A SIMPLIFIED APPROACH TO ON-SITE RELATED RISK FACTORS ASSESSMENT IN EDUCATIONAL INSTITUTIONAL PROJECTS

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ABSTRACT

The degree of differential indices between the expected and actual performances on building projects is becoming increasingly alarming due to many unforeseen and often unpleasant events that come up on site. This paper therefore presents the report of the investigation conducted on site related risk factors which impact building delivery based on a case study of some tertiary educational institutions projects in Nigeria. Data for the assessment were collected from 52 building contracting organizations who had executed building projects in four (4) public tertiary educational institutions in Ekiti State, Southwestern Nigeria, using structured questionnaires. The questionnaires were administered on the contracting organizations' and the client's representatives. Thirty nine (39) questionnaires were retrieved and used to provide quantitative data for the analysis. Data collected were analyzed using mean item score and severity index. Most frequently occurring site related risk factors were; excessive variation order to maneuver site conditions, contractor's improper planning, changes to initial design and design errors. Contractor's improper planning, changes to initial design, problem with sub-contractors and mistakes during the construction stage of the project delivery were among the top factors with lesser degree of severity. The study provides implications for prioritizing responses towards risk variables based on their severity and thus help to improve site planning and overall project performance. Conclusion was drawn that

site related risk factors had significantly contributed to on-site performance of contractors of building projects.

Keywords: building projects, site related risk factors, tertiary education

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1. INTRODUCTION

Risk concept is multidisciplinary in nature because of its vast applications in various fields of human endeavors; information technology related businesses, automobile, pharmaceuticals, insurance, health and construction industry, among others (Hillson, 2004; Ojo, 2010; [3, 7]. Surprisingly, construction industry's risk factors rank highest when compared with the volume of risks experienced in other industries (Patel et al., 2013; Opawole et al, 2019, Zafar, Yousaf and Ahmed, 2016) [10, 8, 15]. Risk in construction are defined by factors not limited to; long project delivery period, complicated processes, unpredictable environment, financial intensity, and dynamic organizational structure. According to the Project Management Body of Knowledge (PMBOK, 2004) [12], construction risk either positively or negatively affect project objectives; time cost and quality. In this regard, significant construction management researches have focused on construction risks (Oztas and Okmen, 2003) [9]. The significant novelty of this work is that it is construction stage specific. It therefore portends the potential to gain insight into the entire spectrum of the construction process and the risk associated with this stage.

Fundamentally, there are five phases in the construction of a building project. These include project planning/feasibility stage, programming and design stage, procurement/tendering stage, construction stage, commissioning and project close out stage (Nnadi and Ogwu, 2013) [5]. Construction phase is often the longest among all the phases in a building project. This implies that the risk factors at this level could be comparatively higher in magnitude and impact compared to those of other stages/phases of a project delivery. As such, appropriate management strategies must be considered in achieving project success and enhancing efficient project performance (Viswanathan and Jha, 2020) [13].

This paper is therefore aimed at investigating site related risk factors that impact building projects with a view to providing 'prioritizing response' information that could offer effective site planning. The specific objectives were to; identify the site related risk factors that are associated with the building projects at this phase and to assess the identified risk factors in terms of frequency of occurrence and degree of impact. To achieve this aim, a survey research approach was adopted to identify the sources of risk factors and to assess the effects on the projects outcomes. For the purpose of this study, the definition of site- related risks is adopted as the uncertain factors or conditions which emanate during the in-progress of the construction activities with the probability of occurrence lying between 1 and 100 % and with the capacity to influence the project objectives of time, cost, quality, scope and environmental sustainability, thereby causing eventual doom or bloom to the building projects stakeholders.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

Baccrini and Acher (2001) [2] submitted that risk is an intrinsic element of construction contract. Therefore the best that can be done to the risk factors is to manage or mitigate them so as to reduce its degree of impact on the project outcomes to the barest minimum (Nieto-

Morote and Ruz-Vila, 2011) [4]. Previous attempts have been made by researchers to investigate risks associated with construction projects as a result of the fact that construction had been widely criticized for poor performance. This is because construction industry has been argued to have the highest magnitude of risk potentials.

