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A Conceptual Model for Risk Allocation in the Construction Industry

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Abstract: Appropriate risk allocation influences positive project delivery on construction projects while inappropriate allocation results in disputes, quality shortfalls, time and cost overruns. The existing body of knowledge provides guides on how risks should be allocated between the contracting parties. Nevertheless, the full appreciation of risks allocation is rarely given as risk allocation is more than just which party should bear a risk. This study provides a conceptual model of the various ways risks could be allocated. Furthermore, the FIDIC-Redbook (1999), NEC3 (2005/2006) and JCT Major building contract (2005), JBCC (2014), JLC (1972) and open national bidding contract (2013) are used to demonstrate the practicality of the conceptual model. An understanding of risk allocation prerequisites might help to mitigate risks that influence project performance negatively. The use of this conceptualization may help to assign a risk with more than one treatment option to maximize a positive outcome of a negative risk factor.

Keywords: Construction, Conceptual Model, Risk Allocation, Threats

Introduction

Risks of various natures and magnitudes are faced on projects of varying sizes and complexities. Risks may be political, economic, financial, social, cultural, technological, technical and managerial etc. (Barlish *et al*., 2013); projects may be small, medium or large scale; could also be viewed as low, medium, high or very highly complex (Kardes *et al*., 2013). All these dimensions determine the risk profile which in-turn affect the success or failure of a project depending on how the risks are managed. Cano and Cruz (2002) define risk as "an uncertain event that, if it occurs, has a positive (opportunities) or negative (threats) effect on a project objective" (p.473).

Poorly managed risks result in disputes, tensions, quality shortfalls, cost and time overruns (Alsalman and Sillars, 2013); even abandoned projects in extreme cases. To a large extent how risks are managed is influenced by how the allocation has been done considering the mitigation measures put in place and how appropriate the measures are in terms of resources, risk owner and mechanism utilized. In this paper, a conceptual model is presented on the various considerations to be made before the actual allocation between contracting parties to influence project outcome. Very often in the existing body of knowledge, risk allocation studies have emphasized on who owns the risk or who should carry a particular risk. This could be why project delivery is marred with negative risk especially in the developing world (Serpel *et al*., 2015) due to little attention paid to other considerations for allocation of risk.

Understanding Risk Allocation

Risk allocation is the division of responsibility associated with a possible loss or gain and the procedure of assigning identified risks to project participants (Lam *et al*., 2007); while Alsalman and Sillars (2013) define it as the assignment of management responsibility and risk liability. Bedenekoff and Steven, (2011) point out that risk allocation is about active risk management within an imposed temporal schedule of changing predation risk(s). Hwang *et al*. (2014) argue that risk allocation strategies are more than just deciding which party should accept the risk. It is for this reason that risk allocation should consider mechanisms, clauses used for contractual risk and resources assigned. It is argued here that the control and organization of management responsibility is vital in achieving success. For risks to be allocated they first have to be identified, analyzed and treatment methods identified then allocated (Toakley and Ling, 1991; Bajaj *et al*., 2010). In addition, risk monitoring and risk communication/reporting has to be carried out throughout the whole process (Project Management Institute, 2008; 1SO 10006; 21500).

Various risk theories are cited in literature (Abrahamson, 1984; Bunni, 2009; Barnes, 1983; Oudot, 2005; Jin, 2012; Jin and Zhang, 2011; Nasirzadeh *et al*., 2014; Xu *et al*., 2010; Khazaeni *et al*., 2012; Chang, 2014; Fu and Li, 2009) on the various theories of how risk should be allocated. In the construction industry, risks are normally allocated before they occur, unlike in the medical field and transportation industry (Chicken and Posner, 1998), law, economics (Oudot, 2005), where allocation of risk is done once the risk has occurred. For other industries such as sports, it is an individual choice to accept a risk or not (Chicken and Posner, 1998). Risk allocation can be categorized as qualitative and quantitative. Qualitative refers to risk allocation matrix, what risk is allocated to which party while quantitative is optimal allocation of risk between the parties if parties behave rationally (Oudot, 2005). The various standard forms of contract demonstrate that the allocation of risks has with it mechanisms in place for action such as insurance, quality tests and cost control mechanisms etc. This implies that resources are to be put in place by a liable contracting party for a given risk. Notwithstanding, risks could be contractual or non-contractual (Murdock and Hughes, 2008). Contractual in that the risk is outlined in the contract and non-contractual risks are not outlined yet are implied (Mason, 2016). Furthermore, the risks could be within the control of the project team (internal risks) or the risks could be outside their control (external risks).

