Journal of Materials and Construction Vol 11 - No. 2 (11 - 2021)

JOURNAL OF MATERIALS & CONSTRUCTION

JOURNAL OF VIETNAM INSTITUTE FOR BUILDING MATERIALS
ISSN 2734 - 9438 ISSN 1859 - 381X
Website: www.jomc.vn

Investigating risks of lumpsum contracts in highrise building projects

Nghia Hoai Nguyen[1, 2], Khanh Pham[1, 2], Bao Van Pham[1, 2]

[1]Lecturer, Dept. of Civil Engineering, International University, Room 01.506, A1 building, KP. 6, Linh Trung Ward, Thu Duc City, Ho Chi Minh City, Viet Nam.

[2]Vietnam National University Ho Chi Minh City, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, Vietnam

KEYWORDS

Highrise building
Lump sum contracts
Ranking
Risks

ABSTRACT

Risks are inevitable in construction projects, especially complex projects such as high-rise building projects. Risk identification helps stakeholders have better success of project management. The study aims at investigating risks of applying lump sum contracts in high-rise projects. The analysis data collected through the survey based on 49 risks explored for literature. The risk effects are ranked by mean values and grouped by a factor analysis technique. The analysis confirms that 25 risks are grouped into five groups: 1) the group of risks of attitude, cognition, and capacity of project personel, (2) the group of risks of delays in project execution, (3) the group of risks of related contract issues, (4) the group of risks of project complexity, and (5) the group of risks of financial capacity of stakeholders. Contractors may utilize the research results as considering signing the lump sum contracts or paying attention during the project implementation.

Introduction

Vietnam is one of the most dynamic economy in the world. In recent years, Vietnam always has high Gross Product Domestic. In order to have high development level, construction industry takes an impressive contribution. As construction is confirmed to be a leading industry in the renovation of infrastructure and technical facilities to serve as a premise for promotion and development for other industries. A construction project can only be implemented when design, technical specifications, and especially a construction contract are available. A construction contract is a written contract between the client and contractor to ensure the construction of the works in accordance with the design and technical specifications. There are several types of construction contracts: fixed unit price contracts, adjusted unit price contracts, time contracts, and lump sum contracts. Each contract type has specific characteristics and scopes of application.

Among those contracts, a lump sum contract is a contract that applies as the quantity of the work can be clearly defined. This form helps the investor actively arrange financial plans for the project. The lump sum contract also proves the contractor capability quantity estimation and forcasting correct contingency during the construction period. However, as the other contract forms, lump sum contracts contain lots of risks when applied (natural, technical, financial, and social risks). Identifying the risks and their relationships when using a lump sum contract may help the contractors focus on responding to crucial risks and eliminate the impact of these risks on the project success.

This study is, therefore, developed to determine: (1) crucial risks related as apllying the lump sum contracts in high-rise buildings construction projects and (2) relationships among the risks. A review of literature on the risks is mentioned in the second section of this paper. Next section includes the applied research methodology. Section four consists of a data analysis and results. Dicussions of the research results is mentioned in section five, followed by the conclusion of the study.

Literature review

Hartman and Snelgrove investigated the risks based on the terms of the lump sum contracts and the distribution of risk to stakeholders [1]. The study was conducted based on the opinions of construction experts who emphasized the importance of 18 risk factors. However, the importance of these factors varies for each stakeholder: investors, contractors and consultants. As a result of the above analysis, Hartman et al. provided a more detail study on the distribution of the lump sum contract risks to stakeholders by the proposal of adjusting the terms of the contracts [2]. The adjustments were then further evaluated by the experts. The evaluation results showed that the adjustment distributed the risks to stakeholders better.

The distribution of risk in the package contract was presented more specifically by [3]. The study examined the allocation of risks to construction stakeholders using the fuzzy theory. In the study, the authors identified five groups of factors: competence, contract and legal, economic, natural conditions, and politics and society. These five groups of factors together with 17 sub-factors were specifically allocated to stakeholders including contractors and investors.