Site related risks are viewed as those parameters at the construction stage of project management whose outcome is unpredictable and uncertain in terms of final project cost, completion time and quality standard (Odeyinka et al., 2006) [6]. The site related risk factors comprises of specific on-site based and some hybrids of off-site based factors defining the construction stage performance. The on-site based risk factors are risk events that actually occur during the implementation phase of the building project. They are not limited to; general safety, accident occurrence and poor site management, among others. Meanwhile, off site based risk factors can be conceptualized as risk event that occur outside the geographical confines of the site operations which directly or indirectly affect the construction phase of the project lifecycle. Examples of off-site related risks include; causes of occurrence of accident by a trailer bringing granites to site, fraud perpetrated by a site purchasing officer and fluctuations of market prices of construction materials. Project Management Institute (PMI, 2008) [11] describes risk as unsure happenings or circumstances which should it occurs will have either positive or negative effect on one or more of project's objectives. Many approaches for managing project risks abound in literature, but their suitability for application depends on the phase of the project lifecycle amongst other factors. According to Adedokun et al. (2013) [1], there are two main types of risk assessment method namely; qualitative risk assessment method and quantitative risk assessment method. The latter, which is adopted in this study, involves ascribing some numerical values to risks depending on probability distribution. This is perceived to generate more accurate assessment result than the qualitative assessment which is based on the judgment of the risk manager.

3. RESEARCH METHODOLOGY

A quantitative approach was undertaken to obtain relevant data for this assessment. The study population consists of active project players; architects, services engineers, project managers, procurement officers and land surveyors. The study population comprises of 52 building contracting organizations that had been awarded building contracts between 2011 and 2016 at the four public tertiary institutions in Ekiti State; Ekiti State University, Ado-Ekiti, Federal University, Oye-Ekiti, The Federal Polytechnics, Ado-Ekiti and the College of Education, Ikere Ekiti. Total census of the organizations' and the client's representatives were adopted due to small population size. The questionnaires were self-administered to the construction professionals while others were reached through their e-mail addresses. The questionnaires were designed to obtain information on site related risks encountered during the implementation of their present and past projects. The questions focused on probability of occurrence of the risk factors and their degrees of impacts on project outcome. Fifty-two copies of questionnaires were administered out of which only 39 retrieved (representing a response rate of 75 %) were found suitable for the analysis. The questionnaire was divided into two sections. The first section solicited information on the respondent's personal characteristics. The second section focused on identifying the site related risk with the aim of assessing their likelihood of occurrence and the degree of impacts. Data obtained from this survey were analyzed using mean item score and severity index. In measuring frequency of occurrence and degree of impact of the factors, an index to measure the rating of the risk factors was developed. The frequency of occurrence of the risk factors was termed (RoI) and degree of impact (DoI).

To arrive at this, the following steps were followed:

- The factors obtained from literature review were rated using one of the five likert scales of very high impact (VHI), high impact (HI), moderate impact (MI), less impact (LI) and no impact (NP) as well as most frequent (MF), very frequent (VF), frequent (F), rare (R) and never (N).
- A weighting values of 5, 4, 3, 2 and 1 were attached respectively to each rating of VHI, HI, MI, LI and NP as well as MF, VF, F, R and N.
- Summation of weighting value (SWV) was calculated. This is the addition of the product of the value attached to a rating and respective number of respondents to the rating.
- SWV was divided by the number of respondents;

$$\sum_{i=1}^5 X_i Y_i$$

SWV is expressed mathematically as: $SWV = \frac{\sum_{i=1}^5 X_i Y_i}{N}$

Where SWV connotes summation of weight value; X_i represents the number of respondents to rating i ; Y_i is the weight assigned a value ($i = 1, 2, 3, 4, 5$). The SWV divided by the number of respondents gives the F.O and D.O.I.

$$\frac{SWV}{\sum_{i=1}^5 i} = F.O \text{ and D.O.I}$$

This is expressed mathematically as: F.O and D.O.I =

The Cronbach's Alpha assessment of the questionnaire for the frequency of occurrence and degree of impact were significant at 0,985 and 0,988 respectively.

