



Identification of Factors Influencing Time and Cost Risks in Highway Construction Projects

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Abstract: The construction of highway projects involves many types of risks throughout the various stages of its project life cycle. Those risks are especially significant due to their impact on the project performance and objectives, mainly in terms of costs and time. Several factors of projects risk had been determined and well explained in the paper. Major risks involved in highway construction in Malaysia are cost risk, safety risk and time risk. Due to lack of opinion from the contractors regarding the critical factors that influencing the project risks mentioned, this study aims to evaluate the contractor's perspective towards the important factors of risk particularly the cost and time risks in highway construction in Malaysia. The methodology used in this study is by using quantitative method. Questionnaire survey was developed by taking into consideration the factors influencing the cost risk and time risk that had been explained in the literature. The respondents were chosen by purposive sampling which enables the researcher to collect the data comprehensively. Results from this study confirmed that the construction risks and financial risks are most often occurred in highway projects. This research identifies potential factors influencing both cost and time risks that have a possibility to occur in highway projects in Malaysia from the perspective of contractors. Among the key findings of the factors that highly influenced the cost risks in the highway projects in Malaysia include service relocation, removal and replacement of material, design changes, additional works, environmental issues, and price fluctuation. On the other hand, the main factors influencing time risks which mostly related to time overrun/delay are permit approval, weather condition, low workers' productivity, slow preparation and drawings approval, design changes and error, and shortage of worker. This study contributes to the current body of knowledge by providing researchers and practitioners with a set of important factors related to time and cost risks that need to be consider in improving the performance of highway projects. It is hoped that this study would help the industry to promote project success of highway projects in Malaysia.

Keywords: Highway construction, cost risk, time risk, safety risk, project objectives

1. Introduction

Highway system in Malaysia plays an essential role in the infrastructure provision and necessary to enhance the nation's competitiveness over its competitors. The development in Malaysia is certainly interrelated with infrastructure development. From this point of view, the development of infrastructure particularly in highway construction, within a certain area, is a sign that the area will be developed soon. Under the 11th Malaysia Plan (11MP), RM259 billion had been allocated for various development works, including high-impact transportation projects such as the Light Rail Transit Line 3, the East Coast Rail Link, the Klang Valley Mass Rapid Transit Line 2 (MRT2), and the Pan Borneo Highway (Bernama, 2020). The 11MP aimed to implement strategies to enhanced connectivity across transport modes, covering improved safety, efficiency, and service levels; expanded port capacity, access and operations; and strengthened regulatory and institutional frameworks for the transport industry. One of the most important projects associated with these strategies includes a plan to develop the rural highways in order to attain balanced economic development across Malaysia (The Report: Malaysia, 2016). The projects include continuing work on the Central Spine Road in central Malaysia, the Kota Bharu-Kuala Krai Highway in the north-east, the East Coast Expressway in Peninsular Malaysia, and the West Coast Expressway.

Undertaking large infrastructure projects such as highway construction, requires a lot of consideration in relation to managing the risks throughout the life cycle of the projects. If compared to other construction projects, highway projects are often recognized as high-risk projects due to its importance to a nation's economic, societal, and political development (Donaldson, 2018). Furthermore, according to Wibowo & Alfen (2015) highway projects are only recognized as successful if finished within the allocated time and budget, meets predetermined requirements and objectives, and cause minimal disruptions to the environment. However, although governments are urging for successful highway projects because of its importance, the Malaysia's economic growth are negatively affected by these projects due to delays and cost overruns (Bank Negara Malaysia, 2018). Riaz, Martin, & Cheung (2011) found in their study that project delays always plague the Malaysian construction industry and the critical factor that contribute to this delay occurrence are risks. In addition, delay in construction has been protracted and almost 80% public sector project are facing delay problems (Riazi & Fiona, 2013). They also indicate that failure in completing the projects within the stipulated time has cause loss to the revenue of the government, loss of reputation, public complaints and affect the industry's GDP contribution.