Chan et al. also identified risk factors that differently distributed to each project stakeholder [4]. The authors confirmed 08 risk factors that

https://doi.org/10.54772/jomc.v11i02.295
Received 18/08/2021, explanation 21/9/2021, Accepted 29/10/2021

should be distributed to the investors: (1) changes in the scope of work; (2) errors in bidding documents; (3) incorrect topograhphical information in the bidding documents; (4) incomplete bidding designs; (5) infeasible designs; (6) lack of the participants of the main contractors during the design phases; (7) lack of risk perception during the design phase; and (8) late payments. On the other hand, the following 6 risks should be handled by the contractors: (1) difficulties in back-to-back contracts for subcontractors; (2) responsibility of construction quality; (3) inadequate supply of materials, equipment, and labour; (4) low productivity; (5) insuficient subcontractors; and (6) changes in interest rates.

Zhang and Li studied FIDIC contracts and Chinese template contracts to identify risks when applying EPC contracts [5]. The authors considered risk sharing between the clients and the main contractors. The clients imposing risks on the general contractor led to losses including increased costs and minimized benefits. To eliminate this risk, the authors proposed a computational model that help share risks between clients and contractors in order to achieve the highest benefits for both parties.

In addition, the studies on perception of project stake holders on the risks were conducted. Chan et al. identified 34 risks of implementing target cost contracts and guaranteed maximum price contracts [6]. These risks are tested and ranked based on the perceptions of the clients, consultants, and contractors.

Wang ranked 20 risk factors affecting the application of lump sum contracts in China from the perspective of government agencies, clients, contractors, and consultants [7]. The study focused on the lump sum contracts for design, procurement, and construction. The crucial factors were confirmed including the ability of the client in engineering issues, the client's concern on construction technologies, and the characteristics of the project and market.

Kaplanogu and Arditi used the pre-project review (PPPR) approach to evaluate the risks before signing the guarantees maximum price contracts [8]. The study emphasized on the planning and procurement issues, personnel, client requirements, contract amount, general conditions, profitability, issues related to subcontractors, occupational safety, worker quality, client satisfaction, legal issues, and information technology.

In Vietnam, the risks of construction projects were also conducted by many researchers. The studies analyzed the relationships between risks and costs [9, 10, 11], between risks and schedules [12, 13]. Moreover, the other studies examined the risks based on the perspectives of the clients [14, 15].

The literature review confirms that the risk factors and relationships when applying lump sum contracts in high-rise building projects were not fully studied. Therefore, the purpose of this study is to examine the risk of applying lump sum contracts in high-rise building projects. Based on the literature review the study filters out 43 potential risks as shown on Table 1.

Table 1.
Risks of lumpsum contracts

Code	Risk	References
WEAT	Extreme weather	[2], [3], [6], [9], [10], [11], [13], [14], [16]
DIAS	Disasters, epidemics	[1], [2], [9], [10], [11], [14]
GEOL	Complex geology	[3], [4], [9], [10]
PROT	Objections of neighbourhood	[9], [10], [13], [14], [17]
INFL	Inflation	[1], [6], [8], [9], [10], [11], [14]
FINO	Financial capacity of Clients	[2], [8], [9], [10], [14]
FINC	Financial capacity of Contractors	[2], [9], [10], [14]
PRIC	Price escalation	[9], [10]
WAST	Wastage	[9], [17]
SISU	Insufficient qualifications of site supervisors	[1], [11], [15], [16]
DSHO	Delay in site handing over	[1], [8], [18]
DAPP	Delay in approval and issuant of documents	[2], [8]
DSUP	Delay in supplying material and equipment	[4], [10], [17]
DCHE	Delay in checking and acceptance	[10], [11], [13], [18]
DPAY	Delay in claim approval	[4], [8], [10], [18]
CPRO	Delay in progress and final payments settlement	[1], [4], [8], [10], [18]
CAPP	Complex procedures of project appraisal, approval, and permit	[1], [2], [8], [15]
INFO	Incomplete information of projects	[8], [16]
CLAW	Changes of regulations	[2], [3], [8]
COMO	Non-compliance with the terms in contracts	[8], [14]
COMS	Incompliances of subcontractors on the agreed and planned activities	[1], [16]
CORS	Changes of scope of works	[2], [15], [16]
INSW	Scope of the works are not described in full detail in contracts	[1], [16]

