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Assessment of the Likelihood of Risk Occurrence on Tendering and Procurement of Construction Projects

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Abstract

The construction industry is plagued by risks above other industries due to its unique features which include the complexity of building activities, extended period of construction, complicated processes, financial intensity and dynamic organisational structure. These risks are not adequately dealt with and result in increased cost, time and reduced quality. While many types of research have been conducted on construction risks, only a few types of research have investigated the impact of risk (at tendering and procurement stage) on construction projects before they commence. Meanwhile, risk issues are better solved at bidding and procurement phase than construction phase as the case has been. Therefore, this paper examines the likelihood, degree of impact and probability of risk occurrence on tendering and procurement of construction projects. It also investigates the significant sources of tendering and procurement risks, the level of awareness and adoption of risk management techniques in construction tendering and procurement. The questionnaire for the study was administered on building contractors and consultants. A total of 44 questionnaires were retrieved and used for the analysis of the study. The statistical tools used for analysis are frequencies, percentages, mean scores and t test. The findings of the study revealed 17 significant sources of risk among the 35 that were investigated. Risks with high likelihood of occurrence, the degree of impact and high probability of occurrence were also indicated in the study. Based on the findings, it was concluded that respondents are aware and adopt risk management techniques on construction projects, but their adoption is at response level rather than identification level. Therefore, the recommendation of the study is that awareness should be created on the need for risk identification before construction projects commence. This should be implemented at professional and organizational level. Construction stakeholders should guard against risks with a high degree of impact and probability of occurrence during tendering and procurement of construction projects. Therefore, this study contributes to the body of knowledge by investigating the significant sources of risks to tendering and procurement, likelihood of risk occurrence, impact of risks and probability of risk occurrence in tendering and procurement.

Keywords: Construction projects, Cost overrun, Impact of risk, Probability of risk, Procurement, Sources of risk, Tendering and procurement.

1. Introduction

The construction industry, like many other industries, is subject to risks (Smith 2003). The industry is one of the most dynamic, challenging and rewarding fields because it is exposed to both predictable and unpredictable risk (Mills, 2001). As a result of the inherent risks in construction process, Tipili, and Ilyasi (2014) concluded that risks cannot be avoided, so it must be recognised, assessed and managed. Buertney, Abeere-inga and Kumi (2013) noted that risks and construction are not mutually exclusive. A risk is an event that can have an adverse impact on project outcome or opportunities that are beneficial to project performance (FAA system, 2000; Oyewobi, Ibrahim and Ganiyu, 2012; Rezakhani 2012).

The risk in the construction industry is more than that of other industries because of its unique features which include complexity of construction activities, extended period of construction, complicated process, financial intensity and dynamic organizational structure. These

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risks are not adequately dealt with thereby resulting in overall increased cost, time and reduced quality (Sun, Man & Wang, 2015). Risk management involves identifying, controlling and assessing managerial resources with coordinated and economic efforts to minimise the probability and impact of unfortunate events to maximise the realisation of poor project objectives (Ahmed, Azhar & Ahmad 2001; Zou, Zhang and Wang, 2007; Mahendra, Pitroda & Bhavsar, 2013).

Risk is a pre-emptive concept rather than reactive and as such if not properly handled, it can lead to risk effects such as cost overrun, time overrun and poor-quality projects (Iqbal, Choudhry, Holschemacher, Ali and Tamosatiene, 2015). There are many kinds of risks namely; safety risks, social risks, business risks, investment risks, military risks and political (Naphade & Bhangale 2013). These risks are commonly faced by contractors in the form of changes in works, delayed payment on contract, financial failure of owner, labour dispute, equipment and material availability, labour productivity, defective materials, equipment productivity, safety, poor quality of work, unforeseen site conditions, changes in government regulation, delays in resolving litigation/arbitration disputes, inflation, cost of legal process and force Majeure (Oyewobi, et al. 2012). The risks faced by the clients are; awarding the design to unqualified designer, defective design and occurrence of accidents because of poor safety procedures (Enhassi & Mosa, 2008).

The concentration of research on construction risks has had efforts mostly channelled towards effects of risks on construction cost, time and quality (Tam, et al. 2004), risk management at design phase (Chapman, 2001) and construction phase (Abdou, 1996). Other researchers investigated risk from life cycle perspective (Zou, et al., 2007), construction projects (Radujkovic & Car-pusic, 2011; Calzadilla, Awinda & Parkin 2012), public private partnership and contingency (Buertney, et al., 2013), organizational performance (Agwu, 2012), Joint venture projects (Adnan, 2008) and insurance in construction industry (Naphade & Bhangale, 2013). However, there is limited research on the impact of risks faced by contractors during tendering and procurement of construction projects. This may be due to underestimation of its importance by both practitioners and the academia. This study argues that risk issues are better solved at tendering and procurement level rather than at construction phase as the case has been.

The importance of tender figures and procurement options for construction projects cannot be overemphasised. Hence, the tendering and procurement phase is a critical stage in the design and construction of projects because it drives the eventual cost, time and quality of construction projects. Therefore, this study contributes to the body of knowledge by investigating the significant sources of risks to tendering and procurement, likelihood of risk occurrence, impact of risks and probability of risk occurrence in tendering and procurement. The study also determined the level of awareness and adoption of risk management techniques in construction tendering and procurement.

2. Literature Review

2.1 Sources of Risks

Ultimately, all risks encountered on a project are related to one or more of the following failures to stay within budgeted cost/forecast/estimate/tender, stipulated time, design, construction and occupancy and meet the required technical standards for quality, functions, fitness for purpose, safety and environment preservation (Flanagan & Norman 1993). For risks to be effectively eliminated, the sources must be identified and appropriately mitigated. According to Slattery and Bodapati (2001), the sources of risks are schedules, cost, quality, technical, unknown conditions, international, environmental and safety. It was noted in Zou, et al. (2007) that cost related risks include tight project schedule, design variations, changes by the client, unsuitable construction program planning, occurrence of dispute, price inflation of construction materials, excessive approval procedures in administrative government departments, incomplete approval, incomplete or inaccurate cost estimate and inadequate program scheduling. Albogamy and Dawood (2015) noted that the sources of risks are majorly lack of project management skills and competencies. The sources of risks identified by Sayegh and Mansour (2015) are inefficient planning, quality compromise and integrity of design. Table 1 shows the updated sources of risks on construction projects based on the compilation of Radujkovic and Car-pusic (2011:2).