3.1. Results and Discussion

3.1.1. Profile of the Respondents

The profile of the respondents that participated in the study is as summarized in Table 1. The results show the highest academic qualification of the respondents as Higher National diploma (HND). About 55.3% of the respondents had B.Sc/B.Tech, 23.7% possessed higher national Diploma (HND) and 21.0 % have Master of Science/ Technology (M.Sc./M.Tech) degree. Respondents with 16-20 and above 26 years' experience accounted for 13.2% and 5.3% respectively. On the average, the year of working experience of the respondent is 10.53years. This gives an indication that the respondents have acquired considerable experience in construction industry. Moreover, 23.7% were members of the Nigerian Institute of Quantity Surveyors (NIQS), 18.4% were members of the Nigerian Institute of Builders (NIOB) and Nigerian Society of Engineers (NSE) 12.7% respectively. More than thirteen per cent (13.2%) had Nigerian Institution of Surveyors' membership (NIS) and 10.5% had other professional qualifications. The high percentage of respondents with professional affiliations is a good indication that the quality of information obtained was reliable. The respondents that have executed between 6-10 projects have the highest percentage (36.1%). Respondents that have executed between 1-5 projects represented 33.3%, 16.7% of the respondents have executed between 11-15 projects. Respondents that have executed between 16-20 and 21-25 projects accounted for 5.6% respectively. In the same vein, majority (50%) of the firms are worth more than 100,000,000. Respondents with firm's worth between 10,000,000 and 100,000,000 and less than 10,000,000 accounted for 33.3% and 16.7% respectively. The variety of experiences between each group was considered to enrich the research with different knowledge and information.

Table 1 Profile of the respondents

Background Information	Parameters	Frequency	Percent	Cum. Freq.	Mean
Highest Educational Qualification	M.Sc/M.Tech	8	21.0	21.0	
	B.Sc/B.Tech	21	55.3	76.3	
	H.N.D	9	23.7	100	
	Total	38	100.0		
Professional Designation	Architect	5	12.8	12.8	
	Quantity surveyor	10	25.6	38.5	
	Engineer	9	23.1	61.5	
	Builders	11	28.2	89.7	
	Others	4	10.3	100.0	
	Total	39	100.0		
Professional Qualification	NIQS	9	23.7	23.7	
	NIA	5	13.2	36.8	
	NIOB	7	18.4	55.3	
	NSE	7	18.4	73.7	
	Others	4	10.5	84.2	
	None	6	15.8	100.0	
	Total	38	100.0		
Years of work Experience	1-5 years	9	23.7	23.7	10.53
	6-10	13	34.2	57.9	
	11-15	8	21.1	78.9	
	16-20	5	13.2	92.1	
	21-25	1	2.6	94.7	
	Over 26	2	5.3	100.0	
	Total	38	100.0		
Number of building contract executed till date	1-5	12	33.3	33.3	
	6-10	13	36.1	69.4	
	11-15	6	16.7	86.1	
	16-20	2	5.6	91.7	
	21-25	2	5.6	97.2	
	Over 26	1	2.8	100.0	
	Total	36	100.0		
					9.06
Company Worth	<10,000,000	6	16.7	16.7	359 x 10 ⁷
	10,000,000 - 100,000,000	12	33.3	50.0	
	>100,000,000	18	50.0	100.0	
	Total	36	100.0		

3.1.2. Assessment of risk factors associated with educational institutional buildings

Table 2 shows the results of relative occurrence (RoI) and degree of impact (DoI) of the site related risk factors evaluated. A total of 83 risk factors were evaluated in the main study containing this piece out of which 46 site related variables are reported in this article. The basis of the significance of the risk factors is that they had mean indices which are above aggregate mean computed for all the 46 factors (i.e. $2.89 \leq \bar{x} \leq 3.32$ and $2.35 \leq RII \leq 3.23$, for RoI and DoI, respectively). Respondents that participated in the study were requested to identify the site related risk factors, their frequencies of occurrence and degrees of impact on the projects where they have been involved.

The RoI of all the 46 variables have the mean item scores which ranged as $2.35 \leq RII \leq 3.23$. Subcontractor related bottleneck is most significant with mean item score (MIS) of 3.23, which is ranked first. Contractor's improper planning, design error, safety issues and poor resource management ranked second with MIS of 3.08. Rework from poor quality of materials and materials shortage equally had MIS of 3.03, making them to rank sixth. Need to

comply with new government regulations, interference by clients, unsteady construction techniques with MIS of 3.00 ranked seventh most occurring site related risk factors. Labour shortage with index 2.98 and rework from poor workmanship (MIS = 2.97) ranked eighth and ninth most occurring site related risk factors respectively. The least occurring factors were; injury to persons (2.53), force majeure (2.55), inadequate contractor's experience (2.56), geotechnical uncertainties (2.61), poor productivity (2.63), materials wastage (2.66) and poor site condition (2.67).

