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Dispute risk management in the procurement systems used in high-rise building projects

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Abstract
Dispute risk is inherent in high-rise building projects because of project complexity and uniqueness. The type of dispute risk management required depends on the procurement method used. No previous study has focused on any specific type of project, such as high-rise building projects, although a need exists to manage dispute risks in procurement systems used in high-rise building projects. Thus, this study aimed to explore the systematic dispute risk management in traditional method with measure and pay (M&P), traditional method with lump sum (LS), and design and build (D&B) with LS procurement systems used in high-rise building projects. Delphi technique comprising three rounds of a questionnaire survey was used to collect the empirical data. By analysing the collected data, dispute risk factors were identified; the severity of the risk factors was assessed; the identified risk factors were allocated among the client, consultant, and contractor; and the appropriate risk response strategies were identified in respect of the procurement systems. 'Lack of skilled labour' and 'inability to complete work on time' were the two most significant risk factors of all three procurement systems. In risk allocation, the risk should be allocated to the party that can best tolerate and manage the risk. Risk response strategies were found to be common in all three procurement systems. Dispute risks can be avoided at the commencement of the project itself by accommodating standard conditions of the contract together with an appropriate (this can be innovative) procurement system.

Keywords
Dispute risk, High-rise buildings, Procurement systems, Risk management.

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1. Introduction

The construction industry is particularly prone to risks because of the highly variable atmosphere created by its complex and dynamic project environments, which ultimately lead to disputes (Fevranoglou & Diakaki, 2019). Dispute risks can cause disagreements among project stakeholders in the absence of systematic risk management and appropriate procurement systems making proper risk allocation difficult (Artan Ilter & Bakioglu, 2018), adversely affecting the technical, operational, socio-political, and business aspects of the project (Cakmak & Cakmak, 2014). Hence, effective risk management, a challenging task for industry practitioners, becomes necessary (El-Sayegh, 2014; Mishra & Malik, 2017). The successful implementation of an effective risk management system is heavily influenced by three procurement variables: project delivery method, the form of payment, and collaboration or partnering arrangements (Younis et al., 2008; Jayasuriya & Rameezdeen, 2011; Xiong et al., 2017). With construction projects becoming increasingly complex and dynamic, different procurement systems have come into play (Osipova, 2008; Khemiri et al., 2017). Each of these procurement systems involves contracts, contractual relationships, information flows, and varying roles and responsibilities within the planning team (Khemiri et al., 2017), requiring a change in the traditional approaches of risk management (Dey & Ogunlana, 2004; Hubbard, 2020).

Risk perception is mostly subjective, and most risk management studies that have been conducted based on surveys and case studies have focused on one stakeholder (Kartam N.A. & Kartam S.A., 2001; Wang & Chou, 2003; Wiguna & Scott, 2006; Xia et al., 2018). Nevertheless, the aim of risk management is to reduce the risks faced by all stakeholders, regardless of which stakeholder carries the risk (Hubbard, 2020). Thus, when determining risks in a project, all the parties should be taken into consideration (Eke et al., 2019). Hence, understanding the combined role of contracting parties in risk management will be important.

Out of many stakeholders involved in a construction project, usually, a large interaction is expected from the internal stakeholders (specifically client, contractor, and consultant) with regard to the finance and management aspects of the project; hence, their engagement is worth special attention (Ujene & Edike, 2015). Since the roles and responsibilities of different contracting parties depend on the client's criteria for procurement, procurement influences risk management (Deep et al., 2018). Rameezdeen and Silva (2002) and Sivakumaran et al. (2015) classify procurement systems based on the project delivery methods adopted [traditional method, integrated systems (design and build), management-oriented systems, and collaborative systems] and on the form of payment [lump sum, measure and pay, and prime cost]. While there is an underlying need to manage the risks depending on the procurement system used, the complexity and dynamic nature of high-rise building projects increase the uncertainty and risks of the projects (Basari, 2017; Sakthiniveditha & Pradeep, 2015).

There are numerous past studies on systematic risk management in avoiding construction disputes (Younis et al., 2008; Arslan et al., 2017). Moreover, there are many studies that cover risks associated with high-rise building projects (San Santoso et al., 2003; Hassanain, 2009; Nieto-Morote & Ruz-Vila, 2011; Basari, 2017). In addition, some researchers have focused on the risk management of different procurement systems (Bing et al., 2005; Ogunsanmi et al., 2011). Even though high-rise building projects are increasing (Li et al., 2018), no studies on the dispute risks of procurement in high-rise building projects have been conducted. Thus, the literature that deals with project dispute risks of procurement in high-rise building projects is scarce. Moreover, this study adopted a holistic approach, unlike most other studies on construction risks faced by only one project stakeholder (Kartam & Kartam, 2001; Wiguna & Scott, 2006).

The aim of this study, therefore, was

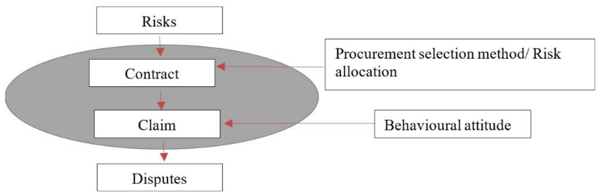

Figure 1. *Conceptual flow chart of dispute evolution, Adapted from: Younis et al. (2008).*

to address the knowledge gap in risk management by exploring the dispute risk factors of procurement in high-rise building projects. The objectives of the study were to (1) determine procurement systems frequently deployed in high-rise building projects, (2) evaluate the most significant risk factors that can create disputes in the identified procurement systems, (3) determine risk allocation among the internal stakeholders of the identified procurement systems, and (4) determine the risk response strategies appropriate for the identified risk factors.

The following sections present the findings of a comprehensive literature review, the methodology used in the study, and the findings of the study. The conclusion, recommendations, and potential future research directions are finally presented.

2. Literature review

2.1. Disputes as a risk in construction

The risks in the construction industry are frequently either disregarded or illogically dealt with by simply adding a contingency to the cost estimate (Addo, 2015), resulting in expensive delays, litigation, bankrupt contractors, poor contractor performance, and high construction project cost (Renault et al., 2016). Since this approach is ineffective, procurement systems have been significantly changed, with clients allocating greater risks to contractors (Wang, & Wang, 2022; Baloi & Price, 2003). Thus, the management of risks has become an all-time need for completing projects on time and conforming to the expected quality and safety requirements while remaining within the expected budgets (El-Sayegh, 2014; El-Sayegh et al., 2021). Various risk management processes have been developed by past researchers. According to Lee et al. (2019), dispute risks in construction can also be managed by employing these processes. This study adopted the process outlined by Kayis and Amornsawadwatana (2007), which has a three-fold approach: risk identification, risk assessment, and risk treatment. Furthermore, risk treatment is divided into two steps: risk allocation (Perera et al. 2009) and risk response (Jayasudha & Vidivelli, 2016).