Methodology

A conceptual model basically shows what is out-there that one plans to study and of what is going on with the things and why (Robson and McCartan, 2016). The development of the conceptual model is mainly through qualitative analysis of literature (Jabaren, 2009). Therefore, a qualitative approach was adopted to formulate a conceptual model using secondary data. Regoniel (2015) outlines a four-step process for creating a conceptual framework/model as:

- Choose your topic (risk allocation)
- Do a literature review
- Isolate the important variables
- Generate the conceptual model/framework

The literature used in the formulation of the conceptual model was identified by searching databases (Science direct, Google Scholar, Emerald, Scopus; and Taylor and Francis). The search terms included risk allocation, construction industry, risk management, procurement, construction contract types and risk factors. As these from the initial reading on the subject seem to influence risk allocation in the construction industry. Furthermore, these were selected as most times there discussion included issues on risk allocation. The articles used are included in the reference section. Peer-reviewed articles, journals, proceedings and textbooks in English between 1970 and 2015 were included. Articles reporting on opportunity management or positive risk were excluded. The full papers were then assessed for relevance. Once this was complete, key concepts relating to risk allocation process were identified after which a relation between each was mapped out and a conceptual model formulated. Document analysis of standard contract forms was used to verify the model. Hwang *et al*. (2014) points out that document analysis is commonly used in construction industry research. Two types of analysis were used in the document analysis: firstly, interpretive analysis aimed to capture hidden meaning and ambiguity. It looks at how messages are encoded, latent or hidden while secondly, content analysis was used to determine the presence of certain words or concepts within text or sets of texts (Robson and McCartan, 2016). The conceptual model was verified by mapping out various risks found in the construction industry (See risk(s) identified by Barlish *et al*. (2013) for building projects and Renuka *et al*. (2014) for critical risks in the construction industry) using construction contracts namely: International contracts (International Federation of Consulting Engineers-FIDIC Red book, 1999; New Engineering Contract-NEC3-2005/2006; Joint Contracts Tribunal (JCT) Standard building contract, 2005). Local Contracts used in the countries associated with the research: Zambia- Joint liaison Committee (JLC) 1972 commonly known as ZIA contract; Open National bidding Contract, (2013) and South Africa (JBCC, 2014). Other researchers on risk allocation have used a similar approach. For instance, Tsai and Yen (2006) formulated a conceptual framework and compared risk allocation on high-speed railroad in Taiwan amongst FIDIC (1995), AIA/A201 (1997), NEC (2005), ENAA model form international contract (1996) and Taiwan High Speed Rail Contract -THSRC (2000). Similarly, Charoenngam and Yeh (1999) used contract documents to verify the risk sharing in hydropower contracts construction using FIDIC and the Taiwanese government Conditions of Contract for hydropower construction. Picha *et al*. (2015) used EPC/Turnkey (FIDIC Silver book: 1999) contracts to determine the suitability in terms of risk allocation and risk coverage for international power projects. Other studies using a similar approach include Mooney and Mooney (2013); Hanna *et al*. (2013). In this study, construction contracts were used as cases for risk allocation verification. Moreover, construction contracts are the main mechanism for risk allocation in the construction industry (Charoenngam and Yeh, 1999; Bunni, 2009; Mead, 2007; Murdock and Hughes, 2008;

Zagloul and Hartman, (2003). The verification process used document analysis on standard contract documents to determine how the risks had been allocated though modifications are done.

Risk Allocation Methods and Mechanisms used within Methods

Early researchers such as Carter and Doherty (1973); Flanagan and Norman, (1993), and Akintoye and MacLeod, (1997) name risk acceptance or retention, risk mitigation/reduction, risk elimination/avoidance and risk transfer as risk allocation methods. This is also in line with the classification made by Mead (2007). In addition to the aforementioned methods, Smith *et al*. (2014); Kutsch and Hall, (2010) add doing nothing as a distinct response or treatment method. Lu and Yan (2013; Osipova and Eriksson, (2011); Lehtiranta, (2014) advocates for risk sharing. Additionally, PMI (2008) outlines exploit, share, enhance and accept as response mechanism for positive risks. Nevertheless, these are outside the scope of this research as the focus is on negative risks. The various methods of risk allocation are discussed below.

