Ranking of Risk Factors Causing Delays on Building Construction Project in Cambodia

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Abstract

As the process of a construction project is complicated with a combination of countless factors ranging from planning to implementation that cause delays on the project timeline, identification of risk factors causing delays on the construction project has been regarded as one of the important steps of increasing the chances of project success. This research aims to identify, investigate, and rank delay factors perceived to affect private finance building construction project in Cambodia. A total of 45 delay factors was identified through previous literature to be included in the questionnaire survey. The survey is conducted with 64 experts, comprising a statistically representative sample that matches research preference. The delay factors derived from the questionnaire survey are analyzed using the Relative Importance Index (RII) to illustrate the rank of delay factors listed from most critical to least critical. The results from the study reveal the top five main critical delay factors namely, a labor shortage, an on-site material shortage, low productivity of labor, design changes by the owner during construction, and the complexity of the project. Overall, the ranking outcomes of delay were dominated by factors related to labor and material. In addition, lack of labor training, incompetent architectural designer, land acquisition, and land privatization dispute were concluded as the newly found delay factors in the Cambodia context. Possible recommendations from experts were presented. Thus, this study serves as a guideline for project managers or stakeholders who want to study about Cambodia building construction industry in order to deliver effective project planning.

Keywords: *Construction Delay, Relative Importance Index, Cambodia.*

1. Introduction

1.1 Research background

According to a National Bank of Cambodia (NBC) press release reported by the Phnom Penh Post newspaper, the economy of Cambodia is expected to remain steady and maintain a growth rate in 2018 despite the global economy's challenges (Kimsay, 2019). The boom of construction and real estate indicates 2 percentage points of the 7.1 GDP growth in 2014, making the sector the single largest contributor to growth estimated by the World Bank (Council for the Development of Cambodia, 2015). As a result, the construction industry is considered a key factor that contributes to Cambodia's economic growth. Nothing is perfect, neither nor the construction. There are always risks, problems, and countless factors ranging from planning to resources that influence the delay of the construction project. There are many risks and unforeseen factors to be studied and assessed in order to deliver a successful project within an expected timeline.

To achieve a successful project, one shall understand what causes a delay in a construction project. Therefore, the identification of factors that push the project to be delayed is significant to the success and profitability of construction projects. Identifying delay factors allow the stakeholders to foresee the causes and to prepare preventive solutions. Meanwhile, identification and ranking of risk factors causing a delay in construction projects have been carried out in the last decade; however, a little has yet been done in Cambodia to examine whether those factors are related and can be solved in the same way. Consequently, the paper is going to fill an important knowledge gap in the Cambodia construction industry by identifying the risk factors causing delay and ranking the importance of delay factors.

1.2 Literature review

Sambasivan and Soon (2007) studies the impact and basis causes of delay in the Malaysia construction industry. They have found some main causes delay as follows: Poor management planning of contractor, Lack of contractor's understanding, Poor site planning of contractor, Insufficient budget of the client, disputed with subcontractors, Inadequate Materials, Lack of labor supply, defection and availability of equipment, Misunderstanding between stakeholders. Baldwin et al. (1971) found that weather, labor supply, and the subcontractor are the main critical factors that led to delay. Another study from Arditi, Akan, and Gurdamar (1985) concluded that lack of material supply, late payment from clients, and different characteristic between the construction company and public agencies are their main delay factors. Mansfield, Ugwu, and Doran (1994), on the other hand, identified sixteen major factors and categorized into four major factors such as shortage of materials and poor planning, Lack of contract management, and late payment for completing scopes. In the study of Assaf, Al-Khalil, and A-Hazmi (1995), the building construction projects in Saudi Arabia have fifty-six delays causes which are grouped into seven major categories. In conclusion, the authors got major factors as follows: late approval of drawings, late payment from the client during the construction phase, many errors and changes in design, the poor performance of subcontractors, improper management in owner's company, inadequate labor supply, and poor labor performances. In Hong Kong construction projects, Chan and Kumaraswamy (1997) investigated eighty-three potential factors which can be grouped into five main causes namely, unforeseen ground factor, lack of supervision and management in the site, indecisive project teams, changes in client's plans, and increases in the scope of works. In Indonesia, construction projects, the study found eleven delay factors and concluded the important factors such as lack of labor commitment and performance, frequent changes in design, lack of resource, and low capability from the contractor (Kaming, Olomolaiye, Holt, & Harris, 1997).