In the construction industry, many disputes arise because of its complexity, high riskiness, competition, and multi-disciplinary environment Cakmak & Cakmak, 2014). Conflicts, which lead to disputes, are 'inevitable in human relationships' (Karthikeyan & Manikandan, 2017). In construction projects also, disputes are inevitable because of the involvement of humans with various perceptions. Ojo (2010) reflected that risk occurrence in construction projects, which is not well analyzed or integrated, is a leading cause of claims and disputes. Figure 1 demonstrates how risks lead to disputes and the factors that influence dispute evolution.

Construction disputes incur costs, both direct and indirect, to different parties, and the costs and antagonism increase as the disputes escalate in the later stages of the projects. The situations can go out of control with indirect costs when one party starts blaming another party for the actions/ inactions of the latter that have caused damages to the first party, thereby amplifying the disputes (Saleh, 2019). However, dispute resolution also costs money, and the magnitude and severity of the dispute would not be known until the dispute has occurred (Song et al., 2009). When the frequency of the disputes is not known, the potential total dispute resolution cost remains uncertain (Song et al., 2009). Thus, disputes create risks and vice versa. Although not all risk factors lead to disputes, factors such as the procurement selection method and behavioural attitude have an impact on the causal chain that leads to a dispute risk (Younis et al., 2008). Therefore, proper procurement selection is one approach that can be adopted to manage risks.

2.2. Procurement systems adopted in high-rise building construction

No studies have been conducted on the risks of procurement in high-rise building projects. However, a clear link exists between the studies conducted on the risks of high-rise building projects and studies on the risks of common procurement systems.

Procurement systems are categorized into four broader types as the traditional method, integrated systems (design and build), management-oriented systems, and collaborative systems based on the project delivery and as a lump sum, measure and pay and prime cost based on their form of payment (Rameezdeen & Silva, 2002). The traditional method or the separated systems method is the most widely used project delivery method in many countries, where the construction starts after the design is completed (Eriksson & Laan, 2007; Sackey & Kim, 2018). The client first appoints a consultant to do the design, and after completing designing in fully, the tendering procedure is held, and a contractor is selected thereafter to carry out the project (Ali et al., 2022; Tang et al., 2019). Design and build have several forms where it is characterized as the contractor taking both design and construction responsibility (McDermott, 1999; Sackey & Kim, 2018). In lump-sum arrangements, the contract sum is agreed before the construction starts, and the risk is very high to the contractor (Rathnasabapathy & Rameezdeen, 2006; Gad et al., 2020). Measure and pay contracts are used where the work has been substantially designed, but final details have not been completed while the contractor is paid according to the amount of work done as measured after the physical completion (Wijewardana et al., 2013). Based on the fundamental principles, several combinations like traditional method with measure and pay, traditional method with lump sum, design and build with measure and pay, design and build with lump sum, are commonly used.

Studies on common procurement system risks, such as Oztas & Okmen (2003) and Gad et al. (2020) on Design And Build (D&B) delivery and fixed price-lump sum payment; Bing et al. (2005) on the private finance initiative, and Ogunsanmi et al. (2011) on D&B have identified the common risks of procurement, which are similar to the most significant economic and financial risks of high-rise apartment projects identified by Perera et al. (2020). Therefore, although under-researched, the risks of project procurement could be significant in high-rise building projects.

2.3. Need for dispute risk management in the procurement systems of high-rise building projects

Disputes in construction projects caused by various risk factors have to be managed because of their irreversible negative impacts on the project (Zhong et al., 2022). A major benefit of risk management in construction projects is that it enables to selection of the most appropriate form of procurement/contract (Zhao et al., 2013). Procurement dispute risks are inherent to certain types of projects, such as high-rise building projects, even if the procurement system has been wisely selected (Mante et al., 2012). Almost all cities in the world have been developing their urban habitat skyward (Fernando, 2016). Increased competition among the projects demands systematic risk management (Ogunsanmi, 2016). Although the procurement system adopted in the project can create risk factors leading to disputes among the project stakeholders (Mante et al., 2012), the impact of the risks can be minimized through the systematic management of the risks. High-rise building projects have specific types of risks owing to their size and complexity (Nieto-Morote & Ruz-Vila, 2011); dynamic nature and project duration constraints (Basari, 2017); high-cost overruns (Fernando, 2016); management and design process (San Santoso et al., 2003); and high occupant density, design configuration, and excessive fuel load during a fire (Hassanain, 2009; Rahmani & Salem, 2018; Sakthiniveditha & Pradeep, 2015). While risk is just only one of the governing parameters of procurement