According to Ramanathan, Narayanan, & Idrus (2012), the effect of delay in project completion had caused the dissatisfaction to all parties involved in the construction project. The occurrence of delays may be due to the nature of the construction itself which is fraud with risks and uncertainties. Risk identification should seek to capture all significant risks and identify potential threats at the earliest possible opportunity in order that a systematic and manageable approach can be employed in time to implement the necessary actions. PMBOK, (2013) mention that the key benefit of this process is the documentation of existing risks and the knowledge and ability it provides to the project team to anticipate events. Project risks often tend to be interrelated, but they can sometimes be considered in isolation. In relation to the construction of highway in Malaysia, there are certain risks that need to be considered in order to deliver the project within the targeted project performance. Therefore, there is a need to explore and identify the project risk involved in highway construction in Malaysia based on current situation. The major risks that usually occurs in the highway construction are cost risks, time risks and safety risks.

Various researchers have identified the main factors affecting risks on their local highway projects to find opportunities for improvements. However, with regard to Malaysia's construction industry, there are still lack of research in the current body of literature that focus on the risk factors for highway projects. Previous studies were more focus on identification of risks based on different categories of risks such as, political risks, construction risks, operating risks, market & revenue risks, and financial risks. Hence, the aim of this study is to evaluate the factors influencing cost and time risks for highway construction based on contractors' perspectives. It is important to have a critical assessment of risk factors in the implementation of highway construction project since it helps to ensure successful project performance.

2. Literature Review

2.1 Risks in Highway Construction Project

According to Goh & Abdul-Rahman, (2013), there are different types of risks involved in different stages of construction project life cycle. Common stages in life cycle construction project are feasibility, design, tendering, construction and handing over and maintenance. Based on Goh & Abdul-Rahman (2013) findings, the construction stage was found as the project stage with higher frequency of risks due to involvement of many investments and longer completion period. Based on research done by Mahamid (2011) and Al-Najjar & Janura (2008), it can be concluded that most likely both building construction and highway construction project has similar factors of risk that contribute to the cost overrun and time delay. Research done by Wang, Dulaimi, & Yousuf, (2013) concluded that risks associated with infrastructure projects in Malaysia which focused on highway projects are under the following categories:

- i) *Political risks*: Government support is the main and important factor which contributes to the ease of the construction of highway in Malaysia. The support may come from the authorizing and approvals of the project, financing partly of concession period and clear framework regarding issues for regulatory and other issues that might arise.
- ii) *Construction risks*: Common risk exist in the construction phase are land acquisition and compensation,

environmental, cost overruns, safety and delay to complete the project within stipulated time and performance.

- iii) *Operating risks*: Operation risk involves the possibility that the operation expenditure will increase beyond what was budgeted and will affect the projected revenue of the entire project. Operation may include such as risks in technology, interfacing with other development near the current highway location and also the cost overrun.
- iv) *Market and revenue risks*: Most highways in Malaysia raised the revenue from the collection of tolls. The sensitivity of toll charges in term of fare changes may affect the revenue of the concession company. Government intervention in controlling the toll charges will is important to control the risk in revenue matters.
- v) *Financial risks*: It is derived from the interest rate and inflation. Risk of interest rate will impact the project when the actual financing cost is higher than anticipated cost. Inflation risk occurs during the operation phase of the construction; mostly affecting the materials and equipment. It can be concluded that the impact of financial risk is cost overrun to the project.

2.2 Factors of Cost Risk

Risk of cost in construction of highway encountered when actual project cost over the budgeted cost. Angelo & Reina (2002) found that cost overrun is a serious matter in construction and this issue need to be addressed urgently. Based on studied on cost overrun on different types of project, Aljohani, Ahiaga-Dagbui & Moore (2017) found that 173 causes of cost overrun have been found in seventeen contexts with the main potential causes being: frequent design change, contractors' financing, payment delay for completed work, lack of contractor experience, poor cost estimation, poor tendering documentation, and poor material management. 50 percent of construction project suffer cost overrun problem. Based on a systematic literature review carried out by Ariyanto, Purba & Purba (2020), it was found that from 50 identified risks, there are 11 risks originating from financial factors. They highlighted that finance is an important factor in the implementation of highway construction projects, and to avoid problems during project implementation project financing must be managed properly.