Retention or Acceptance

Risk acceptance involves accepting the loss, or benefit of gain, from a risk when it occurs (Smith *et al*., 2014). Risk retention is a viable strategy for small risks where the cost of insuring against the risk would be greater over time than the total losses sustained (Odeyinka, 2000). All risks that cannot be avoided or transferred are retained by default (Smith *et al*., 2014). This includes risks that are so large or catastrophic that either they cannot be insured against or the premiums would be infeasible (Odeyinka, 2000). Active risk retention means that an individual is consciously aware of the risk and deliberately plans to retain all or part of it. It is used for two main purposes (Redja and McNamara, 2014). First, to save money and secondly, because commercial insurance is unavailable or can be obtained only by the payment of prohibitive premiums (Ibid)). The most common method of active risk retention is the use of contingency sum (Rybka and Bonda-Nowakowska, 2013). Passive risk retention is retaining risk because the risk is unknown or because the risk taker either does not know the risk or considers it a lesser risk than it actually is. According to Redja and McNamara (2014), certain risks can be unknowingly retained because of ignorance, indifference or laziness. There are conditions for using risk retention as a risk management technique. These include the following (Flanagan and Norman, 1993):

- No other method of treatment is available
- The worst possible is not serious
- Losses are highly predictable

The advantages of retention are that it saves money, lowers expenses, encourages loss prevention and increases cash flow (Flanagan and Norman, 1993; Smith *et al*., 2014). The disadvantages are possibility of higher losses, expenses and taxes (Redja and McNamara, 2014). This mode of allocation is mainly used on risks that are responsibility related.

Transfer

This is the theory of risk allocation which has its basis on allocating the risk to another party (Mead, 2007) normally a third party (PMI, 2008). Risk transfer is basically shifting the responsibility or burden of loss to another party through legislation, contract, insurance or other means or shifting a physical risk or part thereof elsewhere (Rybka and Bonda-Nowakowska, 2013; Murdock and Hughes, 2007). Others mechanisms of transfer include performance bonds, warranties or guarantees (PMI, 2008), collaboration (Kardes *et al*., 2013). It is generally accepted that the party to bear the risk should be suited to handle/manage that risk (Mead, 2007; Uff, 2010; Murdock and Hughes, 2007; Lehtiranta, 2014; Akintoye and Macleod, 1997). This mode of allocation is generally used for financial risk (PMI, 2008). In as much as risk transfer is desirable it has demerits. Firstly, it increases the cost of goods and services and secondly the transfer may not be complete as it may revert to the source of transfer (Allensworth, 1996). It further introduces more contracts, which may be complex e.g., insurance contracts or bonds. Risk transfer, which could be the main method of risk allocation in construction contracts increases risk rather than reduce it (Loosemore and McCarthy, 2008). However, Odeyinka (2000) after evaluating the use of insurance in managing construction risks by transference concludes that it is an effective method.

Share

Risk sharing is a risk allocation practice in which the cost of the consequences of a risk is distributed among several participants in an enterprise (Business dictionary, 2016). It merely signifies the cooperation among those involved to achieve risk pooling (Giannakis and Papadopoulos, 2016). However, for risk sharing to be achieved a mechanism needs to be devised among contracting parties (Chungdong *et al*., 2012). Lehtiranta (2014) and Groton and Smith (2010) argue that risk sharing makes sense as most project risks commonly concern project participants. Further to this, partnering and alliancing (Lehtiranta, 2014); and target cost contracting (Wamuziri and Seywright, 2005) have opened up avenues for risk sharing. This view is supported by Osipova and Eriksson (2011). It is however, common practice that this method of risk allocation is used when no other method can be utilized. Risk sharing is common in Public Private

Partnership arrangements (Chung *et al*., 2010) but not in conventional arrangements much less in separated procurement systems.

Avoidance

Risk avoidance is an informed decision not to become involved in a risky situation (Mead, 2007; PMI, 2008). It is a strategy that works well for an unacceptable risk level (Kardes *et al*., 2013; Rybka and Bonda-Nowakowska, 2013) and strategies include: extending schedule, changing strategy, reducing scope, clarifying requirements, obtaining information, improving communication or acquiring expertise (PMI, 2008). Avoidance may seem the answer to all risks, but avoiding risks also means missing the potential gain that by accepting or retaining the risk may have allowed (Sichone, 2002). Not entering a project to avoid the risk of loss also avoids the possibility of earning profits (Doufman, 2007). This is viewed as impractical as it leads to a project not being undertaken (Akintoye and MacLeod, 1997). The major advantage in risk avoidance is that the chance of loss is reduced to zero or the chance of a loss that previously existed has been eliminated due to abandonment of the activity owing to chance of the loss (Redja and McNamara, 2014).