Table 1: Classification of Risk Sources

External Sources		**Internal Sources**	
Legislative	1. Local regulations	Contract	1. Unrealistic deadline
	2. Permits and agreements		2. Unrealistic price
	3. Law changes		3. Other contract provisions
	4. Standards		4. Quality compromise
Political	1. Policy changes	Resources	1. Shortage of workers
	2. Elections		2. Shortage of machinery
	3. War		3. Machinery breakdowns
	4. Existing agreements		4. Late delivery of materials
Economical	1. Economic regulations	Technical	1. Delay
	2. Price rises	Document	2. Incompleteness
	3. Exchange rates		3. Imprecision
	4. Financing conditions		4. New solutions as consequence of 2&3

	5. Economic policy changes		5. Integrity of design
Social	1. Education, culture	Human Factor	1. Productivity
	2. Seasonal work		2. Sick leaves
	3. Strike		3. Motivation
	4. Human fluctuation		4. Errors and omissions
Natural	1. Climate	Resources	1. Shortage of workers
	2. Soil		2. Shortage of machinery
	3. Subterranean waters		3. Machinery breakdowns
	4. Natural disasters		4. Late delivery of materials
		Technology	1. Poorly chosen tech. solutions
			2. Obsolete technology

These sources were classified into two (external and internal). The internal sources were grouped into six, and the external were grouped into five. Twenty-one of the sources are external, and 19 are internal. Calzadilla, Awinda and Parkin (2012) also classified the sources or risks into external and internal. External sources consist of natural/regional sources and the construction industry while internal sources consist of project and company. Under the national, regional sources, there is political situation (national worker's strike, nationalisation of basic industries and labour union), economic/financial (currency exchange control) and social environment (unskilled labour). Construction industry consists of market fluctuation (suppliers bargaining power and shortage of materials and materials and equipment) and laws and regulations (restriction of import or export materials and equipment). From Figure 1, it is evident that if risks are not controlled from sources, they will lead to effects such as time delays and cost overrun.

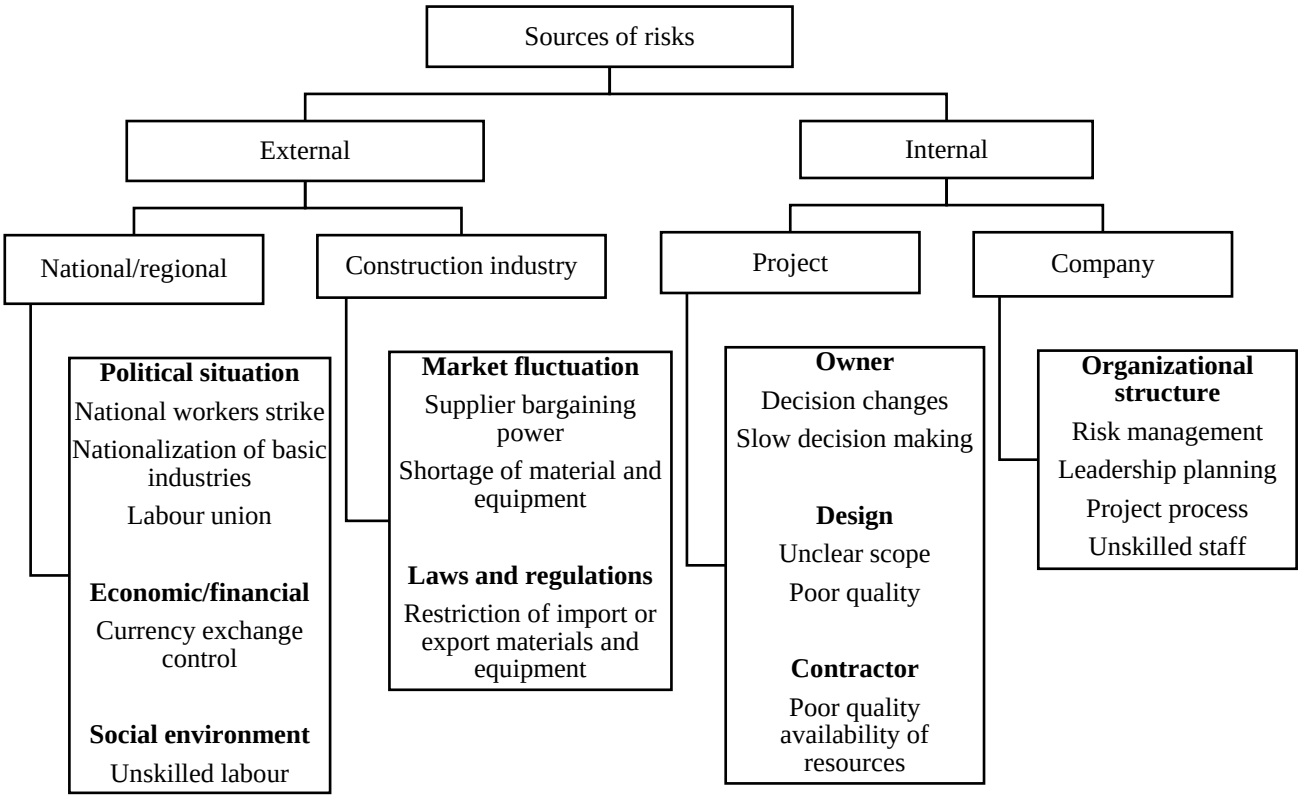

Figure 1: Sources of risks and their effects
Adapted from Calzadilla, Awinda and Parkin (2012: 1215)

2.2 Types of risks in construction

Four types of risks were highlighted by Mahendra et al. (2013) and they are: (1) technical risks- incomplete design, inadequate specification, insufficient site investigation, change in scope, construction procedures and inadequate resource availability, (2) construction risks- labour productivity, labour disputes, site condition, equipment failures, design changes, to high quality standard and slow technology, (3) physical risks- damage to structure, damage to equipment, labour injuries, material, fire and theft and (4) organizational risks- contractual relations, contractor's experience, attitudes of participants, inexperienced work force and poor communication. All these types of risks can be experienced on any construction project; therefore, they must be mitigated from their sources to prevent cost and time overrun.

The types of risks identified by Taghipour, Seraj, Fatemah, Hassani and Kheirabadi (2015) are delays in payment of contractors' claim and low commitment to quality of work by contractor. These types of delays are mutually inclusive because when client delays contractor's payment, the net effect is that contractor's commitment to the work or its quality will reduce. The way to arrest the risks is to identify and control them even before project commences. Ahmed, et al. (2001) noted that the types of risk are acts of God (flood, earth quake, land slide, fire, wind damage and lighting), physical (damage to structure, equipment, labour injuries, materials and equipment fire and theft), financial (exchange rate fluctuation, financial default of subcontractor and non-convertibility), political and environmental (changes in laws and regulations, war and civil disorder, requirement for permits and their approval, pollution and safety rules, expropriation and embargoes), design (incomplete design scope, defective designers and omissions, inadequate specifications and different site conditions) and construction related (weather delays, labour dispute and strike, labour productivity, differing site conditions, defective work, design changes and equipment failure.