Table 1. *Risk factors of high rise buildings.*

Risk Taxonomy	Sub Category	Risk Factor	a	b	c	d	e
1. Physical risk		1. Earthquake	✓		✓	✓	✓
		2. Landslides and subsidence	✓			✓	✓
		3. Fire	✓			✓	✓
		4. Lightning	✓			✓	✓
		5. Heavy rain	✓			✓	✓
		6. Flood	✓			✓	✓
		7. Extraordinary wind	✓		✓	✓	✓
		8. Pestilence	✓			✓	✓
2. Personal risk	2.1 Technician and labour	1. Frequent job changes by skilled labour	✓				
		2. Lack of skilled labour	✓			✓	✓
		3. Lack of unskilled labour	✓			✓	✓
		4. Strikes and labour disputes	✓		✓		
		5. Low productivity	✓	✓		✓	
		6. Poor workmanship	✓				
		7. Brawls and fighting	✓				
		8. Use of illegal foreign labour	✓				
		9. Gambling	✓				
		10. Absenteeism	✓				
		11. Unable to understand drawings	✓			✓	
		12. Communication problems	✓				✓
	2.2 Subcontractor	1. Lack of funds to proceed with work (Insolvency)	✓				
		2. Lack of required technical skill	✓				
		3. Unable to finish work on time	✓				
		4. Low quality of work	✓			✓	
		5. Unable to find qualified subcontractors	✓				✓
		6. Low productivity	✓	✓		✓	
		7. Coordination problems	✓				
		8. Subcontractor unable to afford adequate labour	✓				
		9. Subcontractor takes jobs in several projects	✓				
		10. Subcontractor abandons project	✓				
	2.3 Contractor	1. Incompetence and lack of responsibility	✓				
		2. Absenteeism	✓				
		3. Brawls	✓				
		4. Lack of experienced staff	✓	✓			✓
	2.4 Engineer	1. Incompetence and lack of responsibility	✓				
		2. Absenteeism	✓				
		3. Brawls	✓				
		4. Lack of experienced staff	✓	✓			✓
	2.5 Consultants	1. Does not understand his role/duty	✓				
		2. Poor construction method	✓				
		3. Delays in materials and shop drawing approvals	✓			✓	
		4. Communication and coordination problem	✓				✓
		5. Dishonesty	✓				
		6. Unaccountability of work	✓				
	2.6 Client	1. Interference	✓				
		2. Change orders	✓	✓		✓	✓
		3. Client lacks the managerial capability	✓				
		4. Quality expected beyond standard and specification	✓				✓
3. Technical risk	3.1 Materials	1. Affordable material is more expensive than presented in BOQ	✓			✓	
		2. Proposed materials are not approved	✓				
		3. Material shortage	✓	✓	✓	✓	
		4. Late material delivery	✓	✓		✓	
		5. Quality of material below standard	✓			✓	✓
		6. Material damage during storage	✓	✓		✓	
		7. Material damage during transportation	✓	✓		✓	
	3.2 Equipment	1. Low productivity and efficiency	✓				
		2. Frequently out of order or damaged	✓			✓	
		3. Inappropriate equipment causes problems	✓				
		4. Unavailability of spare parts or cost is high	✓		✓		
		5. No reserve equipment	✓				
		6. Need to import from other countries	✓				
		7. High maintenance cost	✓				
	3.3 Technique	1. New technique is required	✓		✓	✓	
		2. Quality criteria are difficult to achieve	✓				
	3.4 Construction Process	1. Failure to construct as planned	✓				✓
		2. Coordination problems	✓				✓
		3. Delay on the procession the of site after LOA	✓			✓	
		4. Communication problems	✓	✓			✓
		5. Red tape in liaisons with public service consumes too much time	✓				
		6. Irregularity of workload	✓				
		7. Severe climate causes low productivity	✓				
		8. Errors or omissions in BOQ	✓				✓
		9. Insufficient time to prepare bids	✓				
		10. Delay of information from designers	✓			✓	
	3.5 Construction site	1. Access problem	✓			✓	
		2. Construction site is adjacent	✓				
		3. Work hours are limited	✓				
		4. Traffic congestion	✓	✓			
		5. Local regulations	✓				✓
		6. Theft	✓	✓			
		7. Project is threatened by hooligans	✓				
	3.6 Ground condition	1. No site investigation or boring log	✓				
		2. Inadequate site investigation	✓	✓			✓
		3. Errors in information of site investigation	✓				
		4. Unforeseen problems	✓				
4. Safety accident risk		1. Severe accidents occur	✓	✓	✓		
		2. Inappropriate machine induces accident	✓				
		3. Machine is not checked before operating	✓		✓		
		4. There is no fence or protection net	✓			✓	
		5. There is no fire protection system at site	✓	✓		✓	
5. Construction Design causes risk		1. Inadequate and ambiguous specifications	✓			✓	✓
		2. Errors in drawings	✓			✓	
		3. Incomplete design scope	✓	✓			✓
		4. Need innovative construction methods	✓				
		5. Need new materials and equipment	✓				
		6. Non-standard details of drawing induce low quality of work and error in the estimate	✓				
		7. Likelihood of change	✓				
		8. Incompatibility between drawings and method	✓				✓
6. Political and regulation risk		1. Frequent changes in law	✓		✓		
		2. War, revolution and civil disorder	✓		✓		
		3. Requirement to use local labour	✓				
		4. Customs and import restrictions	✓				
		5. Unstable politics	✓		✓		✓
		6. Embargo	✓				
		7. Long procedure for approval and permits	✓				✓
		8. Cost for corrupt government officials	✓	✓			✓
7. Financial risk		1. Payment risk of completed work	✓				
		2. Slow payment by clients due to disputes	✓	✓	✓	✓	✓
		3. Retention is not returned	✓				
		4. Liquidated damages for delay	✓				
		5. Adequate payment for variations	✓				
		6. Financial problems due to errors in estimating	✓				✓
		7. Loss due to default of contractor, subcontractor, supplier or client	✓				
		8. Inflation	✓	✓		✓	✓
		9. Exchange rate fluctuation	✓	✓	✓		
		10. Local and national taxes are high	✓				
		11. Bid and performance bond are unfairly called	✓				
		12. Insufficient insurance	✓				
		13. labour cost is higher than predicted	✓				
		14. Material cost is higher than predicted	✓				
8. Contractual risk		1. Unfair and unreasonable stipulation	✓				
		2. Ambiguous clauses that have several meanings	✓				✓
		3. Work conditions differ from contract	✓				
		4. Misinterpretation	✓				
		5. Extent of work differs from contract	✓				
		6. Red tape in litigation	✓				
9. Government regulations cause risk		1. Construction process causes pollution	✓				
		2. Waste treatment required by law	✓				
		3. Preserving historical finds	✓				
		4. Local environmental regulations obstruct the construction process	✓				

a: Santoso *et al.* (2003), b: Moche (2020), c: Amati, Patel and Patel (2022), d: Ratnaningsih, Yeny and Fitria (2018), e: Bardakci (2020)

system selection, the special characteristics of high-rise building projects also matter in procurement system selection, making procurement complicated and thus risky (Luu et al., 2003).

There have been numerous studies conducted on risk management in the construction sector (Williams, 1995; Wang et al., 2004). A substantial amount of study has been conducted on various elements of risk management around the world (Wiguna & Scott, 2006) with several country-specific models on how to identify, analyse, and manage severe risks. These studies have sufficiently covered contracting parties' perceptions of risk and risk managemen (Kangari, 1995; Cheung, 1997; Ahmed et al., 1999; Kartam & Kartam, 2001; Rahman & Kumaraswamy, 2002) whilst directing both practitioners and researchers on effectively managing risk. However, the majority of the research cited above were primarily based on a single set of project participants. In most cases, only the contractor's point of view was taken into account when determining risk factors (Kangari, 1995; Ahmed et al., 1999; Bing et al., 1999; Kim & Bajaj, 2000; Kartam & Kartam, 2001; Wang & Chou, 2003; Fang, Fong, & Shen, 2004; Wiguna & Scott, 2006). However, risk management attempts to reduce hazards for all stakeholders, regardless of who bears the risk (ASCE, 1979). As a result, the project risk should not be evaluated just by the perspectives of one side. Furthermore, risk management examines the whole project cost as a result of the perceived risks of the many stakeholders, instead of just the costs absorbed by individual parties independently (Rahman & Kumaraswamy, 2002). As a result, it is critical to comprehend the contracting parties' collaborative effort toward risk management.