Risk Reduction and Elimination

Risk reduction, abatement, or "optimization" involves reducing the severity of the loss or the likelihood of the loss from occurring (Ashworth, 2006). For example, sprinklers http://en.wikipedia.org/wiki/Fire_sprinkler are designed to put out a fire to reduce the risk of loss by fire although this method may cause a greater loss by water damage and therefore may not be suitable. Contractors who identify the risk and further note that it is not in the all-risk policy of the contract may decide to implement reduction measures. Most contractors may avoid the risk and think they are in a fortunate position since they are backed by sufficient working capital, thus should the risks materialize they resort to frivolous claims damaging the organizations' reputation (Sibanyama *et al*., 2012). Risk abatement is preferably used in conjunction with other risk management strategies such as adopting complex processes, conducting more tests or choosing a more stable supplier depending on the risk being averted. Using this risk management method alone will not totally eliminate the risk. Risk elimination is possible when risks are identified and are dealt with proactively (Mead, 2007). In order to eliminate a risk an appropriate risk analysis is to be done.

Risk Allocation in Architectural, Engineering and Construction (AEC) Contracts

During AEC contract selection the ability of contract parties to bear the risk consequences of the cost risk or any other risk and the ability of the contract parties to manage risk has to be taken into account (Berends, 2000). This means the risk management capabilities of parties have to be established (Mu *et al*., 2014). It is important for risks to be properly allocated in the contract (Hanna *et al*., 2013). Hanna *et al*. (2013) argues that it is difficult to predict responsibility even by the courts if no clause exists in the contract that properly allocates a given risk. Moreover, one measure of contracts' efficiency and effectiveness is its ability to clearly assign risks between contracting parties (Hartman and Patrick, 1996). This, entails that predictable risks should be managed through contract (Subramanyan *et al*., 2012).

The payment method defined in a contract type has an influence on risk (Oztas and Okmen, 2004). The form of payment defines who takes a risk if the final cost of construction activities is higher than the estimated cost (Osipova and Eriksson, 2011). The form of payment is achieved by using an appropriate contract type that needs to be chosen with the possible risks allocated appropriately. A construction contract is a warranty that the executed job will receive the specific amount of compensation or outlines how the compensation will be distributed (Ke *et al*., 2010; Mason, 2016). Contract types are used to distribute risk (Fig. 1). The fixed price contract is the most common contract normally associated with traditional or separated procurement (Allensworth, 1996; Hackett *et al*., 2007; Hanna *et al*., 2013; Turner, 2004). It is therefore important to establish the extent to which the fixed price contract is used in relation to other methods of pricing since it has been established that types of contract can be used in combination or as hybrids (Hackett *et al*., 2007). In addition, to methods of payment, procurement methods have a bearing on risk allocation.

Risk Allocation and Procurement Methods

Standard forms of contracts used for any particular project are normally dependent on the procurement method being used. A standard form of contract designed for Private Finance Initiative (PFI) can hardly be used for a design-Bid-Build project without modification. Procurement systems are important tools for risk management and allocation (Chege and Rwelamila, 2000; Flanagan and Norman, 1993; Smith *et al*., 2014). The relationship between risk and procurement lies within the risk response stage, were risks are allocated (Chege and Rwelamila, 2000). From the Fig. 2 it can be concluded that the apportionment of risk for various procurement methods differs greatly between client and contractor. The greatest risks to the contractor are in the design and build option while the least risk is in the construction management option. The client has their greatest risk in the Construction management option and the least in the Design and Build option. Nevertheless, in traditional procurement, it is unusual to reduce payment, abatement and compensations if the service is not delivered to the specified standard (Jin and Zhang, 2011).