Code	Risk	References
EGEO	Errors in the geological survey	[1], [2], [14], [15], [17]
INAP	Unreasonable requirements of construction technology	[1], [2], [12]
SMSM	Schedules and construction methodologies are unrealistic	[12], [16]
TSCH	Tight schedules	[12], [16]
INSD	Incomplete designs	[10], [11], [13]
MEAS	Incorrect, insufficient, and inappropriate quantity measurement	[1], [11], [15], [16]
ESII	Incorrect and insufficient estimation	[2], [16]
CRDE	Inappropriate designs and conflicts between disciplines	[12], [15], [16]
CORD	Design changes	[12], [15], [16]
WCON	Reworks	[6], [12], [15]
SAFE	Poor occupational safety	[3], [5]
CONF	Conflicts between subcontractors	[10], [13]
DSCO	Slow resolution of conflicts between parties	[2], [8]
COMM	Poor communication	[2], [15]
ABMO	Poor management skills of clients	[10], [11], [16]
ABME	Poor management skills of consultants	[10], [11], [16]
ABMC	Poor management skills of contractors	[10], [11], [16]
PROD	Low productivity	[2], [12]
WORK	Insufficient personnel	[1], [11], [15], [16]
MPER	Regular changes of managers	[9], [10], [17]

Research methodology

The research framework of this study is shown in Figure 1. Firstly, the literature review is conducted to identify risk when applied lump sum contracts. The result of the literature is the lists of the risks, which is used to develop the questionnaire used for data collection. In order to minimize bias in data collection, pilot studies are performed to ensure the clarity of the questionnaire that means that respondents can finish questions without any further explanation. The other purpose of pilot test is to collect the comments of the experts on the sufficiency of the list of risks. The formal questionnaire is then developed and distributed to the respondents. In the next step, data screening is performed to ensure the validity the collected data. Finally, the screened data are ranked and grouped by the factor analysis technique.

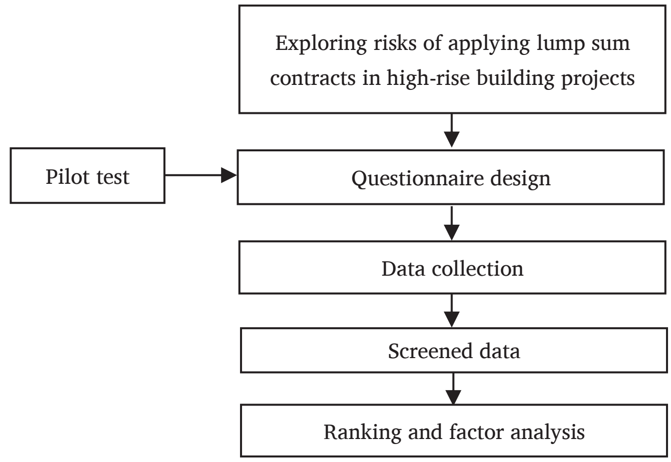

Figure. Research framework.

Data collection and analysis

The original questionnaire that consisted of 43 risks associated with lump sum contracts in high-rise construction projects was developed based on the 5-level Likert scale with five levels (1 = completely disagree and 5 = completely agree). The pilot test was then performed to collect the expert's comment on the questionnaire. As a result of the pilot test, there were six more risks added to the formal survey including: suppliers cannot be selected due to low signed contract amount (LPRI), positive variations are not approved (VARI), negative variations are deducted (VARD), delay in overcoming the consequences of disasters, epidemics, accidents (DOVE), poor worker attitude (ATTW), and poor manager attitude (ATTM). After revising the original questionnaire, the study conducted a formal survey to collect data. The questionnaires were distributed directly and online to the principal stakeholders in construction projects in Vietnam. The convenience sampling technique are utilized in the study to collect data. There was total 210 responses out of 350 sent questionnaires collected via survey. The response was checked with the scale and the normal testing reliability. The results of the Cronbach's Alpha coefficient test confirmed the internal consistency test items. After removing the DCHE, the consistency was confirmed with all cofficiences greater than 0.6. That proves that the scale is appropriate and reliable for each expert's answer. The data were then tested with the normality testing including Z-scores, Skewness, and Kurtosis testings [19]. As the results of testings, nine responses were excluded to ensure the normality of data.

