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Decision Making Tools of Basic Risk Factors on Construction Project in Nigeria (Case Study of Foci, Lagos State, Nigeria)

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Abstract Construction projects are capital intensive and risk laden; and contractors only make use of intuition or guess work in allocating contingencies for the presumed project risks in Nigeria. Emphases have not been placed on risks during construction and such risks when not properly managed have contributed to uncompleted project. Hence this paper aim at assesses the implication of risk factors associated with decision alternatives on project with a view to manage the inherent risks to adverse severe loss. Questionnaire survey was used to elicit information from the indigenous contractors operating in Lagos state under the umbrella of FOCI and employed probabilistic simple random sampling technique. One hundred and seventy one questionnaires were sent out and one hundred and forty six were retrieved and analyzed representing 85.38%. The data collected were analyzed using both descriptive and inferential statistics. The hypothesis was analyzed using ANOVA techniques and T-test. The analyzed data shows that financial and economic risk, delay risk, sub-contractor related risk, safety and social risk and contractual and legal risk were prominent among the major forms of risks associated with construction project. The regression model indicated that there is significant and positive relationship between risk control measures and risk analytical techniques with coefficient ranging from 0.425 to 0.775. The study concluded that decision making on risk analytical techniques requires systemic overview of risk management process to avert cost and time overrun and recommended among others that contractors should embrace risk analytical models in making decisions on risky project and make adequate provision to incorporate construction related risk factors in the bid estimates.

Keywords Construction projects, risks, decision making, Contingencies, contractors

1. Introduction

Construction activities are susceptible to risk and uncertainty due to the magnitude and nature of the project. Hence, the decision either to managed, minimized, shared, transfer or accept risk on any project requires adequate assessment of risk analytical tools to arrive at Decision Support System (DSS) available to practitioners.

Every project either big or small is set up to achieve set objectives. However, a number of pitfalls exist which may prevent such objectives from being achieved. No matter how well management sets its goals and executes its plans, the goals may be thwarted by unplanned events such as fires, storms, flood, tempest, embezzlement, inflation and other losses [1]. The construction industry is considered to be subject to more risks than other industries. Getting a project from the initial appraisal stage through to completion and facility usage entails a complex and time consuming design and construction processes. This design and construction processes involves a multitude of people from different organization with different skill and interests; thus a great deal of effort is required to coordinate the wide range of project activities usually undertaken. Similarly variety of events may occur during the process of project procurement and many of these can cause losses to either the client or other interested parties. Such events are commonly called risks. For instances, an economic downturn, and fluctuation in the prices of project materials and so on, may cause a prospective client to make less than the expected profit or even run a project at a lose. Such a downturn is called risk event [2].

However, contracting is an ideal business for those who enjoy taking risk. The contractor is continually faced with a variety of situation involving many unknown, unexpected, frequently undesirable and often unpredictable factors. These factors can be conveniently grouped together as risk and uncertainties. An important requirement for successful management in the contracting field is effective evaluation of the risks and uncertainties involved in the everyday business, followed by good decisions based on the evaluation and appropriate action taken as a result of this decision. While the term risk and uncertainties perhaps implied different meanings, their effects are similar. Risk generally refers to situation in which the distribution or probability of occurrence of possible outcomes is either known from past experience or can be calculated with some degree of precision. Summarily, risk is a measurable uncertainty; while uncertainty on the other hand cover situation that are of a relatively unique nature and for which the probability cannot be calculated or measured.

Construction projects are complex in nature and have many inherent uncertainties. These uncertainties are not only from unique nature of the project but also from the diversity of resources and activities. There are many types of risks to which any construction project is prone. Just as there has not been a rigid definition of risk, so also there is no categorical classification of risk in construction projects. Based on the literature and a review by a group of experts, 10 types of risks specific to building construction project were developed. These types are environment, geotechnical, labor, owner, design, area conditions, political, contractor non-labour resources, and material [3-6].

2. Literature Review

2.1 Decision Making on Construction Projects

Construction projects are very risky and complex in nature. Moreover, construction is susceptible and exposed to more risk and uncertainty than any other industry sector [7]. Risk is associated with every project and entails decision making throughout the project life cycle. Along the project life cycle (PLC), there are many decisions to be made. Unfortunately, the most crucial decisions are made in the early stages where very limited precise information is available to support the decision maker. However, risk can be managed, minimized, shared, transferred or accepted; but it cannot be ‘ignored’’ [8].