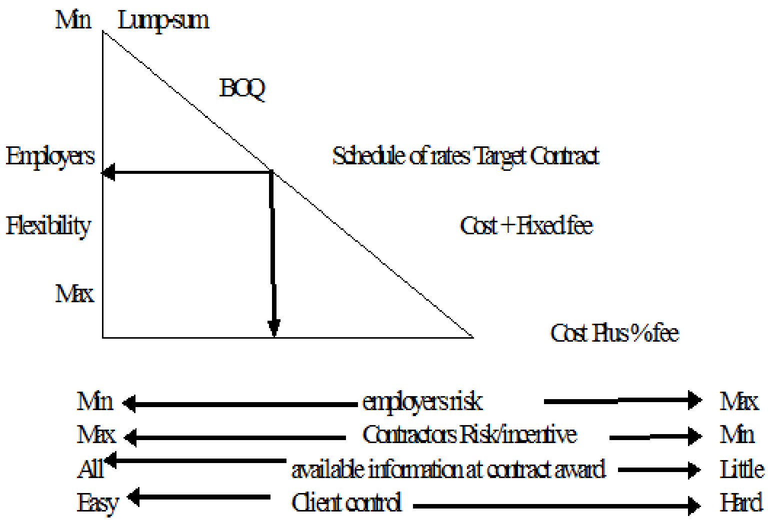

Fig 1. Risk allocation balance by contract type Adapted from Smith *et al*. (2014)

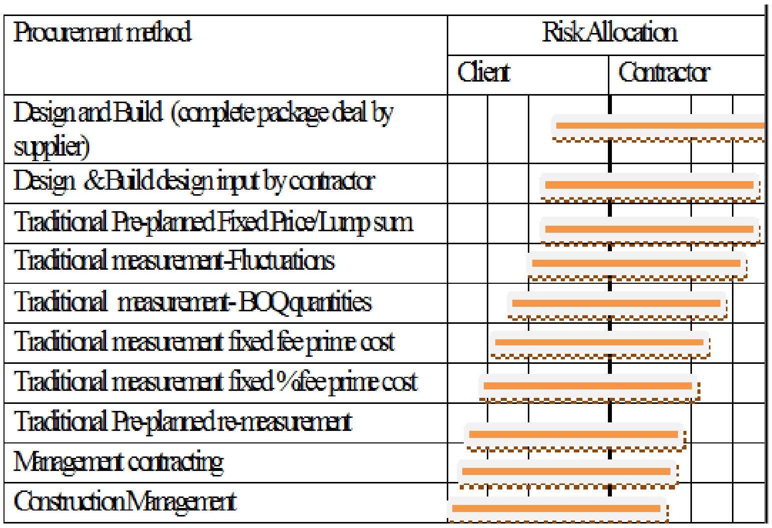

Fig. 2. Risk Allocation balance by procurement method Source: Adapted from Saito (1999; Smith *et al*., 2014)

The Proposed Conceptual Model

The starting point in risk allocation is the selection of an appropriate contract type based on the characteristics of a project (Dhanushkodi, 2012; Osipova and Eriksson, 2011). Zagloul and Hartman (2003); Moazzami *et al*., (2011) agree that inappropriate contract types lead to inappropriate risk allocation. The nature of the contract will be dependent on the intended relation between client and contractor whether separated or integrated approach which normally hinges on procurement method. Smith *et al*. (2014) pointout that the balance between client and contractor risks is dependent on the procurement method employed with client having more in a separated system of procurement compared to an integrated one. Watermeyer (2012) suggests that it would be beneficial to underpin risk allocation in contracts; as contracts govern the risks and responsibilities between parties to the contract and the methods by which a contractor will be paid also governs the relationships which the employer wish to foster with the contractor. This will have an effect on what will constitute internal risk (risk emanating from the project team and contracting parties) and external risks (risks emanating outside the project team).

To a large extent, internal risks and contract type used will influence the risk sharing. For instance guaranteed maximum price contracts allow the contracting parties to decide on how they will share the risk of cost overruns. Furthermore, It dictates what the clients and contractors risks are.