The results of the assessment of the relative impact of the risk factors showed that the MIS of the variables ranged as $2.35 \leq RII \leq 3.23$. Mistakes during construction (3.66), contractor's improper planning (3.57) and equipment unavailability and failure (3.47) ranked in the first, second and third position respectively. Inadequate early planning of the project by client scored mean value of 3.43 to rank in the fourth position while labour shortage, non-availability of adequate resources per day on site, poor productivity equally ranked fifth with index of 3.41. Underestimating of project complexity, rework from poor quality of materials and poor workmanship with indices of 3.38, 3.37 and 3.34 ranked sixth, seventh and eighth respectively. The risk factors with least impact were; treatment of antiquities/archaeological remains (MIS = 2.83), mistake in soil investigation (MIS = 3.00), geotechnical uncertainties (MIS = 3.03), production target slippage (MIS = 3.03), unsteady construction techniques (MIS = 3.05), interference by clients (MIS = 3.06), and terrorist attack (MIS = 3.08).

In computing the severity index (SI) of the risk factors, SI = ROI x RIMi model (Opawole et al., 2019) [8] was adopted. The model computes the SI of individual risk factor by multiplying the values of RoI and DoI, of each risk factors. The SI of individual risk factors and their respective rankings were indicated in column seven and 8 in Table 2. In this regard, contractor's improper planning, mistakes during construction, and subcontractor related bottleneck ranked the top three severe factors with indices of 11.00, 10.80 and 10.66 respectively.

Table 2 Site related risk factors associated with tertiary educational institutional projects

S/ N	SRRF	RoI		RImI		SI = FoO x DoI		S/ N	SRRF	RoI		RImI		SI = FoO x DoI	
		$\bar{x}$	R	$\bar{x}$	R	$\bar{x}$	R			$\bar{x}$	R	$\bar{x}$	R	$\bar{x}$	R
1	Mistakes during construction	2.9	1	3.6	1	10.8	2	24	Contractor's poor site management	2.8	3	3.2	2	9.1	2
		5	6	6		0				3	1	2	4	1	9
2	Contractor's improper planning	3.0	2	3.5	2	11.0	1	25	Inadequate contractor's experience	2.5	4	3.2	2	8.2	4
		8		7		0				6	4	2	5	4	4
3	Equipment unavailability & failure	3.0	8	3.4	3	10.4	4	26	Land acquisition & encumbrances	2.8	2	3.2	2	9.2	2
		0		7		1				7	5	2	6	4	3
4	Inadequate early planning of the project by client	2.9	1	3.4	4	10.1	7	27	Difficulties in obtaining approval from appropriate authorities	2.7	3	3.2	2	8.7	3
		7	3	3		9				1	6	2	7	3	3
5	Labour shortage	2.9	1	3.4	5	10.1	8	28	Materials wastage	2.6	4	3.2	2	8.5	3
		8	2	1		6				6	1	2	8	7	6
6	Poor productivity	2.6	4	3.4	5	8.97	3	29	Constructability failure	2.9	1	3.2	2	9.5	1
		3	2	1		0				7	3	1	9	3	4
7	Non-availability of adequate resources per day to site	2.7	3	3.4	5	9.34	2	30	Inclement weather	2.9	1	3.1	3	9.2	2
		4	5	1		1				3	9	6	0	6	2
8	Underestimating project	2.8	2	3.3	8	9.77	1	31	Inexperience of project team	2.6	3	3.1	3	8.4	3
		9	0	8		1				8	9	6	1	7	9