Shrestha (2011) categorised risks into political risks which include political decision making, the right of way's risk, competing facilities' risk, regulatory risk, protectionism and legislation change. Other categories are economic risks (pre-investment risk, toll revenues, financial risks and cost overrun risk), socio-cultural risks (public opinion, environmental risks, moral hazard, partnering risks and environmental justice), technical risks (project management risks, construction risks, design and latent defect risk, technology risks, force Majeure physical risks). Oyewobi et al. (2012) noted the classification of risks to be design risks (defective design, variation of work, changes in original design and deficiencies in description of work), financial risk (inflation, inadequate cash flow, exchange rates, cost overrun due to schedule delay and contractors default), construction risk (contractors competence, defective material, poor performance of supplier, poor quality of work, productivity of equipment, labour, material and equipment availability and unforeseen site condition) and political risks (political uncertainty, bank policies, changes in government regulations, permits and ordinances and force Majeure).

Table 2 summarises the types and classification of risks as reviewed in this study.

Table 2: Classification and types of risks

Author	Classification of risks	Types of risks
Mahendra *et al.* 2015 Banaitiene and Banaitis, 2012	Technical, Construction, Physical and Organization, Local, Global and Technological Change	Incomplete design, inadequate specification, inadequate site investigation, change in scope, construction procedures and insufficient resource availability; labour productivity, labour disputes, site condition, equipment failures, design changes, to high quality standard and slow technology; damage to structure, damage to equipment, labour injuries, material, fire and theft; contractual relations, contractor's experience, attitudes of participants, inexperienced work force and poor communication
Taghipour, *et al.,* 2015; Iqbal *et al.* 2015; Banaitiene and Banaitis, 2012; Oyewobi *et al*. 2012	Design, Financial, Construction and Political	Defective design, variation of work, changes in original design and deficiencies in description of work; inflation, inadequate cash flow, exchange rates, cost overrun due to schedule delay and contractors default, accidents, defective designs; contractors competence, defective material, poor performance of supplier, poor quality of work, productivity of equipment, labour, material and equipment availability and unforeseen site condition and; political uncertainty, bank policies, changes in government regulations, permits and ordinances and force Majeure, delays in payment of contractors' claim and low commitment to quality of work by contractor
Banaitiene and Banaitis, 2012 Shrestha, 2011	Political, Economic, Sociocultural and Technical	Political decision making, right of way's risk, competing facilities' risk, regulatory risk, protectionism and legislation change; pre-investment risk, toll revenues, financial risks and cost overrun risk; public opinion, environmental risks, moral hazard, partnering risks and environmental justice; project management risks, construction risks, design and latent defect risk, technology risks, force Majeure physical risks.
Ehsan *et al.* 2010	Technical, Logistics, Management related, Environmental, Financial and Socio-political	Inadequate site investigation, incomplete design, appropriateness of specifications and uncertainty over the source and availability of materials; availability of sufficient transportation facilities and availability of resources; uncertain productivity of resources and industrial relations problems; weather and seasonal implications and natural disasters; availability and fluctuation in foreign

		exchange, delays in payment, inflation, local taxes and repatriation of funds; constraints on the availability and employment of expatriate staff, customs and import restrictions and procedures, difficulties in disposing of plant and equipment and insistence on use of local firms and agent
PMBOK, 2008	Technical, External, Organizational, Environmental and Project management.	-
Ritchie, 2007	-	Delay in award of tender, access to site, site conditions, design responsibility, ambiguities in documentation, extension of time, interface risks, fit–out works, subcontracting, scope of works, fit for purpose and cultural heritage.
Ahmed *et al.* 2001	Acts of God, Physical, Financial, Political and environment, Design and Construction related	Flood, earth quake, land slide, fire, wind damage and lighting; damage to structure, equipment, labour injuries, materials and equipment fire and theft; exchange rate fluctuation, financial default of subcontractor and non-convertibility; changes in laws and regulations, war and civil disorder, requirement for permits and their approval, pollution and safety rules, expropriation and embargoes; incomplete design scope, defective designers and omissions, inadequate specifications and different site conditions; weather delays, labour dispute and strike, labour productivity, differing site conditions, defective work, design changes and equipment failure.

From two case study projects, Ritchie (2007) found that the types of risks include, delay in award of tender, access to site, site conditions, design responsibility, ambiguities in documentation, extension of time, interface risks, fit–out works, subcontracting, scope of works, fit for purpose and cultural heritage. Banaitiene and Banaitis (2012) grouped risks into local, global, economic, physical, political and technological change. PMBOK (2008) categorised it into technical, external, organisation, environmental or project management. Financial issues for projects, accidents and defective designs are the important types of risks on construction projects according to Iqbal et al. (2015). Ehsan et al. (2010) pointed out that the categories of risks are technical (inadequate site investigation, incomplete design, appropriateness of specifications and uncertainty over the source and availability of materials), logistic risks (availability of sufficient transportation facilities and availability of resources), management related risks (uncertain productivity of resources and industrial relations problems), environmental risks (weather and seasonal implications and natural disasters) and financial risk (availability and fluctuation in foreign exchange, delays in payment, inflation, local taxes and repatriation of funds), socio-political (constraints on the availability and employment of expatriate staff, customs and import restrictions and procedures, difficulties in disposing of plant and equipment and insistence on use of local firms and agent). From the types and classes of risks reviewed, it evident that only nomenclature changes, the risk types are the same.

2.3 Risk management techniques in the construction industry

Chen, Zhang, Liu and Hu (2015) discovered that risk perceptions have adverse effects on bids and the probability or magnitude of potential gain or loss have significant impacts on risk perceptions. Al-Shilby, et al. (2013) classified risk assessment methods in quantitative and qualitative methods, the qualitative method involves right judgment, ranking options, comparing option and descriptive analysis. The quantitative technique includes probability, sensitivity, scenario and simulation analysis. Qualitative assessment involves identifying: (1) risks hierarchy which is based on probability of risk occurrence and its impact on the project and employees (2) risks scope and (3) risk occurrence factors. Quantitative risk analysis involves evaluation of the impact of all identified and quantified risk. The results of quantitative methods are more objective than those from qualitative risk analysis. Risk management is divided into risk identification, risk assessment, risk response and risk treatment.