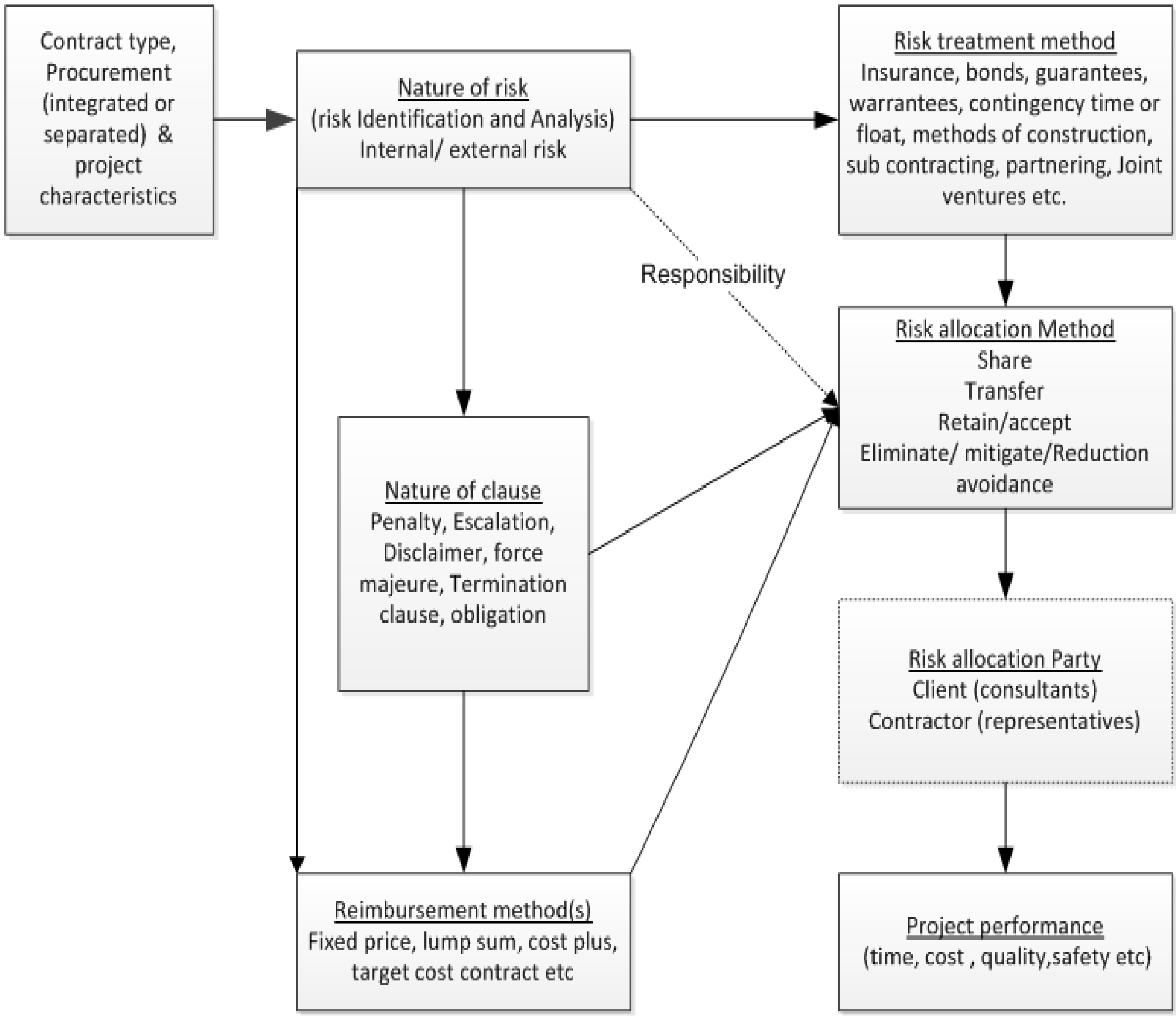

Fig. 3. Proposed conceptual model

An appropriate incentive should be given to the party carrying the risk (Hackett *et al*., 2007). This is usually reflected in the reimbursement methods (Turner, 2004; Smith *et al*., 2014) or type of clause e.g. penalty or escalation clause. Various clause types are used for risk allocation namely obligation clause, force majeure clause, penalty clause, exclusion clause, termination clause, choice of law, severability, confidentiality and others (Mason, 2016). Clauses are designed to record the deals that are agreed between the many parties to a construction contract.

The nature of the risk will direct how the risk can be treated; this will influence the method of risk distribution/allocation in contracts between client and contractor (Smith *et al*., 2014; Zagloul and Hartman, 2003; Flanagan and Norman, 1993). Furmston (2001) contends that the type of clause used to allocate a risk, may be influenced by the nature of the risk. Type of clause used has a bearing on how appropriate the risk allocation will be (Moazzami *et al*., 2011). Moreover, Loosemore and McCarthy, (2008) suggest that contract clauses are designed to record the deals that are agreed between the many parties to a construction contract. Depending on how the distribution has been done, it has a direct impact on project performance (Akintoye and MacLeod, 1997; Alsalman and Sillars, 2013; Hanna *et al*., 2013). Alsalman and Sillars (2013) modelled the effects of risk misallocation on projects in the USA construction industry using a rational decision-making process using data from a questionnaire survey, the findings indicated, tensions cost/time overruns, quality issues and disputes. From the analysis of the literature, Fig. 3 shows the proposed conceptual model which was verified using various construction contracts shown in Table 1.