9	complexity Rework from poor quality of materials	3.0 3	6	3.3 7	9	10.2 1	6	32	Design error	3.0 8	2	3.1 6	3 2	9.7 3	1 2
10	Rework from poor workmanship	2.9 7	1 3	3.3 4	1 0	9.92 0	1 0	33	Injury to persons	2.5 3	4 6	3.1 4	3 3	7.9 4	4 5
11	Poor resource management	3.0 8	2	3.3 4	1 1	10.2 9	5	34	Insecurity issues	2.7 0	3 8	3.1 4	3 4	8.4 8	3 8
12	Materials shortage	3.0 3	6	3.3 2	1 2	10.0 6	9	35	Poor site condition	2.6 7	4 0	3.1 1	3 5	8.3 0	4 3
13	Estimating error	2.8 7	2 5	3.3 2	1 3	9.53 4	1 4	36	Safety issues	3.0 8	2 9	3.0 9	3 6	9.5 2	1 6
14	Subcontractor related bottleneck	3.2 3	1	3.3 0	1 4	10.6 6	3	37	Disruption of work in progress	2.7 1	3 8	3.0 9	3 7	8.3 7	4 1
15	Force majeure	2.5 5	4 5	3.3 0	1 5	8.42 0	4 0	38	Delay in issuance of instruction by the consultants	2.8 5	2 8	3.0 8	3 8	8.7 8	3 2
16	Improper construction method	2.8 9	2 0	3.2 9	1 6	9.51 7	1 7	39	Need to comply with new government regulations	3.0 0	8	3.0 8	3 9	9.2 4	2 3
17	Communication gap between parties	2.8 8	2 4	3.2 7	1 7	9.42 9	1 9	40	Terrorist attack	2.7 9	3 3	3.0 8	4 0	8.5 9	3 5
18	Delay in settling claims	2.8 9	2 0	3.2 7	1 8	9.45 8	1 8	41	Interference by clients	3.0 0	8	3.0 6	4 1	9.1 8	2 7
19	Poor planning and program implementation	2.8 9	2 0	3.2 6	1 9	9.42 9	1 9	42	Unsteady construction techniques	3.0 0	8	3.0 5	4 2	9.1 5	2 8
20	Restricted construction area	2.8 2	3 2	3.2 6	2 0	9.19 0	2 6	43	Production target slippage	2.8 7	2 5	3.0 3	4 3	8.7 0	3 4
21	Poor site coordination and resource management	2.9 5	1 6	3.2 4	2 1	9.56 3	1 3	44	Geotechnical uncertainties	2.6 1	4 3	3.0 3	4 4	7.9 1	4 6
22	Civil disturbance	2.8 4	2 9	3.2 4	2 2	9.20 5	2 5	45	Mistake in soil investigation	2.8 4	2 9	3.0 0	4 5	8.5 2	3 7
23	Communication and network failure	2.7 6	3 4	3.2 3	2 3	8.91 1	3 1	46	Treatment of antiquities/archaeological remains	2.9 4	1 8	2.8 3	4 6	8.3 2	4 2

RoI = risk occurrence index; RIImI = risk impact index; SI = severity index; a = index weighting; R = rank

Equipment unavailability and failure (SI = 10.41) which ranked forth, was closely followed by poor resource management (10.29), rework from poor quality of materials (10.21) and inadequate early planning of the project by client (10.19), which ranked fifth, sixth and seventh respectively. Conversely, the factors with least SI are those of; geotechnical uncertainties (7.91), injury to persons (7.91), inadequate contractor's experience (8.24), poor site condition (8.30) and treatment of antiquities/archaeological remains (8.32). These findings indicated a simplified model which could be extended to develop a multi-factor approach for the management of site related risk in construction projects delivery. The study with specific focus on tertiary educational institutional buildings did not agree with findings of Ojo (2010) [7] which identified that the construction site risk factors with highest degree of occurrence were design changes, inadequate specification, local disturbance, poor site investigation, design error, construction errors and weather condition.

It could be observed; however, that some frequently occurring factors which also constitute the high impact site risks in this study conform to those of Ojo (2010) [7]. These risks include mistakes during the construction stage of the building project and Changes to

initial design. It should be noted that these factors are very crucial to project success as any attempt to undermine any of them might jeopardize the achievement of the projects objectives. As such variables, contractor's improper planning, mistakes during construction, subcontractor related bottleneck, equipment unavailability and failure, poor resource management, rework from poor quality of materials and inadequate early planning of the project by client produce very enormous effect on project and thus should be accorded very considerable attention during project planning.

4. CONCLUSION

The study assessed site related risk factors associated with building projects delivery. Findings of the study identified contractor's improper planning, design error, safety issues and poor resource management, rework from poor quality of materials and materials shortage as the most occurring risk factors on site. It also established that contractor's improper planning, mistakes during construction, subcontractor related bottleneck, equipment unavailability and failure were the most severe and posed a significant treat to on-site performance. However, poor site condition and treatment of antiquities/archaeological remains do not have serious effect on the project's outcomes in case of educational institutional buildings. These findings indicated a simplified model which could be extended to develop a multi-factor approach for the management of site related risk in construction projects delivery. The study therefore recommends adequate preparation at the early design stage and application of efficient planning techniques by the contractors building projects to avoid mistakes during the construction stage. The study provides implications for prioritizing responses towards risk variables based on their severity and thus help to improve site planning and overall project performance.

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