Santoso et al. (2003) has developed risk factors which generally suits to high rise projects in Jakarta by filtering and modifying risk factors derived from various researches. But it emphasis risk factors only important to contractors. Therefore, risk factors for this study purpose is listed out by filtering the risk factors used by Santoso et al. (2003). Only risk factors relevant to Sri Lankan high-rise projects were filtered from a preliminary survey, and the author's experience with high-rise buildings was applied. This risk factors adopted for this research is give in Table 1 below under the risk taxonomy used by Santoso et al. (2003).

Research has been conducted on the importance of systematic risk management in avoiding construction disputes (Younis et al., 2008; Arslan et al., 2017) and on the risks associated with high-rise building projects (San Santoso et al., 2003; Hassanain, 2009; Nieto-Morote & Ruz-Vila, 2011; Basari, 2017). Few researchers have focused on the risk management of different procurement systems (Bing et al., 2005; Ogunsanmi et al., 2011). However, none of these studies has focused on any specific type of projects, such as high-rise building projects, although a need exists to manage dispute risks in procurement systems deployed in high-rise building projects. This study adopted a holistic approach, unlike most other studies on construction risks faced by only one project stakeholder (Kartam & Kartam, 2001; Wiguna & Scott, 2006). Therefore, the study aimed to address the literature gap and the industry need for dispute risk management in the procurement systems adopted in high-rise building projects through risk identification, risk assessment, risk allocation, and risk response in respect of the main project internal stakeholders, namely, the contractor, client, and consultant.

3. Methodology

Describing risks qualitatively is considered convenient; however, researchers object to that type of approach as the collected data would then depend on linguistic variables and be subjective, giving imprecise outcomes (Islam & Nepal, 2016). Delphi is acceptable in risk-based construction research (Markmann et al. 2013; Perera et al. 2014; Hosny et al., 2018; Jepson et al., 2020), especially when data is to be collected through a questionnaire survey. Delphi can be applied in risk management owing to its self-validating mechanism (Sourani & Sohail, 2014). Therefore, this study adopted the modified Delphi technique, a quantitative approach, to determine the risk factors that lead to disputes in procurement systems deployed in high-rise building projects and how they should be allocated and responded to. The study used a modified Delphi approach as the experts reach an agreement in the first round then in the second round, the question is eliminated since the expected result is achieved. Further, Chan (2022) proved that using the Delphi consensus method is more significant in validating the gathered and reviewed data. According to Xia & Chan (2012), an acceptable degree of consensus can be achieved by conducting the Delphi in three rounds; thus, this study had three rounds, namely Round 1, 2, and 3.

The data were collected using the questionnaire survey technique. The questionnaires were designed to target each objective of the study. The Delphi round 1 was a preliminary survey to identify types of procurement systems used in high-rise buildings and risk factors leading to disputes in procurement systems of high-rise building projects, where the literature findings were illustrated in tabular format for the respondents to provide their responses. Similarly, the remaining two rounds followed the same approach where literature findings and findings from previous rounds were presented in tabular formats.

3.1. Delphi round 1

3.1.1. Part 1: Procurement systems frequently used in high-rise building projects

From the literature, six procurement systems were identified under two categories. They were thereafter assessed based on their applicability for 'individual use' or for 'use in combined systems'.

3.1.2. Part 2: Risk factors that lead to disputes in procurement systems of high-rise building projects

The experts were presented with 130 risk factors of high-rise building projects identified from the literature and were asked to indicate whether they lead to disputes or not by marking them with a "YES" or a "NO," respectively.

3.1.3. Evaluation

Procurement systems that scored above 50% were identified as being common, and the risk factors that scored above 50% were identified as causing disputes in procurement systems deployed in high-rise building projects.

3.2. Delphi round 2

3.2.1. Part 1: Severity of the risk factors that lead to disputes in the procurement systems commonly used in high-rise building projects

The experts were asked to comment on the severity of the risk factors short-listed from Round 1 by considering the frequency and impact under each procurement system identified. The frequency of occurrence 'α' and the significance of the impact 'β' of each risk factor had to be indicated using a 5-point scale varying from very low to very high. The severity index was constructed to rate the risk factors based on their criticality. Equation 1 (top) and Equation 2 (bottom) given below were used to calculate the severity index of each risk factor.

$$S_{j=}\alpha_j\beta_j$$

S_j^i = Risk severity level indicated of ith risk factor indicated by the jth respondent
α_j = Frequency level of risk occurrence indicated by the jth respondent
β_j = Significance level of risk occurrence indicated by the jth respondent

$$RS^i = \frac{\sum_{i=1}^{n} s_j^i}{n}$$

RS^i = Risk Severity Index of ith risk factor
n = number of responses

This method had been used by Zou et al. (2006), Sun et al. (2008), and Perera et al. (2014).

3.2.2. Part 2: Allocation of risk factors of procurement systems commonly deployed in high-rise building projects

The experts were asked to strike-out the parties (client, contractor, and/or consultant) who should not be allocated any risks.

3.2.3. Part 3: Risk response strategies applicable to dispute risks in high-rise projects

The experts were presented with 15 risk response strategies applicable in high-rise construction projects identified from the literature and were asked to indicate whether they are applicable or not by marking them with a "YES" or a "NO," respectively.

3.2.4. Evaluation

The parties to which risk should be allocated and which risk response methods are suitable for the next round can also be identified (when above 50% is achieved).