Risk identification involves identifying and applying procedures for identifying opportunities, losses of risks, how and why risks arise, analysing the processes of identifying risks, scenario analysis to identify risks, physical inspection to identify risk, risk source, use of questionnaire, interview, brainstorming, SWOT and examination of local/oversees experience to determine the risk. Risk assessment involves analyses/evaluation of opportunities, SWOT, risk collation, analysis of risk according to likelihood, consequence, quantitative analysis methods, reputation impact, achievement of objectives, financial impact and qualitative analysis method. Risk response involves identification of risk management plan, considering limits to achieve risk management objectives, evaluate cost and benefits of identifying risks, finding out the effectiveness of available controls and risk management responses, prioritising risks that cause great losses and identifying up to rate business continuity plan. Risk treatment involves understanding the risk faced by organizations, regarding communication aboard risk, supporting effective management of risk

between staff and management, providing appropriate level of control regarding risks, risk transfer, risk reduction, monitoring the effectiveness of risk management, avoiding risk and accepting/retaining risk.

Risk management according to Mahendra, et al. (2013) is in four stages – Risk identification, risk assessment, risk response planning and risk control. Risk identification involves brainstorming, Delphi technique, interview/export is categorised into quantitative and quantitative techniques. The quantitative technique involves risk priority numbers, and quantitative technique involves sensitivity analysis, scenario analysis, probabilistic (Monte Carlo simulation) analysis, decision trees, Risk, response involves risk avoidance, risk transfer, risk mitigation/reduction, risk exploit, risk sharing, risk enhancement, risk acceptance and contingency plan. Naphade and Bhangale (2013) noted that the methods of identifying risks are brainstorming, interviews, questionnaire, services specialists and past experience. Risk can be managed by using existing assets, contingency planning and investing in new resources. Risk management strategies are risk prevention (including risk avoidance), impact mitigation, risk sharing, insurance and risk retention. Ritchie (2007) claimed that risk elimination, reduction, transfer and retention are ways of mitigating risk. The risk identification techniques put forward by Kansal and Sharma (2012) are brainstorming, Delphi technique, interview/expert judgment, checklist, influence diagram, flow chart and cause-and –effect diagram. Risk management techniques according to Ehsan, et al. (2010) are risk identification, risk quantification, risk response development and risk response control. Risk response is classified into acceptance, quantification, monitoring the risks, preparing contingency plans, transferring and mitigating risk.

2.4 Impact of risks on tendering and procurement of construction projects

It is important to note that risk inherence is not peculiar to the construction industry alone; however, it is more prominent and grave in the construction industry because of its unique features like complexity of projects, time is taken for construction to complete and the number of stakeholders with different interests involved in a project. Researches have been conducted on risk and risk management concerning cost, time and quality (Tam, et al. 2004) among others. However, the studies appear to be reactive in their approach rather than preventive. Therefore, it would be more beneficial to consider risk and its management at the tendering and procurement stage. The work of Abdul-Razak (2013) indicates that the traditional and integrated/management systems are the two methods of construction projects procurement in Ghana and the traditional system is dominant and popularly used for public projects. Hence, it was discovered that delay in retention release, financial and design risk factors have the highest impact on works procured through National Competitive Tendering (NCT).

Oyewobi, et al., 2012 found that defects in design, inflation, contractor's competence, political uncertainty and changes in government had greatest impact on contractors' tender figure whereas likely trend in wages rates, excessive approval procedure in administration of government departments, unavailability of sufficient amount of unskilled labor and technical manpower and resources of the company were the most significant factors to be considered by contractors when estimating pricing risks. Mantzaris (2014) stated in his work that procurement practices led to corruption in South Africa's national and provincial departments. Hence, concerning the various forms of corruption in the public sector, the roles that systems, risk management imperatives and procurement management play in combating corruption could act as shields against fraud, collusion, extortion and similar corrupt activities. It was also noted that the most crucial element in fighting corruption is political will.

It is worthy of affirmation that there are various fraud and corrupt practices in tendering and procurement of construction projects and this constitutes significant risks to those projects. CIPLA Counter fraud Centre (2015) highlighted key tendering and procurement risks as price fixing, market sharing, bid rigging, manipulation of specifications, manipulation of procurement procedures, bribery for awarding contracts, corruption for disclosing confidential information, conflict of interest and cyber-fraud among others. Agerberg (2012) found that the present risk management process is acceptable but can be improved by a better structure. It was also noted that risk management processes would be enhanced if threats were separated from opportunities both in the identification and analysis phase. CIPLA Counter fraud Centre (2015) pointed out that standard risk management processes and procurement fraud risks should be identified and assessed and appropriate strategies for their management (estimating the probability, impact and proximity of each risk) should be implemented and kept under review. Hence, this study investigates the likelihood, degree of impact and the probability of risk occurrence on construction projects at tendering and procurement phase. This will enable clients, consultants and contractors to know the risks to avoid and how to avoid them.

3. Methodology

The survey research design (quantitative and qualitative methods) was used to collect information for this study. The population of the study is the construction organizations that are involved in project tendering and procurement in Lagos, Nigeria. Lagos was used because it is the economic hub of Nigeria; therefore, many construction works are being executed there. Also, many construction organizations have their head offices or at least a branch office situated in Lagos state, thus making access to projects and respondents easy. The consultants' views were obtained because they are usually involved in the selection process of contractors during the tendering and procurement stage. The construction organizations' list was obtained from the Federation of Construction Industry (FOCI) (57) and construction professional bodies (61). Hence, 118 organizations were obtained and used as the population for this study. To further understand the positions of respondents on the questions raised for the study, informal interviews were conducted with some of them. However, the reports of the interview were not

presented in the study as they were only meant to lend further credence to the questionnaires' responses.

The reliability of the variables used in the study was tested with the Statistical Package for Social Scientists (SPSS 24), and the results of reliability statistics shows that the Cronbach's Alpha for sources of risk is 0.839; likelihood of occurrence of risk is 0.984; degree of impact of risk is 0.896; Awareness of risk mitigation measures is 0.941 and Adoption of risk mitigation measures is 0.623 respectively. Cronbach's alpha values of 0.7 and above indicate higher reliability of instruments and are therefore generally accepted for reliable instruments (Polit & Hungler, 1985).

Using the formula proposed by the Creative Research System (2001), sample size was calculated to be 90 (see formula below). Hence, A total of 90 questionnaires were sent out to capture relevant information on the study and 44 were retrieved giving a response rate of 49%. This response rate is acceptable and not uncommonly low as noted in Dosumu and Onukwube (2013). The sampling was based on convenience as organizations on the lists that are equally willing to provide information were considered for the study. The data for the study were analysed with frequencies, percentages and mean scores.

The formula proposed by the Creative Research System (2001) is stated thus:

$$SS = \frac{Z^2 \times P \times (1-P)}{C^2} \qquad (1)$$

Where: SS = Sample size, Z = Z-value at 95% confidence level (1.96), P = probability of selecting a population member (0.5), C = Margin of error at 95% confidence level (0.05)

Also in calculating total risks and probability of occurrence of risks on construction tendering and procurement, the formulae proposed by National Institute of Standards and Technology (2012) as described below were used:

1. Total Risk = likelihood of occurrence (L) X degree of impact (I)
2. Probability of occurrence (P) = (Total risk/ cumulative total risk)

4. Data Analysis

Table 3 presents the information on respondents, projects and organizations used for the study. Information covered includes profession of those surveyed, type of service rendered, sector of project involvement, work experience, educational qualification, professional affiliation, type of projects handled and procurement methods used for projects.