Meanwhile, in Lebanon, Mezher and Tawil (1998) conducted a study about a delay in construction projects and found sixty-four delay causes. According to the research, payment issues, the relationship between clients and contractors, and poor project execution were the most important variables to project delay. Assaf and Al-Heijji (2006) investigated the delay factors in Saudi Arabia. From their survey, seventy-three causes had been identified by expert groups namely, contractor, client, and consultant. Among the list of delay factors, the researcher concluded that the change orders were the main critical issue in the project. In Ghana building projects, Fugar and Agyakwah-Baah's study (2010) indicated thirty-two factors that led the project to delay. Later in the result section of the research, the common delay factors are mistakes in estimating project cost, lack of understanding of the complexity of technical knowledge, late payment, bad administration and site planning, failure in estimating completion time, inadequate materials, lack of management, and inflation of material cost. Haseeb, Bibi, and Rabbani (2011) researched in Pakistan and discovered important delay issues such as natural disasters, late payment from the owner, poor site management, lack of experience in contractor team, and inadequate supplied materials. In Kuwait construction projects, Soliman (2010) interviewed thirty participants to obtain the causes of delay which shown that payment conflicts and changes in design during the construction phase are often seen as a threat and critical issue in the industry. Back to Malaysia construction industry, Hamzah et al. (2012) specified twenty-two causes that impact the project schedule and cost as the follows: productivity of skill workers, late material delivering, instability of price, inadequate equipment, financial issues from contractor and owner, lack of capability of contractor, poor site management, lack of planning, defective structure design, bad administration and supervision, underestimate project time, frequent changes in design drawing, failure to accommodate required construction site, indecisive client, frequent design errors, late approval of drawing, incomplete contract document, late supervision, insufficient consultant experience, lack of parties communication, weather condition, and permit approval issue from city hall. Abd El-Razek, Bassioni, and Mobarak (2008) addressed thirty-two causes of delay in Egypt. The final results showed that financing by the contractor during construction, late payment from clients, and poor resource management by the contractor are the most important factors. Koushki, Al-Rashid, and Kartam (2005) found that six factors including local political issue, lack of resource allocation, poor project planning, delay in payment, price inflation, weather condition, lack of equipment, lack of detail in contract drawing, and the act of God are the

major impact that setback the timeline of project. In Cambodia, Durdyev and Omarov (2017) reported that shortage of materials on-site, unrealistic project scheduling, late delivery of material, shortage of skilled labor; complexity of project, labor absenteeism, late payment by the owner for the completed work, poor site management, delay by subcontractor, accidents due to poor site safety were the critical delay factors affecting residential construction project by surveying construction professionals in the region. Santoso and Soeng (2016) researched on analyzing delays of road construction projects in Cambodia; as a result, working during rainy season, flooding, land acquisition, award of project to lowest bidder, equipment breakdowns, poor site arrangement, unexpected ground condition and terrain, low quality of the contractor human resources, late progress payments, and low productivity of labor were concluded as significant delay factors. Previous studies mentioned above were all focused on revealing the delay factors, some of which are repeated and have the same meaning in terms of impact. It can be viewed that most of the construction projects had almost common variables that are identical, especially those happened in private finance building construction projects.

In this case, it allows the author to comprehend and seize all of the important aspects of delay to study and to relate with the Cambodia construction industry. As seen, there are many common delay factors to be found in all of those researches despite organizational cultures and different countries and companies. Thereupon, this study found forty-five delay factors that are in common and crucial in private finance building construction projects. This study categorized those found delay factors into nine major groups namely, consultant related group, contractor related group, design-related group, equipment related group, external related group, labor-related group, materials related group, client-related group, and project-related group in order to illustrate the responsibility of the delay causes (Gündüz, Nielsen, & Özdemir, 2012).

2. Objectives

The purpose of this research aims to (1) identify potential delay factors; (2) to investigate delay factors in the private finance construction projects in Cambodia; (3) to rank the delay factors using the Relative Importance Index (RII) with expert's analysis.