Table 1. Verification of conceptual model

Risk factor	Mode of allocation	FIDIC (Red book)- 1999 Clauses	NEC 3-2005 /6 various options-option	JCT standard building contract 2005-sections	JBCC (2014) - Clauses	Open National contract (2013) - - Clauses	Joint Liaison Committee (1972)- Clauses
Responsibility							
Defective design	Retained by designer of works	17.3(g)	X15, 2	2.2,2.19,2.20, 6.11	7	11b	1
Defective workmanship	Contractor	7.6, 11	40.4,43	2.3, 2.35, 2.38, 3.17, 3.19	17.1.10, 17.1.11,21	33	6.1,15
Inadequate site Investigation	Client	4.10	60.2,60.3	2.20		41.f	
Incompetent contractor	Contractor	15	9	8			
Low quality of works	Contractor, Client	4.9,7.3, 7.4,9.1	40.5,41	2.38,3.19,3.18		30,31	6.1
Inadequate specifications	Designer	1.5,1.9, 1.1.1.5	dependent on option	2.14, 2.3.3	5.5,6.4,13.2.3, 17.1.1-2	32,41.C	1
Low productivity	Contractor	4.10	X17, 32	2.27		41.2, 41.1.j, 47,30	20
Poor supervision	Client representative/ and contractor	3.1	dependent on option	3.2, 3.6			
Contractors underestimation	Contractor	4.11	dependent on option			44	
Delayed site handover	Client	2.1	33	2.4	12.1.7,12.2.17, 23.2.1	21, 20	21
Frequent changes to scope	Client	13.1	Dependent on Option	Section 5,3.14	17.1.2	37	11
Delayed design information	Designer	1.9	6	2.8.3	12.1.14	41.c	23, 26
Poor materials planning	Contractor	19.1, 4.10	X			9.1	23f
Poor organisational structure	Project team						
Delayed mobilisation	Contractor	14.2					
Bankruptcy of client	Client	16.2 (g)	91	8		56.c	26.1.d
Bankruptcy of contractor	Contractor	15.2 (e)	91.1	8		56.c	25
Insolvency of client	Client	16.2 (g)		8		56.c	
Insolvency of contractor	Contractor	15.2 (e)		8	14.6	56.c	
Lack of coordination /cooperation	Project team	4.6	10.1, 16.3	2.2.3		26.2	
Corruption, fraud, bribery	Project Team	15.2 (f)	85.2	6.8		57	30.7a
Delayed permits, approvals and statutory requirements	Employer	1.13, 2.2	80.1	2.29.7	2.1,9.1.2	17,11	4, 26
Poor communication	Team Leader	1.3, 1.4	13	1.8	2.3	6.1	2.3
Contagious diseases							
Time delays	Contractor/Client	4.1	30	2.29		41,30	22
Inaccurate setting out	Contractor	4.7	41, 44	2.1	13.2.1		5
Loss of or wear and tear of	Client	10.2	80.1	2.33	9.2.9	13	16
Loss of or wear and tear of after practical completion							
Poor cost control by client							
Poor cost control by contractor					12		
Delay in material supply		19.1		2.27	23.1.2	12	23
Technological complexities		4.10d					
Reimbursement Method							
Unstable exchange rates	Specific to contract	14.2, 15.15	Z	N/A		43	
Inflation fluctuation	Specific to contract	13.8	X1	4.21	29.9.5	44	31.A
Frequent changes in materials prices	Specific to contract	13.8	Depend on procurement option	4.25	29.9.5	44	31
Contractors under estimation of works	Specific to contract	14.11	Depend on procurement option	2.29.4			
Losses and expenses arising from clients instructions	Specific to contract	20	6	3.24		41	24
Clause type							
War and disorder	Force majeure	17.3,19.1, 19.2	80.1	6.8, 2.29.13	10.1.3	11	32,33
Adverse weather conditions	Escalation	4.12	60	2.29.8	23.1.1	30	23b
Poor safety on site	Specific to contract	4.8	27.4,80.1	6.4.1.2, 6.5.1		18	
Fundamental breach of contract	Termination	15, 16	9	8	29	56	17,20 25,26
Delayed completion of work	Penalty	8.7	X17	2.32	12.2.6, 12.2.8	46	22
Delayed payment	Escalation	14.8	51.2	4.13.6,4.14	24	40	26 (termination clause)
Delayed notification on risk event	Exemption	8.4, 20.1	16, 61.3	4.23		41.4	
Terrorist attack	Specific to contract	17.3	80.1	Schedule 3	8.7	11	32
Delayed site possession	Specific to contract	2.1	60.12	2.4, 2.5	12.1.7,12.2.14	20, 41.a	21
Termination of contract	Termination	15.2, 16.2	90	8	29	56	25
Change in law	Escalation	13.4, 4.10d	X2		17.1.4	3.1	
Copy right issues/patents, intellectual property		17.5		2.41			7