Researchers have carried out research on different theories and have come up with various tools and methodologies to assist practitioners in assessing risk and making more informative decisions in the case of uncertainty. Many Decision Support Systems (DSSs) are available for practitioners.

The choice of appropriate decision support systems (DSS) tools depends mainly upon the difficulty at knowledge acquisition, required data, explanation capacity, difficulty at development and the appropriate domain [9]. For example, Probability theory (PT) has been extensively deployed in project risk analysis especially project duration risk. Fuzzy Set Theory (FST) and the Analytic Hierarchy Process technique (AHP) are also extensively used for risk assessment and decision making in construction industry.

Unfortunately, in reality such tools are rarely used. Instead, practitioners used to rely upon their personal judgment, past experience, intuition and gut feeling.

Decision making is crucial for the successful completion of any construction project. The decision making process takes place at various stages throughout the project [10]; For example decisions are taken in order to determine the set of construction activities and methods needed for doing the work, and to draw the necessary plans for carrying it out. Such decisions could have a significant impact and performance. In the case of a construction company in particular, this could mean the difference between completing project in curatively and making loss due to the occurrence of failure costs [11].

Considering all sets of construction activities, sequences and possible methods can grow very high and each alternative will have different risks associated with it. In practice it is not possible for managers to deal or investigate the high number of options available and instead they merely rely on judgment and experience in choosing the construction method to be used for carrying out the work [12]. The consequence of such approach is that decision will be made without taking into account the full range of feasible alternatives that might produce more favourable results in terms of potential risks.

3. Research Method

The targeted population the study is the registered construction firms with the Federation of Construction Industry (FOCI) in Nigeria construction industry that are based in Lagos state being the commercial nerve/centre of the nation and where most of the contractors handling major projects in the country reside or have their base and the use of well structured questionnaire administered to appropriate construction firms in Nigeria. The data collected from survey was analyzed through the use of descriptive and inferential statistics. The descriptive statistics entails percentiles, pie-chart, bar-chart among others while the inferential statistics employed were mean score, weighted mean score, mean item score (MIS), relative importance index (RII) and chi-square methods.

4. Analysis and Results

4.1. Demographic Information

Table 4.1 represents the respondents' profile. It shows that majority of the respondents had Higher National Diploma degree (31.50%) while those with the Post Graduate Diploma degree were (19.2%), Bachelor Degree (24.7%) and Masters Degree were (17.8%) respectively. Also, the respondents have had more than nine years of experience while on the job. This implied that the information provided by the respondents is reliable and dependable.

Table 4.1: Respondent's Profiles

Description/Range	Mid-value	Frequency	Percentage
Academic qualification (N= 146)			
Higher National Diploma		46	31.50
Post Graduate Diploma		28	19.20
Bachelor Degree		36	24.70
Master Degree		26	17.80
Doctoral Degree		0	0.00
Others		10	6.80
Years of experience (N= 146)			
1 – 5	3.00	48	32.88
6 – 10	8.00	40	27.40
11 – 15	13.00	32	21.92
16 – 20	18.00	22	15.10
Over 20	23.00	4	2.70
	Mean =	9.37	

Table 4.2 revealed that commercial projects with a mean value of 24.02 were prominent among the projects handled by the respondents in the last five years. This was followed by institutional projects with a mean value of 19.07, Industrial has a mean value of 18.44 while residential projects were least handled during the period. This implied that the organisation have had experience on all aspect of construction categories.

Table 4.2: Project Category Undertaken in the Last Five Years

Project Category	Mean Value
Commercial	24.02
Institutional	19.07
Industrial	18.44
Residential	15.50

4.2. Major Risks on Construction Projects

Table 4.3 categorized the major construction risks on the basis of occurrence and it shows that financial and economic risks; safety and social risks and delay risks with mean interval score value of 3.25; 3.07 and 3.04

respectively occurs very often on construction projects while sub-contractor related risks; contractual and legal risks; design risks; physical risks and operational risks with mean interval score value of 2.88; 2.81; 2.75; 2.74 and 2.67 respectively often occurs on construction projects; and force majeure risks with mean interval score of 1.96 seldomly occurs on construction projects. This implied that the data obtained were authentic and viable.