3.3. Delphi round 3

3.3.1. Part 1: Risk allocation among the main three internal stakeholders of a construction project (for most significant risk factors)

When a risk factor occurs under the listed procurement processes, the experts were asked to designate the percentage of risk that should be borne by each party.To analyse the results, the average method was used as shown below (Equation 3).

$$A^i = \frac{\sum_{j=1}^{n} P_j^i}{n}$$

A^i = Average Percentage of Risk allocation of ith party
P = Rating (percentage) of each Factor given by the jth respondent
n = Number of responses

3.3.2. Part 2: Risk response strategies applicable to the significant risk factors

The experts were asked to identify from among the response strategies short-listed in Round 2, the response strategy most suitable for each of the risk factors identified as significant. The Relative Importance Index (RII) was used to evaluate the significance of each risk response strategy. RII facilitates the evaluation of a nonparametric sample by giving a value for each factor and is commonly used to determine the relative significance of several attributes (Doloi, 2008) using Equation 4 given below.

$$RII = \frac{\sum Wn}{NA}$$

W = Rating of each factor given by the respondent
n = Frequency of the responses
N = Total number of responses
A = Highest weight

The adopted research methodology is graphically illustrated below,

As the sample of the survey, 35 ongoing high-rise building projects which consisted of more than 20 floors were selected. This is covered almost all high-rise construction projects over 20 floors in Sri Lanka. The questionnaires were sent to 90 professional engineers, quantity surveyors, and architects in those 35 projects who possess more than 15 years of experience in high-rise projects. Each project stakeholder, namely the client, constructor, or consultant, was represented by 30 out of 90 sample of experts. All of the experts possessed good communication skills and were willing to participate in all three rounds of the questionnaire survey. The questionnaire survey was conducted either face-to-face or via email. The interviewee profiles and the response rates are given in Table 2.

Most of the Managing Directors, Construction Managers, and Project Managers selected for the questionnaire survey have worked as Risk Managers in high-rise projects. Further, the risk management division is a subdivision under the project management unit in most of the projects.

4. Findings and analysis

The study findings are discussed under three headings: procurement systems frequently used in high-rise building projects, dispute risk factors that are significant, risk allocation among internal project stakeholders, and risk response strategies. One of the major concerns in data collection is the reliability of the responses. Therefore, Cronbach's alpha value was calculated during each round, which is considered a measure of internal consistency (Bonett & Wright, 2014). Cronbach's alpha value should surpass the 0.700 threshold, if the alpha value tends more towards 1 more, it is considered to be more reliable (Aghimien, Aigbavboa, & Oke, 2020). During all three rounds, Cronbach's alpha value exceeded the 0.7 thresholds implying that the questionnaire inputs were consistent and reliable.

4.1. Procurement systems frequently used in high-rise building projects (Delphi round 1: Part 1 findings)

According to the survey results, four procurement systems are frequently used in high-rise building projects, namely the traditional method with measure and pay (M&P), traditional method with Lump Sum (LS), D&B with M&P, D&B with LS with percentage responses of 43%, 23%, 28%, and 6%, respectively. Since combining D&B with M&P is not encouraged and considering the relatively low response, this procurement system received only the traditional method with M&P, traditional method with LS, and D&B with LS were considered in the next round.

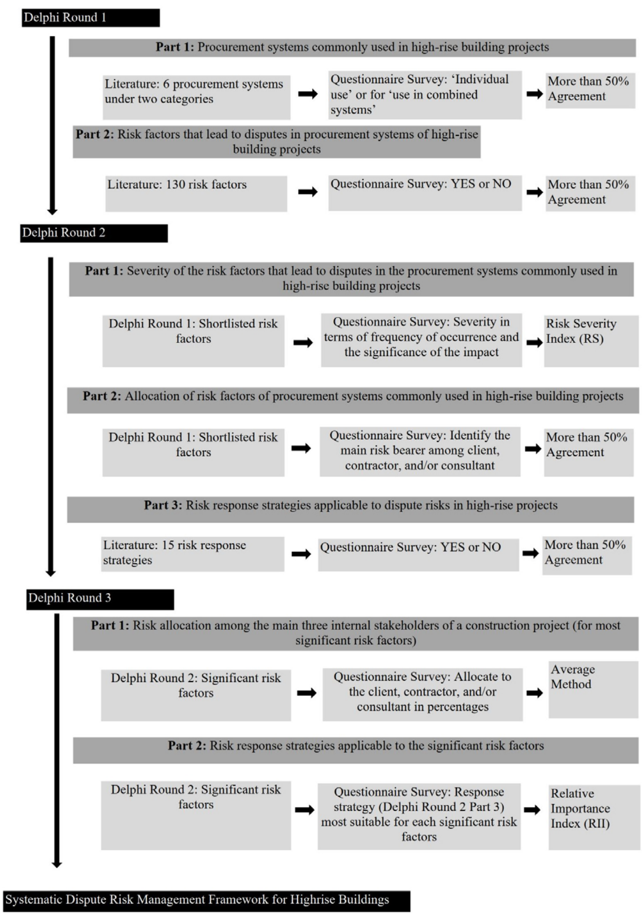

Figure 2. Research methodology.

4.2. Significant risk factors which lead to disputes of the procurement systems (Delphi round 1: Part 2 and Delphi round 2: Part 1 findings)

One hundred and thirty risk factors related to construction disputes were identified from the literature, and the two risk factors, earthquakes and landslides/ subsidence among them, were considered inappropriate as they only occur in particular geographic regions. Seventy-eight respondents (87%) agreed that the remaining one hundred and twenty-eight risk factors could cause disputes. The respondents

Table 2. *Survey samples of the Delphi rounds.*

Designation	Nr of years with high-rise experience	Round 1	Round 2	Round 3
Managing Director	20+	4	3	3
Commercial Manager	20+	6	5	5
Arbitrator	15 to 20	7	7	6
Project Manager	15 to 20	1	1	0
	20+	5	5	5
Construction Manager	15 to 20	5	5	5
	20+	4	3	3
Contracts Manager	15 to 20	4	4	4
	20+	2	2	2
Chief Architect	15 to 20	8	8	8
	20+	3	2	2
Chief Engineer	15 to 20	5	5	5
	20+	5	4	3
Chief Quantity Surveyor	15 to 20	5	5	4
	20+	2	2	2
Total number of responses		**66**	**61**	**57**
Frequency of the responses		**73.3%**	**67.8%**	**63.3%**

Table 3. *Severity Indexes of the risk factors of procurement systems used in high-rise building projects.*