Many researchers have done studies with regards to the factor that contributes to the project cost risks. Flyvbjerg, Skamris & Buhl. (2004) revealed that 9 out of 10 construction projects experienced cost overrun with an average budget overrun of 28%. 258 construction projects in 20 countries were studied where the cost performance were very poor. Another study conducted by Cantarelli et al. (2009) revealed that cost overrun is a common issue in construction projects, in which they investigated 87 no. of projects and found that on average 10.3% of projects faced cost overruns. Meanwhile in other research, it was found that there are 6 critical factors of cost overrun in construction of highway project such as design changes, contract tender price changes, increase in quantity measure, latent condition, removal and replacement of material due to change in design and design changes due to environmental issues (Creedy, Skitmore & Wong, 2010).

2.3 Factors of Time Risk

Construction industry involves with time constraints and require the parties involved to have proper time management. Delay occurrences in construction project is related with time management. If the time management of the project is not managed properly, the issue such as delay project abandoned will be not resolved and will affect the occurrence of another. To have proper time management, factors of time risk shall be considered by the organisation involved. According to Assaf and Al-Hejji (2006) 70% of projects experienced time overrun. The average time delay ranges from 10% to 30% of the original duration of the project. The study identified six (6) main causes including change order, delay in progress payment, ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, shortage of labours and difficulties in financing project by contractor as most critical factors responsible for this time overrun.

Further study by Enhassi, Arain, & Al-Raei, (2010) found that the factors that affecting time risk is problem between project stakeholders such as owners, contractor and sub-contractor, consultants and legal. This factor definitely will affect the project completion with the possibility of actual completion more than budgeted time. Other than that, Kazaz & Ulubeyli, (2012) found that there are five critical factors that affecting the project time risks which are changes in design and material, payment delay, cash flow diagram, financial problem of the Contractor and low workers' productivity.

3. Methodology

The research process started with deriving the literature review on the issues of risks in a construction project. There is a little conducted and hence the lack of peer-reviewed articles published on the topic, the literature search is extended to cover the potential risks in highway construction projects by reviewing factors that could negatively affect the success of a project.

This research applied a quantitative research design with 130 sets of questionnaires to suit the aims and objectives of the research. The survey conducted in two stages which are the postal questionnaire and face to face questionnaire session. To get the efficiency of the response rate, the questionnaires were purposely designed to be short and simple while the face-to-face questionnaire session were took place at head offices or site of the organisation. The questionnaire

was tested by pilot survey to determine the reliability of each question before final questionnaire distributed to the respondents. The questionnaire was tested among the selected population and the feedback received were useful to finalise the questionnaire. The questionnaires are replicated from previous researcher questionnaires and concentrated to G5, G6 and G7 contractors registered with the Construction Industry Development Board (CIDB) Malaysia which involved or have experience in highway constructions within Klang Valley. Data gained were gathered and analysed to get the findings. The data collected is analysed by using Statistical Packages for Social Science (SPSS) version 21.0. After total average score mean values were analysed and arranged by its frequency and ranking, the results were further analysed by using Landell’s scale either Low (1.0-2.33), Moderate (2.34-3.68) or High (3.69-5.00). This was to determine the classification scale of all the variables from the rankings such as cost risk and time risk for this study.

4. Result and Discussion

4.1 Respondents’ Background

The total of questionnaires distributed was 130 and only 65 questionnaires (50%) were received for data analysis. The first part of the questionnaires consists of the respondent’s working experience. The results revealed that, 46.2 percent (%) of the respondents having working experience between 11 to 15 years, 24.6 percent (%) have experience more than 16 years, while 20 percent (%) have the working experience between 6 to 10 years, and the lowest experience which is less than 5 years constitute 9.2 percent (%) of the respondents only.