It can also be deduced from Table 3 that builders and quantity surveyors dominate the study and contractors who work in both public, and private projects are well represented in the study. Respondents with 1-15 years' work experience, B.Sc, M.Sc and appropriate professional qualification are the information providers for the study. Thus, the respondents of the study are well qualified. The types of buildings handled by respondents' organisation are 36.4% residential, 9.1% institutional, 9.1% religious and 45.5% commercial. The traditional procurement method was used on 9.1% of projects, design and build method was used on 45.5% of projects and project/construction management method was used on 45.5% of projects.

Table 3: Background information on respondents, projects and organizations

Profession of respondents	**Frequency**	**%**
Architecture	4	9.1
Civil/Structural engineering	8	18.2
Quantity surveying	16	36.4
Building	12	27.3
Others, specify	4	9.1
Type of service rendered		
Consultancy	16	36.4
Contracting	28	63.6
Sector of project involvement		
Public	20	45.5
Private	24	54.5
Work experience		
1-5	16	36.4
6-10	16	36.4
11-15	8	18.2
16-20	4	9.1
Educational Qualification		
HND/B.Sc.	20	45.5
M.Sc.	24	54.5
Professional affiliation		
Nigerian Institute of Architects (NIA)	4	9.1
Nigerian Society of Engineers (NSE)	8	18.2
Nigerian Institute of Quantity Surveyors (NIQS)	20	45.5
Nigerian Institute of Building (NIOB)	12	27.3
Type of projects handled		
Residential	16	36.4
Institutional	4	9.1
Religious	4	9.1
Commercial	20	45.5
Procurement method		
Traditional	4	9.1
Design and Build	20	45.5
Project/Construction Management	20	45.5

Table 4 indicates that the highly rated sources of risks in construction tendering and procurement according to mean values are poorly chosen technical solution (3.73), bad management (3.64), errors and omission (3.55), unrealistic price (3.55) and economic

Table 4: Sources of risks in construction tendering and procurement

Sources of risks	Mean	Std. Deviation	Rank	p- value	Remark
Unrealistic deadline	3.82	1.126	1	0.000	Significant
Poorly chosen technical solution	3.73	0.973	2	0.000	Significant
Bad management	3.64	1.080	3	0.000	Significant
Errors and omission	3.55	0.999	4	0.001	Significant
Unrealistic price	3.55	1.320	4	0.009	Significant
Unskilled staff	3.50	1.377	6	0.027	Significant
Economic regulations and price inflation	3.45	1.247	7	0.020	Significant
Education and culture	3.36	1.163	8	0.044	Significant
Changes in law and standards	3.36	1.080	8	0.031	Significant
Climate and soil condition	3.36	1.080	8	0.031	Significant
Financing conditions	3.36	1.313	8	0.073	Not significant
Late delivery of materials	3.36	1.163	8	0.044	Significant
Delay in preparation of document	3.36	1.313	8	0.073	Not significant
Sick leaves	3.30	0.911	14	0.044	Significant
Obsolete technology	3.27	1.370	15	0.194	Not significant
Incomplete document	3.18	1.352	16	0.377	Not significant
Unfamiliarity with local conditions	3.09	1.254	17	0.633	Not significant
Human fluctuation	3.09	0.910	17	0.511	Not significant
Local regulations, permits and agreements	3.09	1.178	17	0.611	Not significant
Inadequate contractor experience	3.00	1.141	20	1.000	Not significant
Risk management planning process	3.00	1.294	20	1.000	Not significant
Low productivity	3.00	1.141	20	1.000	Not significant
Shortage of materials	2.91	1.326	23	0.652	Not significant
Shortage and breakdown of machinery	2.91	1.326	23	0.652	Not significant
Imprecise specification	2.91	1.460	23	0.682	Not significant
Season-related work	2.91	1.254	23	0.633	Not significant
Poor motivation	2.82	0.724	27	0.103	Not significant
Shortage of workers	2.73	0.973	28	0.070	Not significant
Suppliers bargaining power	2.73	1.227	28	0.148	Not significant
Electioneering process of politicians	2.73	0.872	28	0.044	Significant
Exchange rates	2.64	1.511	31	0.118	Not significant
Uncertain relationship between project participants	2.45	1.389	32	0.013	Significant
War and unrest	2.45	1.577	32	0.027	Significant
Force majeure	2.18	0.843	34	0.000	Significant
Natural disaster	1.91	1.522	35	0.000	Significant

Regulations and price inflation (3.45). However, when the one sample t test was applied to determine the significance of the sources of risks statistically, it was discovered that 17 out of the 35 sources investigated are statistically significant ($P < 0.05$). It is important to state that, some of the statistically significant sources of risks have low mean values, but the statistical inference makes sense in practical terms. For example, electioneering process, uncertain relationships among project participants and natural disasters have low mean scores, but it is practically reasonable that risks are constituted when any of them exist. Therefore, if risks are to be averted, the 17 discovered significant sources of risks should be prevented regardless of what the mean scores read in the study. Table 5 depicts the likelihood of risk occurrence, degree of impact of risks, total risks and probability of occurrence of risk on construction tendering and procurement.

Table 5: Total risk and probability of occurrence of risk in construction tendering and procurement

Risks	Likelihood of occurrence	Degree of impact	Total risk	Probability of occurrence
Flood, earthquake, landslide, fire, wind	1.09	2.55	2.78	0.0075
Inclement weather	2.36	2.45	5.78	0.0156
Design failure/defective design	2.09	2.45	5.12	0.0138
Human resource management challenge	2.00	2.70	5.40	0.0146
Equipment failure	2.60	3.18	8.27	0.0223
Project complexity	2.20	2.82	6.20	0.0167
Poor project management	1.60	2.64	4.22	0.0114
Wrong construction technology	1.82	2.45	4.46	0.0120
Inadequate site investigation	2.00	2.00	4.00	0.0108