The mean values of 48 risks of lump sum contract application were calculated based on survey data. Table 2 presents the ranking order of ten most crucial risks.

Table 2.

Ranking of risks of lump sum contract application.

Risks	Mean	Standard Deviation
Incorrect and insufficient estimation	4.28	0.869
Positive variations are not approved	4.24	0.859
Incorrect, insufficient, and inappropriate quantity measurement	4.21	0.905
Negative variations are deducted	4.20	0.961
Extreme weather	4.14	0.856
Disasters, epidemics	4.09	0.845
Incomplete designs	4.06	0.902
Delay in approval and issuant of documents	4.04	0.945
Delay in claim approval	4.02	0.938
Inappropriate designs and conflicts between disciplines	3.98	0.776

Table 3.

KMO and Bartlett's Tests.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.881
Bartlett's Test of Sphericity	Approx. Chi-Square	2105.405
	df	300
	Sig.	0.000

Table 4.

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.964	31.854	31.854	7.964	31.854	31.854
2	2.591	10.364	42.218	2.591	10.364	42.218
3	1.506	6.023	48.241	1.506	6.023	48.241
4	1.319	5.277	53.517	1.319	5.277	53.517
5	1.073	4.291	57.808	1.073	4.291	57.808
6	0.966	3.863	61.671			
7	0.930	3.721	65.392			
8	0.842	3.370	68.761			
9	0.804	3.217	71.978			
10	0.749	2.994	74.973			
11	0.682	2.730	77.703			
12	0.615	2.462	80.164			
13	0.575	2.299	82.463			
14	0.549	2.194	84.658			
15	0.492	1.967	86.625			
16	0.457	1.827	88.452			
17	0.423	1.691	90.143			
18	0.399	1.597	91.739			
19	0.391	1.564	93.304			
20	0.357	1.429	94.733			
21	0.320	1.280	96.013			
22	0.301	1.203	97.216			
23	0.270	1.080	98.296			
24	0.246	0.984	99.280			
25	0.180	0.720	100.000			

Table 5.

Rotated Component Matrix with Varimax rotation method.

	Component				
Risk	1	2	3	4	5
ATTW	.820				
ATTM	.760				
MPER	.734				
SISU	.709				
WORK	.630				
ABMC	.581				
CPRO		.715			
DPAY		.627			
DAPP		.558			
DIAS		.518			
SMSM		.515			
GEOL		.474			
LPRI		.466			
DSHO		.447			
PROT		.445			
CORS			.785		
COMS			.719		
CORD			.687		
INSW			.530		
MEAS				.831	
ESII				.820	
INSD				.740	
CLAW				.414	
FINC					.847
FINO					.831

Next, the main component analysis was utilized to evaluate the 48 remaining risks. The Kaiser-Mayer-Olkin (KMO) and Bartlett's Test are used to assess the relevance of data before performing EFA analysis (Table 3). The KMO value = 0.752, and the Sig. value of Bartlett's Test = 0.000 demonstrated that the data were appropriate for conducting the analysis. The analysis was performed with the main component analysis (PCA) method with Varimax rotation and the factor loading of 0.4 used. After five analyses, 23 risks were removed because they were able to simultaneously explain both groups of risks. The final results of the main component analysis that consists of five groups with 25 associated risks are shown in Tables 4 and 5.

Discussions

The ranking results show that the incorrect and insufficient quantity measurement and estimation are the most crucial risks when the lump sum contracts are applied in the high-rise building projects. That confirms the lump sum contract characteristics of accuracy in quantity measurment and contract amount estimation. The contractors may also face with the extreme problems of getting variation approvals as the risks are ranked in the second and fourth positions. The risks of extreme weather, disasters, and epidemics are rather important with the ranks of fifth and sixth positions respectively. The incomplete designs, delay in approval documents, delay in approval claims, and inappropriate designs are then followed in the list confirmed their relative importances.