Risk Taxonomy	Risk Sub Taxonomy	Risk Factor	Severity Index Traditional method with LS	 Traditional method with M&P	 D&B with LS
1. Personal risk	1.1 Technician and labor	R1. Frequent job changes made by skilled labor	14.94	14.85	14.76
		R2. Lack of skilled labor	20.41	20.68	20.44
		R3. Lack of unskilled labor	14.76	15.00	14.88
		R4. Poor workmanship	13.91	14.03	14.12
	1.2 Subcontractor	R5. Lack of technical skills	15.12	15.12	15.35
		R6. Inability to complete work on time	19.44	19.71	19.85
		R7. Subcontractors' inability to afford the required labor	13.06	12.97	12.94
		R8. Subcontractors' involvement in several projects	14.09	13.97	13.74
	1.3 Contractor	R9. Lack of experienced staff	12.29	12.29	16.29
	1.4 Consultant	R1O. Lack of understanding of the roles/duties	15.50	16.09	2.44
		R11. Delays in receiving material and shop drawing approvals	16.82	16.35	3.06
		R12. Communication and coordination issues	16.15	16.32	2.68
	1.5 Client	R13. Interference	15.94	15.88	15.79
		R14. Change orders	15.06	15.29	15.56
2. Technical risk	2.1 Technique	R15. Need for a new technique	8.62	8.38	13.44
	2.2 Construction process	R16. Insufficient time available to prepare the bids	16.94	9.74	16.59
		R17. Delay in receiving information from the designers	14.94	15.32	5.59
3. Construction risk		R18. Need for innovative construction methods	11.41	11.41	17.91
		R19. Need for new materials and equipment	11.44	11.44	13.97
4. Political and regulation risk		R20. Frequent changes made to the applicable laws	11.74	11.91	14.88
		R21. Requirement to use local labor	13.06	13.06	13.15
5. Financial risk		R22. Actual labor cost becoming higher than the predicted labor cost	11.74	11.35	14.76

LS: Lump Sum, M&P: Measure and Pay, D&B: Design and Build

were also free to include any new risk factors.

The significance of each risk factor was calculated based on its severity index as outlined in the section on "Research Methodology", and only the risk factors that had severity indexes exceeding 50% (>12.5) were identified as significant Perera et al. (2014) justified that the cut off can be above 25%) (Table 3).

In Table 3, the degree of severity has been indicated using a colour scale in which black depicts the highest severity and light grey the lowest severity. White tabs denote that the risk factor is insignificant.

Only five risk taxonomies among the identified nine were found to significantly contribute to disputes in high-rise building projects. Physical risks, accident risks, contractual risks, and legislative risks were found to be insignificant. Even though the impacts of physical and accident risks are high, their occurrence has a very low probability, which makes them insignificant. The mitigation actions employed in high-rise building projects also make them insignificant. This is because of the mitigation actions already taken by each high rise project in Sri Lanka due to its high risks and legal influence. All five risk taxonomies are significant in D&B with LS systems, while personal risks, technical risks, and political and regulatory risks are significant in both traditional method with LS and traditional method with M&P systems. Out of the 22 risk factors, 16 are significant in traditional method with LS systems, 15 is traditional method with M&P systems, and 18 in D&B with LS systems.

The four consultant-relevant-risk factors, namely 'lack of understanding about the roles/duties', 'delays in receiving material and shop drawing approvals', 'communication and coordination issues,' and 'delays in receiving information from the designers' are insignificant in D&B with LS systems although they are significant in the other two procurement systems. This insignificance can be attributed to the poor involvement of the consultants in D&B with LS systems in which the consultant is only involved in construction supervision and not in designing. The reason for it may be the comparatively less involvement of consultants in D&B with Lump Sum systems as they only involve in the construction supervision part but not in the design part. However, delays in receiving information from the designers are not applicable in D&B with LS systems as the designing in these systems is done by the contractor.

The risk factors 'lack of experience in contractor's staff,' 'need for a new technique,' 'need for innovative construction methods,' 'need for new materials and equipment,' 'frequent changes made to the relevant laws,' and the 'actual labour cost becoming higher than the predicted labour cost' is significant only in D&B with LS systems since, in these systems, the contractor does the design only after the design cost has been finalized. Labour can be categorised as skilled and unskilled, and it can be noted that the risk significance of labour scarcity in both aspects is quite different from each other. This is because high-rise constructions require a skilled and well-trained labour force. Therefore, their shortage of service is more significant than unskilled labour. Besides, there is a risk of a shortage of unskilled labour also due to attractive job opportunities in other fields like agriculture, transport, etc.

The risk factor 'insufficient time to prepare bids' is insignificant only in traditional method with M&P systems, because in these systems, the contract sum is determined only after the construction has commenced, and the contractor is paid according to the amount of work done measured after the physical completion of the work. Therefore, the risk is less than the risk of any other system.

'Lack of skilled labour' and 'inability to complete work on time' are the two most significant risk concerns in all three procurement systems. The 'need for new building methods,' which is relevant exclusively in D&B with LS systems, is the third most significant risk factor.

Building maintenance units, Aluminum and glazing systems, IT infrastructure systems, and vertical transportation systems, which are unique to high-rise building projects, require special skills. Even though most of the other types of buildings also have these services, high-rise buildings require special installation/ maintenance skills in respect of these services. Even though most of the other buildings also have services such as LPG gas, fire protection, mechanical ventilation and air conditions, electrical, drainage, home automation, high rise buildings require special skills for those due to their complexity. For instance, a chiller system may require for high rise buildings while others are using normal split units. Moreover, there is a construction boom in Sri Lanka as a result of foreign investments in post-war development, which has ultimately resulted in a high-skill labour scarcity. However, in accordance with Sri Lankan law, foreign labours are not allowed to work in Sri Lanka, and only a few can be recruited for Board of Investment (BOI) projects under the special approval of BOI.

Although high-rise building planning is done considering the complexity of the buildings caused by their heights, time extensions cannot be avoided during their construction. Variations issued by the client also require time extensions. Most high-rise buildings are apartments, in which clients usually request changes, thereby delaying all interrelated works and causing time extensions. Therefore, completing work on time is highly risky.

'Need for innovative construction methods' under design risk is the third most significant risk in D&B with LS systems, where the contractor does both the design and construction for a pre-determined price. Designing and constructing high-rise buildings using innovative methods without obtaining the services of specialist consultants is challenging despite its high demand. Even though the D&B contractor can outsource specialist consultants, determining the cost in advance becomes difficult because it has been pre-determined, thereby making the exercise highly risky.

4.3 Allocation of significant risk factors which lead to disputes among the internal stakeholders of the significant procurement systems (Delphi round 2: Part 2 and Delphi round 3: Part 1 findings)

Risk allocation of significant risk factors of each procurement system to the client, contractor, and consultant is shown in Table 4. The black tabs depict the findings of Delphi Round 2: Part 2, during which the parties were not allocated any risks. Risk allocation percentages that are higher than 50% are shown in grey, while the percentages lower than 50% are shown in white.