Inappropriate specifications	2.67	1.73	4.62	0.0125
Labour and material supply challenges	1.91	2.73	5.21	0.0141
Unavailability of equipment and productivity challenge	2.00	2.73	5.46	0.0147
Bad market condition	2.45	3.18	7.79	0.0210
Financial default by client	2.73	3.09	8.44	0.0228
Interest rate challenge	2.09	3.36	7.02	0.0190
Delayed payment	2.18	2.18	4.75	0.0128
Global economic pressure	2.64	2.27	5.99	0.0162
Incomplete design	2.27	2.82	6.40	0.0173
Differing site conditions	2.36	2.73	6.44	0.0174
Change in scope	2.18	3.00	6.54	0.0177
Estimation error/methods	2.27	2.60	5.90	0.0157
Low credibility of shareholders and lenders	2.36	2.27	5.36	0.0145
Change in bank formalities and lenders	1.55	2.45	3.80	0.0103
Insurance risk	3.00	3.18	9.54	0.0258
Inadequate cash flow	3.00	3.09	9.27	0.0250
Contractors default	2.73	3.18	8.68	0.0234
Local taxes	2.27	2.55	5.79	0.0156
Increased material cost	2.82	2.00	5.64	0.0152
Low market demand	1.82	1.91	3.48	0.0094
Legislative/statutory influence	1.73	3.00	5.19	0.0140
Customary rights and litigation	2.45	1.82	4.50	0.0122
Public opinion	1.45	1.64	2.38	0.0064
Availability and employment of expatriate staff	1.91	2.00	3.82	0.0103
Difficulty in disposing of bad plant and equipment	1.27	3.30	4.19	0.0113
Bribery and corruption	3.20	2.40	7.68	0.0207
Language and cultural barrier	2.09	2.18	4.56	0.0123
Bureaucracy	1.82	1.80	3.28	0.0089
Force majeure	1.20	2.09	2.51	0.0068
Defects in supervision	2.36	2.82	6.66	0.0180
Safety of workers and materials	3.36	3.45	11.59	0.0313
Poor quality of work	2.91	2.64	7.68	0.0207
Location of project	2.73	2.36	6.44	0.0174
Unforeseen site conditions	2.73	3.27	8.93	0.0241
Defective work	2.27	3.00	6.81	0.0184
Breach of contract by project partner	1.73	2.82	4.88	0.0132
Lack of enforcement of legal judgment	1.36	2.09	2.84	0.0077
Improper verification of contract document	1.73	2.18	3.77	0.0102
Uncertainty and unfairness of court judgment	1.45	1.55	2.25	0.0061
Internal management problem	1.55	1.73	2.68	0.0072
No past experience on similar project	1.18	1.27	1.50	0.0041
Short tender time	1.82	2.20	4.00	0.0108
Improper project feasibility study	1.64	2.27	3.72	0.0100
Poor relation and dispute with partner	2.09	2.09	4.37	0.0118
Poor team work	1.73	2.60	4.50	0.0122
Industrial relation problem	2.00	2.55	5.10	0.0138
Land acquisition	1.73	2.73	4.72	0.0127
Damage to structure and equipment	2.20	2.30	5.06	0.0137
Labour injuries	1.64	2.27	3.72	0.0100
Defective design	1.64	2.45	4.02	0.0109
Errors and omission	2.36	3.00	7.08	0.0191
Variation of work	2.18	2.55	5.56	0.0150
Changes to original design	2.00	2.55	4.72	0.0127
Deficiencies in description of work	1.64	2.36	4.59	0.0124
Wrong construction procedure	2.27	2.80	4.95	0.0134
Logistics	2.09	2.18	4.56	0.0123
Bad contractual relations	1.73	2.73	4.72	0.0127
Contractors and work force experience	2.09	2.91	6.08	0.0164
Poor attitude of participants	2.55	2.64	6.73	0.0182
Poor communication	1.82	3.10	5.64	0.0152

It is worthy of note that risks with high likelihood of occurrence and degree of impact are the ones that have high probability of occurrence. Hence, those risks need to be watched by contractors and other stakeholders during

tendering and procurement of construction projects. from the calculations in table 4, the risks with the highest probability of occurrence in tendering and procurement are equipment failure (0.022), market condition (0.021), financial default by client (0.023), insurance risk (0.026), inadequate cash flow (0.025), contractor default (0.023), bribery and corruption (0.021), safety of workers and materials (0.031), quality of work (0.021) and unforeseen site conditions (0.0241). The implication of this result is that knowledge of the risks with the highest probabilities of occurrence will assist construction organizations to guard against them and devise appropriate risk management technique to be adopted for them.

Table 6 shows the respondents level of awareness and adoption of risk management techniques for construction tendering and procurement. The respondents are mostly aware of past experience (3.40), interview/ expert opinion (3.20), ranking options (3.09) and risk control (3.0) among other techniques. Also, it is clear that the level to which respondents adopt risk management techniques in construction tendering and procurement include; risk sharing (3.55), comparison (3.45), risk enhancement (3.27), contingency plan (3.27), risk transfer (3.27), descriptive analysis (3.27), interview/ expert opinion (3.20), ranking option (3.18), flow chart (3.0), risk control (3.0) and risk exploit (3.0). It is important to note that on top of the table are risk response strategies, followed by risk assessment strategies and then risk identification strategies. This indicates that many of the respondents' organisation only do risk intervention and evaluation while risk identification is utterly neglected. When risk identification is made, there may be less need for risk assessment and response because they may have been averted at the point of identification.

Table 6: Level of awareness and adoption of risk management techniques for construction tendering and procurement

Management techniques	Mean	Awareness	Rank	Mean	Adoption	Category	Rank
Risk sharing	2.64	Normal	9	3.55	Normal	Risk response	1
Comparing options	2.55	Normal	15	3.45	Normal	Risk assessment	2
Risk enhancement	2.64	Normal	9	3.27	Normal	Risk response	3
Contingency plan	2.45	Normal	19	3.27	Normal	Risk response	3
Risk transfer	2.45	Normal	19	3.27	Normal	Risk response	3
Descriptive analysis	2.73	Normal	6	3.27	Normal	Risk assessment	3
Interview/expert opinion	3.20	Normal	2	3.20	Normal	Risk identification	7
Ranking options	3.09	Normal	3	3.18	Normal	Risk assessment	8
Flow chart	2.64	Normal	9	3.00	Normal	Risk identification	9
Risk control	2.64	Normal	9	3.00	Normal	Risk control	9
Risk acceptance	3.00	Normal	4	3.00	Normal	Risk response	9
Risk exploit	2.73	Normal	6	3.00	Normal	Risk response	9
Brainstorming	2.64	Normal	9	2.91	Normal	Risk identification	14
Probabilistic analysis	2.64	Normal	9	2.91	Normal	Risk assessment	14
Risk mitigation/reduction	2.45	Normal	19	2.82	Normal	Risk response	16
Scenario analysis	2.45	Normal	19	2.73	Normal	Risk assessment	17
Decision tree direct judgment	2.64	Normal	9	2.55	Normal	Risk assessment	18
Risk priority number	2.73	Normal	6	2.55	Normal	Risk assessment	18
Questionnaire	2.27	Low	27	2.55	Normal	Risk identification	18
Checklists	2.90	Normal	5	2.55	Normal	Risk identification	18
Monte-Carlo simulations	2.36	low	24	2.55	Low	Risk assessment	18
Sensitivity analysis	2.64	Low	9	2.36	Low	Risk assessment	23
Cause-effect diagram	2.30	Low	26	2.33	Low	Risk identification	24
Risk avoidance	2.55	Normal	15	2.27	Low	Risk response	25
Delphi technique	2.45	Normal	19	2.18	Low	Risk identification	26
Influence diagram	2.36	Low	24	1.73	Low	Risk identification	27

