	
QI.1.4		0.12	(0.05,0.28,0.38,0.13,0.18)	
QI.1.5		0.11	(0.10,0.10,0.23,0.35,0.23)	
QI.1.9		0.12	(0.20,0.23,0.20,0.33,0.05)	
QI.1.10		0.12	(0.05,0.10,0.15,0.45,0.25)	
QI.1.11		0.11	(0.03,0.35,0.23,0.23,0.18)	
QI.1.12		0.11	(0.08,0.10,0.20,0.30,0.33)	
CMC 2	**APPLICATION**			
QI.2.4		1.00	(0.05,0.43,0.03,0.38,0.13)	(0.05,0.43,0.03,0.38,0.13)
CMC 3	**COMPETENCIES**			
QI.3.11		1.00	(0.05,0.13,0.35,0.35,0.13)	(0.05,0.13,0.35,0.35,0.13)
CMC 4	**STANDARDIZATION**			
QI.4.10		1.00	(0.03,0.15,0.38,0.25,0.20)	(0.03,0.15,0.38,0.25,0.20)
CMC 5	**SOCIALIZATION**			
QI.5.2		0.33	(0.03,0.38,0.10,0.38,0.03)	(0.09,0.30,0.22,0.24,0.10)
QI.5.5		0.33	(0.00,0.15,0.33,0.20,0.23)	
QI.5.8		0.33	(0.23,0.33,0.20,0.13,0.03)	

After establishing appropriate weightings and membership functions, a model was selected and this was used to determine the overall change management capability maturity level (OCMCML) of contractors' organisation. Tables 2 and 3 summarises the computed overall change management capability maturity level (OCMCML) and the maturity of each principal attributes of this research.

Table 2: The membership functions of overall CMC level for Contracting Organizations.

CMC Capability Area	Weighting	Membership function of Level 2	Membership function of level 1
Leadership	0.61	(0.10,0.19,0.27,0.31,0.20)	(0.08,0.22,0.24,0.30,0.17)
Application	0.07	(0.05,0.43,0.03,0.38,0.13)	
Competencies	0.07	(0.05,0.13,0.35,0.35,0.13)	
Standardization	0.06	(0.03,0.15,0.38,0.25,0.20)	
Socialization	0.18	(0.09,0.30,0.22,0.24,0.10)	

Table 3: Overall CMC and capability of principal attributes

Change Management Capability	Level
Leadership	*3.53*
Application	3.17
Competencies	3.41
Standardization	3.47
Socialization	2.81
Overall CMC Capability	**3.29**

3.5 Determining relationship between change management capability level of contractors and cost performance of building projects.

The major aim of this study was to assess the relationship between contractors' change management capability level and time performance of building projects. However, establishing this relationship will not only provide a solid platform for contractors to assess and continuously improve their change management capability level but will serve as a framework for construction practitioners particularly clients to evaluate contractors change management capability maturity level prior to contract award. Furthermore, the relationship will facilitate easy elimination of incompetent contractors and thus create enough opportunity for fair competitions among contractors during bidding exercise and clients will through this process get better value for their investment.

In determining the relationship, overall change management capability maturity level of 40 contractor's organisation was computed using the same procedure above together with data collected in respect of approximate percentage of cost overrun experienced on building projects by contractors. These data were ranked and analysed using statistical package for social sciences (SPSS VER.21) software computer. However, the regression model that resulted from this, estimates that a given set of attributes of time overrun will impact on change management capability maturity level of contractors' organisation. Therefore, the relationship is presented thus; (table 6).

$$\text{CMCML} = 4.084 - 621\text{TRK} + e \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2)$$

Where,

CMCML; is the change management capability maturity level of contractor's organisations.

CRK; is the approximate percentage cost overrun due to change orders on building projects.

e; Error term

The model has R^2 value of 0.385 and an adjusted R^2 value of 0.369, while the R value stands at 0.621, significance level = 0.000, table 1.5

The predictive ability of a regression model is widely believed to be measured by its coefficient of determination otherwise known as R^2 value. This value according to [15, 29] measures the degree of strength of the linear relationship between the dependent variable and independent variables. If a perfect relationship exists between these two or more variables (dependent and independent variables), R^2 will definitely be one and if there is no relationship, R^2 will turn to be zero. The correlation coefficient R = 621signifies there is a strong association between the observed CMCML and those predicted by the regression model (time). The spearman's rank correlation coefficient result signifies a negative (inverse) correlation which represents an inverse relationship rho = - 0.621, N = 40.

However, the predictive efficacy of the time performance model was found to be pretty strong but not high, [7] with R^2 = 0.385 and adjusted R^2 = 0.369. This signifies that the model which includes time is capable of explaining 30.5% of the variance in dependent variable. Hence the result indicates that project time overrun is negatively related to change management capability maturity (CMCML) i.e an increase in CMCML with an associated decrease in project time overrun, rho = - 0.621, $p < 0.0001$) at the level of significance less than 0.05.

Moreover, the F statistic of a model normally tests how best-fit the model, as a whole accounts for the dependent variable's behaviour. Result from the ANOVA table 5 indicates the model R^2 to be significantly different from zero; F(1, 38) = 23.806, $p < 0.000$. Hence, F – value of the model was found to be statistically significant at less than 0.000 level, indicating a good degree of fitness. Tables 4, and 6 summarizes the regression analysis result.

Table 4: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.621[a]	.385	.369	.89944

a. Predictors: (Constant), Time Rank
b. Dependent Variable: CMC Rank

Table 5: ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	19.259	1	19.259	23.806	.000[b]
Residual	30.741	38	.809		
Total	50.000	39			

a. Dependent Variable: CMC Rank
b. Predictors: (Constant), Time Rank

Table 6: Coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	4.084	.354	-.621	11.522	.000
Cost Rank	- .621	.127		-4.879	.000

a. Dependent Variable: CMC Rank

4. Validation of the Model

Table 7, shows the result of the regression test on the time performance model. In this table, the coefficient of determination as defined by the R^2 value is 0.357 and the intercept and the slope are - 0.569 and 4.019 respectively. However, from this comparison which indicates the amount of variance accounted for by cost in the dependent variable, it can therefore be concluded that there is no significant difference between the observed and the predicted value of the time performance model. Hence, the model developed in this research can accurately predict change management capability maturity level of contractors and this result agree with [2, 27].

Table 7: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.598[a]	.357	.340	.85644

a. Predictors: (Constant), Time Rank
b. Dependent Variable: CMC Rank

5. Conclusion

The result of this research identified leadership, application, competencies, standardisation, and socialisation as major attributes for evaluating contractor's change management capability maturity level. The result further shows that contractor's change management capability level is a critical criterion needed by construction practitioners particularly clients and consultants for evaluating contractors during pre-qualification and tender evaluation exercise. Furthermore, the study reveals that change management capability level of contractors is negatively correlated with the time performance of building project. On this basis, the predictive model for change management capability level was established and validated.

This therefore, indicates that it is possible to forecast the contractor's likelihood performance in terms of time duration based on the assessment of the contractor's CMCML. As elicited earlier, establishing the relationship will enhance easy elimination of incompetent contractors during bidding exercise and create fairer competition among contractors. Applying this model, it is believed that it will create avenue for improvement in contractor's performance in terms of completing projects to time schedule and assist construction practitioners in selecting competent hands to handle construction of building projects in Nigeria.

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