The contract agreement, contract

conditions, specifications, preamble notes, and so on allot risk among the parties. Generally, according to contract conditions, the client and the contractor are the only parties to the contract. However, the client can allocate a portion of a risk that has to be borne by the client under the agreed contract to the consultant through a separate consultancy agreement. In this study, risks were allocated to all three parties, namely the client, contractor, and consultant. It is recommended to allocate all personal risk factors associated with labour, subcontractor, and contractor to the contractor.

4.4. Risk response strategies for the significant risk factors (Delphi round 2: Part 3 and Delphi round 3: Part 2 findings)

Fifteen risk response strategies were identified from the literature (see Table 45 legend). Although the participants were free to list any additional risk response strategies during Round 3, they considered the 15 listed strategies vital. Table 5 presents the five most significant risk response strategies for each significant risk factor of the three procurement systems.

***Table 4.** Risk allocation of significant risk factors of procurement systems used in high-rise buildings among the project internal stakeholders.*

Taxonomy	Risk Sub Taxonomy	Risk factor	Risk Allocation Percentage: Traditional Method with LS			Traditional Method with M&P			D&B with LS		
			Contractor	Client	Consultant	Contractor	Client	Consultant	Contractor	Client	Consultant
1		R1	93%	6%	1%	93%	7%		94%	6%	
	1.1	R2	88%	12%	1%	87%	12%		89%	11%	
		R3	88%	11%	1%	88%	12%		89%	11%	
		R4	95%	5%		94%	6%	0%	95%	5%	
		R5	91%	9%		91%	9%		91%	9%	0%
	1.2	R6	90%	10%	0%	90%	10%		91%	9%	
		R7	91%	9%		90%	10%		92%	8%	
		R8	91%	9%		91%	9%		93%	7%	
	1.3	R9		N/A			N/A		96%	4%	
		R10	0%	31%	69%	0%	29%	71%			
	1.4	R11		30%	70%		30%	70%		N/A	
		R12	5%	43%	52%	5%	43%	52%			
	1.5	R13	13%	87%	0%	14%	87%	0%	16%	85%	0%
		R14	18%	83%		19%	81%		20%	80%	
2	2.1	R15		N/A			N/A		16%	81%	4%
	2.2	R16	77%	23%	1%				75%	24%	1%
		R17	8%	24%	68%	7%	22%	71%		N/A	
3		R18							81%	18%	1%
		R19		N/A			N/A		81%	18%	1%
4		R20							33%	67%	
		R21	45%	55%	0%	43%	57%	0%	42%	58%	0%
5		R22		N/A			N/A		30%	70%	

LS: Lump Sum, M&P: Measure and Pay, D&B: Design and Build

***Table 5.** Risk response strategies for the significant risk factors of each procurement.*

Risk Taxonomy	Risk Sub Taxonomy	Risk Factor	Recommended Risk Response Strategy: Traditional Method with LS 1	2	3	4	5	Traditional Method with M&P 1	2	3	4	5	D&B with LS 1	2	3	4	5
01	1.1	R1	RR11	RR9			RR1	RR11	RR9			RR1	RR11	RR9			RR1
		R2	RR10	RR1	RR6		RR2	RR10	RR1	RR6		RR2	RR10	RR1	RR6		RR2
		R3	RR1	RR10		RR8		RR1	RR10		RR8		RR1	RR10		RR8	
		R4	RR10	RR6	RR2		RR12	RR10	RR6	RR2		RR12	RR10	RR6	RR2		RR12
	1.2	R5		RR1			RR2		RR1			RR2		RR1			RR2
		R6	RR2		RR4		RR6	RR2		RR4		RR6	RR2		RR4		RR6
		R7	RR10	RR12		RR1	RR8	RR10	RR12		RR1	RR8	RR10	RR12		RR1	RR8
		R8	RR2			RR8	RR6	RR2			RR8	RR6	RR2			RR8	RR6
	1.3	R9											RR10	RR1	RR6		RR2
	1.4	R10			RR10	RR7	RR8			RR10	RR7	RR8					
		R11	RR12	RR3	RR11	RR8	RR7	RR12	RR3	RR11	RR8	RR7					
		R12															
	1.5	R13	RR7	RR8	RR9	RR2	RR1	RR7	RR8	RR9	RR2	RR1	RR7	RR8	RR9	RR2	RR1
		R14	RR9	RR3	RR8	RR11	RR7	RR9	RR3	RR8	RR11	RR7	RR9	RR3	RR8	RR11	RR7
02	2.1	R15											RR10	RR15	RR9	RR2	RR3
	2.2	R16	RR9	RR2	RR3	RR1	RR8						RR9	RR2	RR3	RR1	RR8
		R17	RR11	RR9	RR12	RR2	RR3	RR11	RR9	RR12	RR2	RR3					
03		R18											RR10	RR13	RR15	RR14	RR9
		R19													RR14	RR15	
04		R20											RR9	RR7	RR1	RR8	
		R21	RR10	RR7	RR9	RR1	RR2	RR10	RR7	RR9	RR1	RR2	RR10		RR9	RR1	RR2
05		R22											RR9	RR8	RR1	RR3	

Code	Risk Response Strategy	Code	Risk response methods
RR1	Tendering a high bid	RR9	Allocation of the contingency plan
RR2	Including conditions on the bid	RR10	Education and training
RR3	Pre contract negotiations as to which party should take the identified risks	RR11	Encourage team work culture
RR4	Transferring the risk to the subcontractor	RR12	Use of the appropriate standard conditions of contract
RR5	Transferring the risk to the insurance company	RR13	Provision of physical protection to reduce the likelihood of risk

For the majority of risk factors/taxonomies, 'education and training' has been advocated as the optimal response method. 'Using appropriate standard conditions of contract' has been mostly recommended for personal risks under both the consultant and subcontractor. Usually, nonstandard contracts are used for both subcontract and consultant's contracts in Sri Lanka. As a result, it is strongly advised to employ standard contract terms in order to minimize/avoid hazards. For instance, FIDIC –Subcontract 2011 can be used for subcontracts and FIDIC white can be used for consultant's contracts.

It is also recommended that a contingency plan for unavoidable risks, such as 'change orders' and the 'need for a new technique', be established when no other option is available. It is also recommended that teamwork culture be encouraged for the risk factors such as 'frequent job changes made by skilled labour 'and 'delays in receiving information from the designers' to retain the labour gang. The findings suggest offering a high bid for the risk factor 'lack of unskilled labour' to avoid securing the project. For the risk factors such as 'inability to complete work on time 'and 'subcontractors' involvement in several projects ', it is recommended that appropriate conditions be included in the bid. For the inability to complete work on time, time for completion can be included as a condition and for a delay 'delay damages '(penalty) can be levied. It is recommended that the risk allotted to the client for risk factors such as the client's unnecessary interference be retained.