5. Discussion of Findings

The study of the impact of risks on tendering and procurement of construction projects is necessary to prevent cost and time overrun before their symptoms begin to unfold. The significant sources of risks on construction projects according to this study are poorly chosen technical solution, bad management, errors and omission, unrealistic price, economic regulations and price inflation among others. 17 statistically significant sources of risks were identified from the 35 that were investigated. In comparison with the previous study, the results of this study are quite different those of Flanagan and Norman (1993) and Slattery and Bodapati (2001) among others. The finding of Zhou, et al. (2007) is consistent with the result of this study in the area of materials price fluctuation and bad management. These two variables are closely related as only bad project managers would let materials' price fluctuation catch up with them on any project. In Nigeria, many project managers are inexperienced and not fit for the projects they manage. This usually results in unwise decisions and bad project management. The work of Dosumu, Idoro and Onukwube (2017) indicate that errors and omission in contract documents are potential risks for any construction project as they increase cost by about 10% of contract sum. Moreso, as a country, Nigeria does not have any serious economic policy for construction projects and this is likely one of the reasons for unrealistic pricing of construction projects.

The study also found that risks with high likelihood of occurrence and degree of impact eventually have the highest probability of occurrence in tendering and procurement. This indicates that variables with high likelihood and degree of impact should be prevented before they occur. In this study, the risks with high probability of occurrence are equipment failure, market condition, financial default by client, insurance risk, inadequate cash flow, contractor default, bribery and corruption, safety of workers and materials, quality of work and unforeseen site conditions. Although many studies did not calculate the probability of risk occurrence; the results of this study is not unexpected as most of the risks identified occur on Nigerian projects. Many of the equipment used on construction projects are obsolete and poorly maintained, market prices are unstable due to lack of economic policy, clients default financially due to high bank interest rates and delays leading to inadequate cash flow. When cash flow becomes inadequate, contractors would likely default. Bribery and corruption in the Nigerian construction industry have eaten deep into many of the stakeholders especially the consultants that allow shoddy works to pass to the next stage of construction thereby leading to building collapse, defects, wastages, quality problems, cost and time overrun and sometimes disputes. Many projects in Nigeria do not have health and safety plan before, during and after construction. This explains the reason for high accidents on Nigerian projects as noted in Dosumu and Onukwube (2014). Bribery and corruption are not peculiar to Nigeria alone; Mantzaris (2014) also pointed out that there is corruption in South Africa's national and provincial departments of procurement. This is disheartening because it is disgusting to know that professionals are going that low to acquire money through extortion.

The result of the study also indicates that the respondents have knowledge of the risk management techniques as shown in Table 5. The respondents also adopt them at a normal level. The problem is the stage at which the risk management techniques are utilised. According to the categorization of adoption level in Table 5, it is evident that the order of adoption of risk management techniques is risk response, risk assessment and risk identification respectively. However, the correct order is supposed to be risk identification, assessment, response and control. The current order indicates that many of the respondents' organisation only do risk response and assessment while risk identification is utterly neglected. There may be less need for risk assessment and response because they would have been averted at the point of identification and this is what should be campaigned to construction organizations. Risk identification should be made a routine activity before construction begins. Government establishments should ensure that risk identification is made approval criteria for construction projects.

6. Conclusions

The findings of the research are that the significant sources of risks are poorly chosen technical solutions, bad management, errors and omission, unrealistic price, unskilled staff, economics regulations and price inflation among others. Also, safety of workers and materials, interest rate challenge, difficulty in disposing bad plant, unforeseen site condition, equipment failure, contractor default, market condition, insurance risk, communication, financial default by client, inadequate cash flow, errors and omission, legislative influence, changes in scope, defective work, contractors and workforce experience, breach of contract by project partner, defects in supervision, project complexity, incomplete design, construction procedure, land acquisition, contractual relations, equipment availability and productivity challenge, differing site conditions and variation of work have a high degree of impact on construction tendering and procurement.

The study also found that respondents are aware and adopt risk management techniques on construction projects; however, their adoption is at response level rather than identification and assessment level. This is dangerous because it may not help construction projects avert cost and time overrun in most cases. Risks with the highest probability of occurrence are flood, earthquake, inclement weather, design failure, human resource management challenge, equipment failure, project complexity, project management, construction technology, inadequate site investigation, inappropriate specifications, labour and material supply challenges, market conditions and financial default by client. The respondents are aware of the use of past experience, interview, ranking options, risk control, checklists, risk exploit, risk priority number, descriptive analysis, probabilistic analysis, risk enhancement, decision tree, direct judgment, flow chart, risk sharing, brainstorming, risk avoidance, comparing options sensitivity analysis, risk acceptance, risk mitigation, contingency plan, scenario analysis and risk transfer.

The study, therefore, concludes that there are many sources of risks for construction projects at the tendering and procurement stage. These sources have the capacity to increase the probability/likelihood of risk occurrence on construction projects, hence the need to adopt the available management techniques of risk identification to mitigate them. Having noted that construction organizations ignore risk identification before project commences, it is recommended that risk management should follow the order of risk identification, assessment, response and control. Based on the result of the study that respondents have low awareness on the use of management techniques such as questionnaire, cause-effect and influence diagrams to conduct risk identification of construction projects, the study recommends that appropriate awareness should be created in that regard. Questionnaire, cause-effect and influence diagrams are scientific approaches to risk identification (problem solving) in construction projects and as such, may require the engagement of construction consultants (especially academics) who have sufficient scientific knowledge to conduct risk identification of construction projects before they commence. Hence, it is recommended that construction consultants should be engaged to conduct scientific identification of project risk before they start; this will go a long way to averting cost and time overrun on projects. The government should also make risk identification a criterion for building approval.

References

Abdou, O. A. (1996). Managing Construction Risks. Journal of Architectural Engineering, 2(1) 3-10

Abdul-Razak, S. (2013). The impact of project risk factors on the selection of public works procurement methods in Ghana: a focus on national competitive tender. An M.Sc thesis of the department of Building Technology and Procurement Management, College of Architecture and Planning, Kwame Nkrumah University of Science And Technology, Kumasi.