3. Materials and Methods

3.1 Scope of the study

This study focuses on private finance residential building construction projects with a design-build delivery system using reinforced cast-in-place concrete structure. The construction cost of the project ought to be in the range between eighty US dollars to five-hundred and eighty US dollars per square meter. The types of construction projects included in this research are as follows.

Table 1 Project Preference

Project Building Type	Floors of Building	Cost per Square Meters (Labor)	Cost per Square Meters (Finished)
Flat House	(1F-4F)	80-85	280-320
Villa/Gate House	(1F-3F)	85-95	350-420
Apartment & Condominium	(5F-9F)	85-95	355-425
Apartment & Condominium	(10F-20F)	100-130	430-580
Residential Office	(1F-3F)	85-95	350-420
Administration Building	(4F-7F)	N/A	400-450

3.2 Sample size

The sample was restricted to registered engineers in the Board of Engineers Cambodia. Based on the official statement of H.E. Pich Sophorn, Secretary of State at the Ministry of Labor and Vocation Training (MLVT) during the seminar held on 26th April 2017, 76 out of 108 registered civil engineers with Board of Engineers Cambodia are currently staying in Phnom Penh city and are working in a private sector. By using the Cochran Formula below with a 95% confidence interval, a total of 64 respondents were chosen for the study.

$$n = \frac{n'}{1 + \frac{(n'-1)}{N}} \quad (1)$$

Where n'= Cochran's sample size recommendation and N = available population.

3.3 Ranking and computation of relative importance index (RII)

The procedure of this research methodology is divided into three main stages, namely, delay identification, potential delay determination, and conclusion. The study uses a questionnaire survey to get experts mainly from contractor, consultant, and designer to respond with scale and further detailed information to determine the critical delay factors. The data are then analyzed with the Relative Importance Index (RII) with 5-Linkert scales to rank the delay factors. The score weight of each of the delay factors as critically perceived by the experts is examined and computed using the below equation (1).

$$RII = \sum W \div A \times N \quad (2)$$

Where W = the weighting given to each factor by the respondents ranging from 1 to 5, A = the highest weight, and N = the total number of respondents.

The higher value of RII means a more important cause of the delays. To determine the ranking, the overall of RII scores determined from the viewpoint of each participant categories are calculated accordingly. After the scores of each delay factor have been accumulated, the paper classifies the scores into three separate groups namely contractor, consultant, and designer. Consequently, the paper sums up all of the three parties' scores and divide by three to determine the overall score on that same factor in order to compare with other delay factors to produce the ranking. The author uses Spearman's Rank Correlation Coefficient test to understand whether there is disagreement or agreement among three groups, namely, the contractor group, the consultant group, and the designer group of ranking delay factors. The perfect positive correlation value of plus one (+1) shows two variables' agreements on one point while the perfect negative value of minus one (-1) indicates an opposite relationship. In this study, the positive value of greater than zero from the calculation is a reliability parameter of the result obtained from the respondents. The below equation (2) is the formula of Spearman's coefficient test.

$$rs = 1 - \left[6 \sum d^2 \div \left(n^2 - n\right)\right] \quad (3)$$

Where d = the difference in the ranking between two variables and n = the total number of factors.

4. Results and Discussion

4.1 Survey Results

A total of 64 respondents constituted the sample size. Sixty- four sets of questionnaires were distributed to the identified respondents, and out of these, sixty- four were returned, representing a 100% response rate. Among the experts, there are 21 clients/ consultants, 21 designers/ architects, and 22 contractors/constructors.

Table 2 Professions of respondent

ID	Professional cadre of respondents	No. of respondents	Percentage %
1	Clients/Consultants	21	32.8
2	Designers/Architects	21	32.8
3	Contractors/Constructor	22	34.3
	Total	64	100

This research is limited to engineers whose ages are more than 18, having experiences ranging from 4-30 years in construction practice and license registration of the Board of Engineers Cambodia. Statistical analysis was used to depict the differences in the perspective among the expert groups, namely, the client/consultant, the designer/architect, and the contractor/constructor, ensuring that all experts were having the same perspective in ranking private finance building construction projects' delay factors. The results from the Spearman Rank Correlation Coefficient Test show that the three parties agreed on the level of importance of each delay factor.