5. Discussion

The procurement systems that were identified in this study as being common in high-rise building projects to correspond to the procurement systems identified by Rameezdeen & Silva (2002), while the findings on the significant risk factors of high-rise construction correspond to the outcomes of San Santoso et al. (2003). San Santoso et al. (2003) found 130 country-specific risk factors of high-rise building construction. Hiyassat et al. (2020) focused on Jordan. The focus of Ikediashi & Okolie (2020) was on contractors' cash flow projections in South-South, Nigeria, while Kamal et al. (2019) made a risk study on Pakistan building projects. Since this study did not focus on any specific country, country-specific risk factors are absent in the study findings. None of the risk factors identified is common to all three procurement systems. If the risk factors are significant in all three procurement systems, they would require special attention. Labour shortage and the inability of the parties to deliver the project on time and at the specified quality have been collectively identified as the leading cause of disputes in all procurement systems (Mashwama et al., 2019). When the contractor fails to deliver the project at the client's desired quality/standard with the unskilled labour available, dispute risks will be encountered, requiring costly dispute resolution (Bingham & Nabatchi, 2019). According to the questionnaire survey outcome, these two types of risks are interrelated and, if not addressed, will continue to have an impact on the project (Ahmed & Nassar, 2016). Similarly, when the risk of 'inability to complete work on time' surfaces, the prospect of a dispute will be very high, as the intended profit margin is linked to project completion time (Soni et al., 2017). Similarly, the client's interference and change orders cause conflicts leading to dispute risks (Balbaa et al., 2019). Perez et al. (2017) discussed the cost increases resulting from the failure to manage internal and/or external disputes that arise owing to the change requests made by the client and the unavailability of specialized labour. However, the risk factor 'requirement to use local labour', which can be present in any procurement system, has not been considered significant in the literature. It can be seen that some risk factors that are significant to high rise construction projects are absent in the above table [ex: work accidents and natural hazards, including winds (Perera et al., 2020). This is because their significance is known to the stakeholders, and consequently, they lead to very few disputes among the parties.

In risk allocation, the risk should be allocated to the party that can best withstand and manage the risk. (Brunnermeier & Cheridito, 2019). When establishing a minimal expectancy for the consultant's role in the procurement system, no (or only nominal) risk allocation should be made (Surahyo, 2018). Likewise, a proportion of the risk should be allocated to other parties in the case of 'delays in receiving information from the designers', which should generally be completely borne by the consultant (Surahyo, 2018). The highest proportion of the construction risk should be allocated to the contractor since the contractor has to come up with innovative strategies (Thomas & Ellis, 2017).

Risk response strategies relating to the significant risk factors that were identified in this study had been mentioned by Motaleb and Kishk, (2014); Zhangand Zuo; (2016); Perera et al. (2020) as well. These risk response strategies can be categorized under risk avoidance, risk transfer, risk mitigation, and risk acceptance. Dispute risks can be avoided at the commencement of the project itself by accommodating standard conditions of contract together with an appropriate (this can be innovative) procurement system (Dixit, 2022). For example, FIDIC-Subcontract 2011 can be used for subcontracts, and FIDIC white can be used for consultant contracts, which allow for including conditions in the bid whenever necessary (for example, when the work cannot be completed by the project deadline) (Mante, 2018). Lam & Siwingwa (2017) have acknowledged that the strategy 'allocate a contingency plan for unavoidable risks' would help manage such risks using the funding plans included in the project cost estimate. Many causes of disputes, including the delays in receiving information, are found to be not due to the incapability of any party but due to a lack of teamwork culture. Thus, the best way to address dispute risks caused by delayed information, frequent job changes, etc. is to promote teamwork (Arditi et al., 2017).

6. Conclusions and recommendations

Dispute risks of procurement systems should be managed through systematic risk management to avoid negative consequences. Three procurement systems are frequently deployed in high-rise building projects: traditional method with M&P, traditional method with LS, and D&B with LS. One hundred and twenty-eight risk factors were found to lead to disputes in high-rise building projects. However, only 22 of them were determined to be significant, and only 16, 15, and 18 of those 22 were found to be significant in the traditional approach with LS systems, traditional method with M&P systems, and D&B with LS systems, respectively. ''Lack of skilled labour' and 'inability to complete work on time' are the two most significant risk concerns in all three procurement systems. Through the study, 15 risk response strategies suitable to high-rise construction projects could be identified and for each risk factor, the five most appropriate strategies among the 15 strategies were identified. Risk response strategies were found to be common in all three procurement systems.

As high-rise building projects are unique, it is recommended that the most appropriate procurement system be selected before the project is commenced. The risk management framework should complement the chosen procurement system and identify the project participants who can best manage the risks allocated to them. Providing education and training to stakeholders is an economical and convenient strategy that will increase the awareness of the stakeholders about high-rise building projects. It is also recommended that standard conditions of contracts be used with subcontracts and consultant contracts with the consultants to minimize/avoid risks.

This study highlights the implications of dispute risk management on different procurement systems deployed in high-rise construction projects through risk identification, risk assessment, risk allocation, and risk response. It considered apportioning the risks to each contracting party. The study findings would enable the better management of dispute risks of different procurement systems, paving the way for more effective implementation of those systems. The theoretical contribution of this study was to provide a benchmark for dispute risk management in the different procurement systems deployed in projects other than high-rise construction projects, such as road construction and reclamation projects. Besides, it will theoretically integrate the dispute risks, procurement systems, and high-rise building projects, which future researchers will find useful.

Study findings can also be applied to the infrastructure projects of other countries and other types of buildings and to investigate their suitability. The study can be extended based on the findings of a thorough study of other procurement systems. In this study, buildings 30–60 m in height were considered high-rise buildings. The study was limited to procurement systems frequently deployed in high-rise building projects in Sri Lanka. Risk allocation was done only to the client, contractor, and consultant. The definition of the consultant was limited to the consultants who were appointed by the client and did not include the in-house consultants appointed by the D&B contractor, while the definition of the subcontractor was limited only to domestic subcontractors. In addition, the findings can be applied to high-rise constructions of other countries as high-rise constructions in any country possess some similar and common characteristics, specially during the initial stages. However, the ranking of the risk factors may vary from country to country. In addition, this study can be considered a benchmark for further studies in different countries.

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