Table 4.3: Major Risks Associated with Construction Projects

S/N	Category of risk	Weighted mean	Rank
(i)	Financial and economic risk	3.59	1
(ii)	Delay risk	2.87	2
(iii)	Contractual and legal risk	2.86	3
(iv)	Safety and social risk	2.78	4
(v)	Sub-contractor related risk	2.77	5
(vi)	Physical risk	2.67	6
(vii)	Design risk	2.55	7
(viii)	Operational risk	2.47	8
(ix)	Force majeure risk	2.15	9
(x)	Others	1.23	10

Table 4.4 shows the relationship between decision alternatives and risk control measures, and was explained as follows:

Sensitivity: Prediction, Specialization, Control with a mean score of 3.23, 3.18 and 3.16 respectively are strongly affected by (Sensitivity) risk analytical techniques while Diffusion, Selection with a mean score of 2.81 and 2.56 shows affected and Consolidation 1.12 shows not affected.

Decision Tee: Consolidation, Specialization, Control, Prediction, Selection, with a mean score of 3.12, 3.04 and 3.01 are strongly affected with Decision Tree while Prediction, Diffusion, Selection with a mean score of 2.97, 2.71 and 2.62 are only affected the techniques.

Monte Carlo Simulation: Consolidation, Prediction, Specialization, Control, Selection, Diffusion, with a mean score of 2.96, 2.92, 2.88, 2.78, 2.71 and 2.66 respectively shows affected with Monte Carlo simulation.

Probability Theory: Control, Specialization, Prediction with a mean score of 3.16, 3.14 and 3.01 are strongly affected with Probability theory while Diffusion, Consolidation, Selection with a mean score of 2.89, 2.84 and 2.74 only shows affected.

Portfolio Theory: Control, Specialization, Selection, Prediction, Consolidation, Diffusion with a mean score of 2.93, 2.90, 2.89, 2.88, 2.82 and 2.75 respectively shows affected with Portfolio Theory.

Delphi method: Control, Specialization, Selection, Prediction, with a mean score of 3.27, 3.12, 3.03 and 3.01 are strongly affected with Delphi method while consolidation, Diffusion with a mean score of 2.97, 2.86 shows affected with this technique.

Influence Diagram: Consolidation, Control, Specialization, Prediction, with a mean score of 3.19, 3.16, and3.07 are strongly affected with Influence Diagram while Selection, Diffusion with a mean score of 2.96, 2.90 are strongly affected with this technique.

Latin-Hyper-Cube Theory: Control, Selection, Prediction, Diffusion, Specialization, Consolidation, with a mean score of 2.89, 2.82, 2.77, 2.75, 2.74 and 2.68 respectively shows affected with Latin-Hyper-Cube Theory. The survey shows that .Monte Carlo Simulation, Portfolio Theory, Latin-Hyper-Cube Theory mean sore are all affected with the risk analytical techniques.

Table 4.4: Effects of Risk Analytical Techniques on Control Measure

S/N	Risk Analytical techniques	Risk Measures	MIS	Strongly affected	Affected	Indifference	Not affected
1	Sensitivity	Prediction	3.23	Strongly affected			
		Specialization	3.18	Strongly affected			
		Control	3.16	Strongly affected			

		Diffusion	2.81		Affected	
		Selection	2.56		Affected	
		Consolidation	1.12			Not affected
2	Decision Tree	Consolidation	3.12	Strongly affected		
		Specialization	3.04	Strongly affected		
		Control	3.01	Strongly affected		
		Prediction	2.97		Affected	
		Diffusion	2.71		Affected	
		Selection	2.62		Affected	
3	Monte –Carlo Simulation	Consolidation	2.96		Affected	
		Prediction	2.92		Affected	
		Specialization	2.88		Affected	
		Control	2.78		Affected	
		Selection	2.71		Affected	
		Diffusion	2.66		Affected	
4	Probability Theory	Control	3.16	Strongly affected		
		Specialization	3.14	Strongly affected		
		Prediction	3.01	Strongly affected		
		Diffusion	2.89		Affected	
		Consolidation	2.84		Affected	
		Selection	2.74		Affected	
5	Portfolio Theory	Control	2.93		Affected	
		Specialization	2.90		Affected	
		Selection	2.89		Affected	
		Prediction	2.88		Affected	
		Consolidation	2.82		Affected	
		Diffusion	2.75		Affected	
6	Delphi Method	Control	3.27	Strongly affected		
		Specialization	3.12	Strongly affected		
		Selection	3.03	Strongly affected		
		Prediction	3.01	Strongly affected		
		Consolidation	2.97		Affected	
		Diffusion	2.86		Affected	
7	Influence Diagram	Consolidation	3.19	Strongly affected		
		Control	3.16	Strongly affected		
		Specialization	3.07	Strongly affected		

		Prediction	3.07	Strongly affected	
		Selection	2.96		Affected
		Diffusion	2.90		Affected
8	Latin-hyper-cube	Control	2.89		Affected
		Selection	2.82		Affected
		Prediction	2.77		Affected
		Diffusion	2.75		Affected
		Specialization	2.74		Affected
		Consolidation	2.68		Affected

4.3. Test of Hypothesis

H_O: There is no significant relationship between risk analytical techniques and risk control measures.