Table 4 Project Preference

Parties	Spearman's Coefficient of agreement on delay factors
Contractor/ Consultant	0.9849
Contractor/ Designer	0.9944
Designer/ Consultant	0.9818

4.2 Rank of Delay Factors

Table 5 presented the results which were grouped as the followings; (1) consultant-related group, (2) contractor-related group, (3) design-related group, (4) equipment-related group, (5) external-related group, (6) labor-related group, (7) material-related group, (8) client-related group, and (9) project-related group. Below, Table 5 illustrates the ranking of the delay factors as perceived by the respondents.

Table 5 Ranking of Delay Factors

Delay Factor Description	Category	Overall RII	Rank	Delay Factor Description	Category	Overall RII	Rank
Labor Shortage	6	0.9937	1	Frequent change of subcontractors	2	0.9506	8
On-site material Shortage	7	0.9876	2	Escalation of material prices	7	0.9444	9
Low productivity of the labor	6	0.9815	3	Ineffective project planning and scheduling	2	0.9377	10
Design changes by the owner or the agent during the construction	3	0.9752	4	Delay in progress payments (Funding problem)	8	0.93189	11
The complexity of the project (Type, Scale, Fund, etc.)	9	0.9690	5	Accidents during construction	5	0.916017	12
				Change orders	8	0.909957	13
Labor Absenteeism	6	0.9659	6	Complexity of project design	3	0.905628	14
Late delivery of materials	7	0.9567	7	Frequent equipment breakdowns	4	0.904185	15

Table 5 Ranking of Delay Factors (Cont.)

Delay Factor Description	Category	Overall RII	Rank	Delay Factor Description	Category	Overall RII	Rank
Equipment allocation problem	4	0.9001	16	Lack of design team experience in construction projects	3	0.7625	31
Delay in manufacturing materials	7	0.8974	17	Inadequate modern equipment	4	0.7595	32
Act of God (ex: rain effect on construction activities)	5	0.8502	18	Changes in government regulations and laws	5	0.7563	33
Changes in material types and specifications during construction	7	0.8000	19	Delay in obtaining permits from the municipality	5	0.7531	34
Inaccurate Site Investigation	1	0.7968	20	Lack of consultant experience in construction project	1	0.749928	35
Inadequate contractor experience	2	0.7937	21	Incompetent project team	2	0.749928	36
Inappropriate construction method	2	0.7905	22	Delay in approving design documents	8	0.6	37
Design errors and omissions made by designers	3	0.7874	23	Conflicts between consultant and design engineer	1	0.59697	38
Delay in performing inspection and testing	1	0.7843	24	Conflicts between joint-ownership	8	0.593795	39
Delay in performing final inspection and certification by the third party	5	0.7811	25	Low motivation and morale of labor	6	0.59062	40
Insufficient data collection and survey before survey	3	0.7779	26	Inadequate definition of substantial completion	9	0.587446	41
Original contract duration is short	9	0.7747	27	Improper project feasibility study	8	0.584271	42
Delay in approving major changes in the scope of work by the consultant	1	0.7717	28	Ineffective delay penalties	9	0.581097	43
Improper equipment	4	0.7687	29	Legal disputes between project participants	9	0.577922	44
Low efficiency of equipment	4	0.7657	30	Personal conflicts among labor	6	0.4	45

5. Conclusion

The perspectives of 64 experts on the 45 delay factors were analyzed using the Relative Importance Index. The findings from this research are shown in Table 5. In line with the Spearman's Coefficient of the agreement on delay factors, the results were proved to be reliable and valid due to the similarities of the respondents' professions and demographic backgrounds.