Adnan, H. (2008). An assessment of risk management in joint venture projects (JV) in Malaysia. Asian Social Science, 4(6) 99-106

Agerberg, J. (2012). Risk management in tendering process. An M.Sc thesis of the Department of technology management and economics. Chalmers University of Technology, Sweden

Agwu, M. O. (2012). The effects of risk assessment on organizational performance in selected construction companies in Nigeria. British Journal of Economics, Management and Trade, 2 (3) 212-224

Ahmed, S. M, Azhor, S and Ahmad, I. (2001). Evaluation of Florida general contractor's risk management practices. Florida International University

Albogamy, A. and Dawood, N. (2015). Development of a client-based risk management methodology for the early design stage of construction processes: Applied to the KSA. Engineering, Construction and Architectural Management, 22 (5), 493-515

AL-Shibly, H. H., Lonzi, B. M and Hiassat, M. A. (2013). The impact of risk management on construction project success from the employees' perspective. Interdisciplinary Journal of Contemporary Research in Business, 5(4) 12-42

Banaitiene, N and Banaitis, A. (2012). Risk management in construction projects. Intech open science, 429-448

Buertney, J. I, Abeere-Inga, E. and Kumi, T. A. (2013). The financial impact of risk factors affecting project cost contingencies: Evidential reasoning method. Journal of Engineering, Project and Production Management, 3 (2) 65-73

Calzadilla, E., Awinda, K. and Parkin, A. (2012). An examination of the risk management process in Venezuelan construction projects In Smith, S-D(Ed) Proceeding 28th Annual ARCOM Conference, 3-5 September 2012, Edinburg, UK, 1209-1218.

Chapman R. J. (2001). The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management. International Journal of Project Management, 19, 147-160

Chen, Y. C., Zhang, S. Liu, L. S. and Hu, J. (2015). Risk perception and propensity in bid/no-bid decision-making of construction projects. Engineering, Construction and Architectural Management, 22 (1) 2-20,

CIPFA Counter Fraud Centre (2015). Managing the risk of procurement fraud. Retrieved at https://www.local.gov.uk/sites/default/files/.../managing-risk-procurement- on 12 January 2017

Dosumu O. S. and Onukwube, H. N. (2014). Impact of health and safety practices on the productivity of skilled construction site workers in Lagos state: workers perspective. Proceeding of CIB Conference held on 28-30 January 2014 at Orchid Hotel, Lagos, Nigeria.

Dosumu, O. S, Idoro, G. I. and Onukwube, H. N. (2017). Cause of errors in construction contract documents in Southwestern, Nigeria. Journal of Construction Business and Management 2(1) 50 – 62

Dosumu, O. S. and Onukwube, H. N. (2013). Analysis of project success criteria in the Nigerian construction industry. International Journal of Sustainable Construction Engineering & Technology, 4, 1, 31-47

El-Sayegh, S. M. and Mansour, M. H. (2015). Risk assessment and allocation in highway construction projects in the UAE. Journal of Management and Engineering, 31 (6) 1-11

Enshassi, A and Mosa, J. A. (2008). Risk Management in Building Projects: Owners' Perspective. The Islamic University Journal (Series of Natural Studies and Engineering), 6 (1)95-123

FAA System Safety Handbook (2000). Operational Risk Management. Safety Handbook

Flanagan, R. and Norman, G. (1993). Risk Management and Construction. Oxford: Blackwell.

Iqbal, S., Choudhry, R. M., Holschemacher, K., Ali, A. and Tamošaitienė, J. (2015). Risk management in construction projects, Technological and Economic Development of Economy, 21 (1) 65-78

Kansal R. K. and Sharwa M. (2012). Risk assessment methods and application in construction projects. International Journal of Modern Engineering Research, 2 (3) 1081-1085

Mahendra, P. A., Pitroda, J. R and Bhavsar, J. J. (2013). A study of risk management techniques for construction projects in developing countries. International Journal of Innovative Technology and Engineering 3 (50) 139-142

Mantzaris, E. (2014). Public procurement, tendering and corruption: realities, challenges and tangible solutions, African Journal of Public Affairs, 7 (2) 67-79

Mills, A. (2001). A systematic approach to risk management for construction. Structural Survey, 19 (5) 245–252.

Naphade, P. V. and Bhangale, P. P (2013). Study on risk management risk treatment strategies and insurance in construction industries. International journal of Innovative Technology and Exploring Engineering, 3(4) 68-74

National Institute of Standards and Technology (NIST). (2012). Risk likelihood, risk impact and risk level definition. Retrieved from www.hipaacow.org/wp-content/uploads on 12th January 2017

Oyewobi, L. O, Ibrahim, A. D and Ganiyu, B. O. (2012). Evaluating the impact of risk on contractor's tender figure in public building in the northern Nigeria. Journal of Engineering, Project and Production Management, 2(1) 2-13

Polit, D. & Hungler, B. (1985). Essentials of nursing research: Methods and application. Lippincott Williams and Wilkins

Radujkovic, M. and Car-Pusic, D. (2011). The attributes of risk sources and drivers in construction project. Faculty of Civil Engineering, University of Zagreb, Zagreb, Croácia

Rezakhani, P. (2012). Classifying key risk factors in construction projects. Universität technical, 1-11

Ritchie, J (2007). Treatment options for risks in construction, Civil and mining projects. Australian Construction, 18(10): 1-4

Shrestha, M. (2011). Risk framework for public, private partnerships in highway construction. An M.Sc thesis submitted to the Department of Civil and Environmental Engineering, University of Wisconsin-Madison

Slattery, K. and Bodapaty, N. (2001). Risk management of construction. ASC Proceedings of 37th Annual Conference University of Denver, Colorado, April 4-7, 95-100

Smith, N. J. (2003). Construction Management Series: Appraisal, Risk and Uncertainty. London: Thomas Telford Publishing.

Sun, C., Man, Q. and Wang, Y. (2015). Study on BIM-based construction project cost and schedule risk early warning. Journal of Intelligent and fuzzy system, 29, 469-471

Taghipour, M., Seraj, F., Hassani, M. A. and Kheirabadi, S. F. (2015). Risk analysis in the management of urban construction projects from the perspective of the employer and contractor. International Journal of Organizational Leadership, 4, 356-373

Takim, R. (2010). Analysis of effectiveness measures of construction project success in Malaysia. Asian Social Science, 4, 7, 74-91

Tam, C. M., Zeng, S. X. and Deng, Z. M. (2004). Identifying Elements of Poor Construction Safety Management in China. Safety Science, 42, 569-586.

Tipili, L. G. and Ilyasu, M. S. (2014). Evaluating the impact of risk factors on construction projects cost in Nigeria. The International Journal of Engineering and Science, 10-15

Zou, P. X., Zhang, G. and Wang, J. Y. (2007). Understanding the key risks in construction project in China. International Journal of Project Management, 25, 6 601–614