Table 1 Continue

Delayed design information	Escalation	1.9	6	2.8.3	12.1.14	30, 41	23
Site conditions/ geological condition/ physical/ground conditions	Specific to contract	4.12	60.1.12	6.5,2.29		41f	19.2
Time delay	Penalty/ escalation	8.7	X7, 60.1.3/5	4.3.3, 2.3.2	12.2.8,12.2.9	46	24
Low contractor productivity	Specific to contract	8.7	X17		12.2.8,12.2.9	12	
Archaeological find(s), fossils, antiquities	Specific to contract	4.24		3.22-24	13.2.4	19	34
Inclement weather Response mechanism	Specific to contract	4.10b	60.1.13	2.29.8	23.1.1	30	23b
Inadequate skill of contractor	Sub-contracting or Joint Venture	4.4, 15.2, 1.14	Z			7.1	17
Material quality problems	Tests/ inspection	3.2	4	2.3	17.1.5,17.1.6	32	6
Flood	Insurance	18	8	6.8	8.7	13	20
Errors and omission in design documents	Checking design						
Delayed in resolving disagreements	Specific to contract	20, 3.5	W1.4, or W2.4	9	30.2	21.4	35
Subcontracting		15.2	C26, D26, E26, F26	3.7	14	7.1	17
Protection of work/ persons on site	Indemnification, insurance	18,17.1	80.1,84,	6.8	8	13	19
Remedying of defect	Retention bond/fund	14.9	X16	Schedule 6 PT 3	8.2.1, 4.19	45.1	30.0
Disputes	Dispute resolution methods	20.	W1 or W2	9	30	21.4	35
Contractors financial Instability	Subcontracting,/ partnering/advance payment, J.V	14.2,15. 2, 1.14	Depend on procurement option	3.9.1, 3.7	12.1.9	7.1	17
Inadequate budgeting	Early warning	8.3	Depend on procurement option				
Lack of experience in similar works/low competency	Vetting				12.2.11		
Unfavorable dispute outcome	Dispute resolution	20	W1 0r W2	97	30	21	35
Conflict due to cultural differences	Dispute resolution						
Time delay	Early warning	8.3	16.1	2.27	12.2.8	30,47	23
Civil commotion-strike, riot	Specific to contract	6.11	80.1	2.29.10/11	10.1.3		22d,26
Poor monitoring	Monitoring /reports / meetings	421	X20.2		1.23	35.2, 29	
Tax	Deduction	1.13	50.2, 52.1	2.21	25.3.8	42	31A.a.iii
Fire	Insurance	18	8	6.13-16	10	13	20
Criminal acts: theft, vandalism	Insurance	4.22,18	8	6	8.7	13	20
Uncertain contractors financial stability	Advance bond or guarantee/ Performance security	14.2	X14	Schedule 6 PT 1	9.2.10, 11.1.4	48	
Inadequate resources	Subcontracting (s) and /or partnering (p)	4.4 (s), 4.17	X12 (p) 26 (s)s	(s)	12.2.12, 12.2.15	7.1	
Contractor performance Uncertainty bond/security	Performance	4.2	X13	8.4	11.0, 11.1.5	49	

Conclusion

Risk allocation remains the weakest link in managing risk on construction projects. A risk allocation model of how risks are allocated is presented and verified using selected risks and contracts for Architectural, Construction and Engineering. It has been shown that risks are allocated to contracting parties (client and contractor) by various criterions using specific mechanisms, specific clause types, payment methods and responsibilities. It has been demonstrated that the allocation can use more than one of the aforementioned. The non-contractual risks mainly are allocated based on responsibility. However, only few contracts were used to verify the allocation. These are contracts closely related to the countries associated with the study thus Zambia and South Africa. Future research can thus focus on more contract forms used in different countries. Additionally, a similar model could be generated for positive risks.

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Author’s Contributions

Chipozya Kosta Tembo-Silungwe: Contributed to conceptualization, Document analysis and manuscript preparation. She produced the manuscript in its original form and revised it into its final form.

Nthatisi Khatleli: Contributed to research supervision.

Ethics

The authors confirm that this manuscript is original and has not been published elsewhere.

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