5.1 Top-Five Critical Delay Factors

5.1.1 Labor-related group

As presented in Table 5, the outcomes of this study showed that a labor shortage is ranked the first in its importance level among all explored delay factors. Considering this issue, the mass of workers in Cambodia is migrating to other neighbor countries seeking higher wages. There were approximately 350,400 Cambodian migrants in 2010 (World Bank, 2011). As a result, the construction sector is facing a labor shortage to supply the demands (Dene & Khoun, 2013). Because the construction is dangerous in some cases and pays low wages to local workers, most of them chose to migrate to find a better salary. As labor shortages are increasing, the construction projects experience delays and take longer than what has stipulated in the contract. From the surveys, the experts recommended construction companies to create a healthy work culture and attractive incentive rate. Besides, since the construction has a bad reputation for its dangers and risks;

therefore, the experts suggested that the company or project stakeholders promote safety to popularize the construction work.

Refer to Table 5, Low productivity of labor came in as the third most important delay factor. In Cambodia, construction workers are hired based on their willingness, yet not their skills. Most of the construction firms usually recruit local workers as temporary laborers for the projects. Aiming for low costs and a high quantity of workers, unskilled local people around the project site are the company's targets. Thus, after recruitment, most firms do not have or offer any training programs for the workers. The only common knowledge that the workers need to have is to follow the site supervisor's instructions and guidelines. These conditions impact the productivity of the work implementation on the site. The experts urged all of the construction firms to conduct training programs for laborers from time to time. They suggested that the company shall promote a friendly working environment for workers to the extent that the working place is perceived as a learning opportunity as well.

Lack of labor training is a new common delay factor in Cambodia, as suggested by experts. Labor used their pass-on knowledge that they have learned from friends and family rather than undergoing proper education and training. Lack of proper training can result in rework and correction which also delay the project timeline. This problem usually arises in the apartment and condominium projects where complex designs were involved, such as a building structure or complex building façade.

5.1.2 Material-related group

The second most important delay factor is an on-site material shortage, according to Table 5. Regarding the questionnaire survey, poor estimation of materials quantity and poor workmanship are the hidden reasons why the shortage of on-site material occurred. Poor estimation by QS engineer before and during the construction stage gave rise to reordering especially when construction materials in Cambodia are needed to be imported from overseas. In 2017, Cambodia imported USD 12 billion, making it the 83rd biggest importer in the world. During the most recent five years, the imports of Cambodia have expanded at an annualized pace of 0.5%, from USD 11.5 billion in 2012 to USD 12 billion in 2017 (OEC word, 2019). Thus, poor workmanship, such as poor finishing, can render a big impact on the shortage of material on the site. Some workers overused the materials, while some others completed their tasks unprofessionally resulting in the rework. As a result, compensation for the poor finishing work requires additional materials that are not in the planning. Experts suggested that in order to improve the current situation, project managers and engineers ought to optimize materials delivery timing and minimize inventory quantities. The project team should understand the Just-in-Time (JIT) application, which helps the team to manage materials procurement more effectively.

5.1.3 Design-related group

The changes in design by the owner or agent during construction ranked as the fourth significant delay factor, as listed in Table 5. Experts described this issue as an inevitable case, especially with residential projects. The clients often change their minds from time to time when it comes to architectural design and interior works. In most cases, it requires both a contractor and an architect to work together to change and redesign following the client's demands. Those adjustments, either big or small, require time to proceed with the provision of contract and work conditions. Experts suggested having a daily monitored to avoid defects and quality non-conformance. Thus, the client shall be explained by the contractor that modification during the construction phase is possible, yet just to the degree that no unfavorable impacts happened regarding crucial activities in the critical path. Project team shall understand the impact of design changes at all aspects of the project. With a good understanding of its cause and effect, the project team is able to explain effectively to the client regarding the impact of changes. It brings immediate attention to the client and mays prevent further design changes in the projects.

An incompetent architectural designer is another new delay factor found in the Cambodia construction industry, as suggested by experts. Architects were often blamed for handing over only the conceptual designs to the contractor without feasible shop-drawings. The contractor often revised the architectural plan on the spot due to poor architectural design plans and layout. This problem usually

happened when the client wanted a low-cost design team and approached the junior architects to design their project.