Furthermore, the factor analysis results shows that the risks of lump sum contract application are combined into five groups. The five groups are formed with the related risks. The first group named as the risk of attitude, cognition, and capacity of project personel consists of the six risks: poor worker attitude (ATTW), poor manager attitude (ATTM), poor management skills of clients (ABMO), regular changes of managers (MPER), insufficient personnel (WORK), and insufficient qualifications of site supervisors (SISU). Contractors must pay attention to issues related to the working attitude and capacity of personnel, especially of site supervision [1, 11, 16]. In addition to ensuring the effectiveness of project management, it is not recommended to change senior managers. These risks reduce work efficiency and the quality of work. This group of risks relates to the ability to implement the project.

The second group includes the risk of delay in claim approval (DPAY), delay in site handing over (DSHO), delay in approval and issuant of documents (DAPP), delay in progress and final payments settlement (CPRO), objections of neighbourhood (PROT), suppliers cannot be selected due to low signed contract amount (LPRI), disasters and epidemics (DIAS), schedules and construction methodologies are unrealistic (SMSM), complex geology conditions (GEOL). The group are able to classify as the risk of delay in project execution. Contractors must be aware of the risks associated with delays in payment, approval and release of relevant documents, progress and final payments, site handover, or delays due to the opposition of project neighborhood, natural disasters and epidemics, complexity of geology [4, 8, 10]. These delays lead to an impact on project schedules, cash flows, and profits. This group of risks is related to schedule and payment.

The risks of incompliances of subcontractors on the agreed and planned activities (COMS), changes of scope of works (CORS), design changes (CORD), and scope of the works are not described in full detail in contracts (INSW) are in the third group that are named as the risk of related contract issues. Contractors should pay attention to changes orders due to changes of design and scope of work [12, 16]. Unclear scope of works and uncooperative subcontractors should be taken into consideration due that they may lead to conflicts and disputes. This group of risks lead to disputes and lawsuits.

The fourth group is a combination of the risks: incorrect and insufficient estimation (ESII); incorrect, insufficient, and inappropriate quantity measurement (MEAS); incomplete designs (INSD); and changes of regulations (CLAW). Based on the formation of the group, this can be called as the risk of project complexity. Due to the complexity, contractors face with the risks of inadequate design, incorrect quantity calculations and improper estimations [1, 11, 16]. This group of risks causes the inaccuracy of contract amount and affects the cash flow and profitability of the contractors.

The last group is the smalled group that is formed by the two risks of financial capacity of clients (FINO) and financial capacity of contractors (FINC). It is clear to call this group as the risk of financial capacity of stakeholders. The contractors are not aware of the financial capacity of the clients as signing the lump sum contracts only but the balance his or her financial capacity also [2, 9, 10]. The group of risks is related to the financial settlement ability that ensure the sufficient financing to implement the project.

Conclusions

The study aims to identify the risks that may occur as applying lump sum contracts for high-rise building projects. There is total 48 risks assessed. The most crucial risks are confirmed from the analysis result including: (1) incorrect and insufficient estimation, (2) positive variations are not approved, (3) incorrect, insufficient, and inappropriate quantity measurement, (4) negative variations are deducted, (5) extreme weather, (6) disasters and epidemics, (7) incomplete designs, (8) delay in approval and issuant of documents, (9) delay in claim approval, and (10) inappropriate designs and conflicts between disciplines. Factor analysis is used to determine the main components from 48 survey risks. The results of the factor analysis confirmed that the 25 risk factors were grouped into five main groups: (1) the group of risks of attitude, cognition, and capacity of project personel, (2) the group of risks of delay in project execution, (3) the group of risks of related contract issues, (4) the group of risk of project complexity, and (5) the group of risks of financial capacity of stakeholders.

The results of the study provide an overview of the risks of applying the lump sum contracts in high-rise building projects. To eliminate risks, contractors are recommended to pay attention to the highly ranked risk factors. Furthermore, the group of risks related to attitude, perception, work capacity, financial capacity, contract-related issues, factors that cause delays and the complexity of the project should also be aware as applying the lump sum contracts.

The survey mainly conducted from the companies located in Ho Chi Minh City therefore the analysis results may not be possible to fully cover all Vietnamese contexts. Further study is needed to gather more responses from the companies located in other provinces rather than Ho Chi Minh City to reflect the wholly context of Vietnam. Detail analyses of confirmatory analysis or structural relationship among risks are also recommended.

Acknowledgement

The research is funded by the International University under grant number T2020-01-CE/HĐ-ĐHQT-QLKH

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