H_I: There is significant relationship between risk analytical techniques and risk control measures.

Table 4.5 presents the relationship between risk control measures and risk analytical techniques. The result revealed that there is significant, high, positive relationship between risk control measures on each of the analytical techniques with coefficient ranging from 0.425 to 0.775 except control which has moderate coefficient (r=0.425). That is, the relationship between Consolidation (r=0.530, F=5.912, P<0.05), Specialization (r=0.552, P=6.609,P<0.05), Control (r=0.425, F=3.338, P<0.05), Prediction (0.649, F=10.070, P<0.05), Diffusion (r=0.775, F=22.691, P<0.05) and selection (r=0.711, F=15.451, P<0.05). The coefficient of determination r^2 varied between 0.181 to 0.600.In order words, all the identified risk analytical techniques jointly explained 28.10% (r^2=0.281), 30.40% (r^2 =0.304), 18.10% (r^2=0.181), 42.10% (r^2=0.421), 60% (r^2=0.60) and 50.60% (r^2=0.506) of the total variance in Consolidation, Specialization, Control, Prediction, Diffusion and Selection respectively. The remaining un-explained variation in each of the elements of risk analytical techniques can be attributed to variation in other parameters other than Sensitivity Analysis, Probability analysis, Monte Carlo simulation, Decision tree analysis, Latin hyper-cube sampling, Portfolio theory, Delphi method, Influence diagram and others which are otherwise included in the stochastic error term.

Table 4.5: Regression Analysis of Risk Control Measures and Risk Analytical Techniques

Risk Control Measures.	R	R^2	$\bar{R}^2$	F	Sig. F
Consolidation	0.530	0.281	0.234	5.912	0.000
Specialization	0.552	0.304	0.258	6.609	0.000
Control	0.425	0.181	0.127	3.338	0.001
Prediction	0.649	0.421	0.382	10.970	0.000
Diffusion	0.775	0.600	0.574	22.691	0.000
Selection	0.711	0.506	0.473	15.451	0.000

4.4. Discussion of Findings

Assessing the major form of risks and variables associated with construction project. It was observed that out of 9 factors considered financial and economic risk. Delay, sub – contractor related risk, safety and social risk, contractual and legal risk, design risk are the five most highly form of risk associated with construction project while operational, physical and force majeure are the least three factors affecting construction project delivery.

Analysis of risk techniques to arrive at a decision on management of risk on construction project show that sensitivity has the most highest percentage value while Delphi and influence diagram has the least values that shows means of arriving at a decision cannot be arrive through it.

Moreover, the paper showed that risk control measure affect construction project positively. Prediction, one of the risk control measures ranked 1st with mean score of 3.33, specialization (3.22) 2nd and control (3.11) 3rd shows that they are strongly affected. Survey shows that they have positive impact on construction project. Diffusion, consolidation, and selection with mean score of 2.97, 2.75 and 2.59 respectively shows that they both agreed.

The P- value of the correlation coefficient at 95% confidence level indicates that there is no significant relationship between risk analytical techniques and risk control measures. Therefore the null hypothesis is accepted. The regression model result indicated that the significance is high and there is positive relationship between risk control measures and each of the analytical techniques with coefficient ranging from 0.425 to 0.775. This implied that the risk techniques account for 50.60% of variation while 49.40% account for others (unexplained) in the regression model.

5. Conclusion and Recommendation

The construction industry required an effective decision making on construction risk management system in the delivery of construction project. The risk factors should be properly identified, analyzed and controlled. This can be achieved by given preference to risk analytical models, risk control measures in order to respond to risk. The highly important major risk factors such as unavailability of funds, construction delay, inadequate specification, sub-contractors' failure, equipment productivity and other risk factors should be carefully analyzed in managing risks particularly in decision making. Contractors should be given ample time to analyzed risk on construction projects by employing any of the risk analytical techniques in order to avoid being risk averse.

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