5.1.4 Project-related group

The complexity of the project ranks as the fifth significant delay factor which impacts the building construction project, according to Table 5. Most of the parties, namely, a consultant, a contractor, and an architect agreed on this particular matter. The size, fund, type, and design specification of the project are the variables that led to project delays. Designers or architects often found themselves struggling with the size of the projects. Most cases were the poor estimation of the project time, which often takes longer than what was planned due to the design's complexity. During the construction phase, with complex specification and schedule, the contractors found themselves hard times dealing with the change orders that led to project delays. In some cases, the projects have several stakeholders and parties involved making it more complex. To avoid the project delays, a good communication and coordination with each party are the key to tackle. Moreover, careful planning and design simplification are experts' recommended action to reduce the complexity degree in building construction project.

5.2 New Delay Factors Related in Cambodia

5.2.3 External-related group

Land acquisition is a rare delay factor yet severe once it happens. In Cambodia, landowners usually do not register the certificate of ownership for their property since it is easier to sell the land property and to avoid paying property tax by not having the certificate of ownership. It also means that there will not be any reliable sources for previous land measurements. When the new owner arrived and registered with the Ministry of Land, the contractor often found that the actual measurement from the Ministry of Land was varied from what had been told by the client. This problem forced the designer to redesign the layout, which impacted the commencement date.

Land privatization dispute is another factor that led to project delays based on two great examples of Boeung Kak Lake Development and JICA white building development. Boeung Kak Lake was a community consisting of 4,000 families. After Phnom Penh City Hall and the development firm Shukaku Inc announced an agreement to transform the Boeung Kak lake area into a sprawling mixed-use development, those 4,000 families have been forcibly evicted or resettled. During the construction period, an on-going protest was a daily obstruction for the contractor, in which some tasks were delayed and some were cancelled for the whole year. The same goes for JICA white building development; unsettled families would come daily to abrupt the construction site by throwing and burning stuff during demolition and site clearance period.

5.3 Summary and Recommendations

According to the outcome in Table 5, the list of delays affecting private financed building construction projects in Cambodia was majorly dominated by the factors related to labor and material. This outcome substantiates the study of Durdyev and Omarov (2017), where labor and material factors played major roles in residential project delay. Consequently, it is implied that a labor shortage, an on-site material shortage, low productivity of labor, labor absenteeism, and late delivery of materials are the internal factors distinctly responsible by the contractors. Foreperson in contractor companies must put their best efforts in mitigating such critical delay factors to their magnitudes of influence. By doing so, on-time project delivery can be effectively achieved. The respondents had given few important recommendations as follows: (1) an improvement of local labor wage and incentive, (2) a development of skilled workers' ability and knowledge in the construction field, (2) preplanning of workforce and material plan, (3) guarantee auspicious delivery of on-site materials, (4) appropriate and effective method statements for construction activities, (5) usage of modern technologies such as precast, (6) preplanning for rainy seasons, (7) on-time progress payment from the owner, (8) a standard limit to design changes from the owner to avoid adverse effects on the critical path, (9) effective selection of a subcontractor based on experience and qualification, (10) detailed and realistic work schedule, and (11) promoting daily safety toolbox meeting, improvement of site conditions and

management, and training programs for workforce as well as engineers regarding safety regulations and educational programs.

In addition, the study also revealed the new delay factors such as land acquisition and land privatization disputes, which are related to the Cambodia construction context. Those delay factors are considered as external factors, and the government is responsible for resolving them. Although it seldom happens, the effect of these two external delay factors on building construction projects is drastic yet radical for the developer. The study recommended as follows; (1) The Ministry of Public Works and Transport and The Ministry of Land Management, Urban Planning, and Construction must insist on facilitating public conflicts and strengthening law and regulations for construction. Both ministries must institute measures to ensure that project development goes through a proper land acquisition without any corruption and bribe. Such disputes render security issues for all the project participants; therefore, more attention is required in maintaining site security to provide chances for the contractors to deliver the projects promptly. The government shall develop a transparent legal framework for fighting unclear or unresolved disputes.

To summarize, the major contribution of this research to the Cambodia construction industry is the ranking of delay factors. With the level of importance to each of the causes, contractors, project managers, and clients can understand which vital factors should be prioritized before or after to prevent the project delays. In this research proposition, the main contractors in Cambodia's private financed building construction must aim to avoid or mitigate labor and material delay factors when managing the schedule of the project.

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