Table 1 - Company registration grade

Company Registration Grade	Frequency	Percent (%)
G5	6	9.2
G6	14	21.5
G7	45	69.2
Total	65	100.0

Table 2 - Number of highway project involved

Number of Highway Project Involved	Frequency	Percent (%)
Less than 5	21	32.3
6-10	31	47.7
11-15	12	18.5
16 & above	1	1.5
Total	65	100.0

The second part of the questionnaire consists of company registration grade of the respondents. As shown on Table 1, the results revealed that 69.20 percent (%) of the respondents currently working with G7 contractor organization, 21.50 percent (%) works with G6 contractor, while the remains 9.20 percent (%) of the respondents works for G5 contractor organization. The table showed that majority of the respondents comes from G7 contractor companies and thus reflect that they constituted most of the respondents who are willing to answer the questionnaire and their involvement in highway construction is high. To obtain further understanding on the respondent knowledge and related to their experiences, it is important to analyse the number of their involvement in the highway construction project. This is to make sure that all the respondents will answer the questionnaires with the most appropriate answer to fulfil the objective of this research paper. The tabulation of the data is shown as per Table 2. The table exposed that 47.70 percent (%) of the respondents have involved between 6 to 10 numbers of highway projects, 32.30 percent (%) have involved with less than 5 projects and another 18.50 percent (%) of the respondents have involved between 11 to 15 numbers highway construction project. The remaining 1.50 percent (%) from the respondents have involved with 16 and above of highway project which is contribute the least response in the survey.

Table 3 - Types of involvement

Types of Involvement	Frequency	Percent (%)
Main Contractor	23	35.4
Sub-Contractor	36	55.4
Supplier	6	9.2
Total	65	100.0

To further understand the demographic pattern of the respondents, it is worthwhile to analyse their type of involvement in highway construction project. This is due to different type of involvement in the construction of highway constitute to different scope of works and responsibilities of the party. The results revealed in Table 3 shows that 55.40 percent (%) of the respondents involved as sub-contractor and another 35.40 percent (%) involved as the main contractor. While the remaining 9.20 (%) of the respondents involved as a supplier in the of construction highway.

4.2. Frequency of Risks in Highway Construction

For this research, the frequency distribution table was produced in order to analyse the level occurrences of risks in highway construction and the responses were recorded using Likert scale ranging from never (1) to often (4). In addition, the variable also analysed and ranked as shown in Table 4.

Table 4 - Data analysis and finding on frequency of risk occurrence in highway construction

Frequency of risk occurrences	Frequency of the respondents				Total (N)	Mean Value	Ranking
	Never	Very Occasionally	Sometimes	Often			
Construction risk	0	1	5	59	65	3.89	1
Financial risk	0	1	42	22	65	3.32	2
Operating risk	0	8	37	20	65	3.18	3
Market and revenue risk	0	9	38	18	65	3.14	4
Political risk	0	31	20	14	65	2.74	5

Table 4 shows that construction risks are often occurred in highway construction as it ranked number 1 with the highest mean value (3.89). At the second and third ranking are financial risk (mean value= 3.32) and operating risks (mean value= 3.18) respectively. It was found that both market and revenue risks; and political risks are at the lowest rank which shows that both occurred very occasionally in highway projects. According to Wang, Dulaimi, & Yousuf, (2013), the common risks occur in the construction phase and this is similar to the result shown in Table 4 above. They identified several construction risks such as land acquisition and compensation, environmental, cost overruns, safety and delay to complete the project within stipulated time and performance.

Construction companies are particularly exposed to financial risk due to the nature of the industry, extreme competition, relatively low entry barrier, high uncertainty and risk involved, and unpredictable fluctuations in construction volume (Kolhatkar & Dutta, (2013). The statement consistent with the research findings that financial risks appeared to occur more frequent (2nd ranking) in highway projects. This can also be supported by the findings from Ariyanto, Purba & Purba (2020) based on their systematic literature review that finance is the highest risk percentage of the article analysed. The general types of financial risks as identified by Kolhatkar & Dutta are bankruptcy of project partner, fluctuation of inflation rate, fluctuation of interest rate, fluctuation of exchange rate, rise in fuel prices, insurance risk, currency exchange risk, liquidity risk, change in bank formalities and regulations. The third type of risks that is often occur in highway construction projects is operating/operational risks. This is strongly supported by Mohamed Ghazali (2009) where he identified key operational risks that have high possibility to occur in the highway projects in Malaysia include initial toll-tariff decided by the Government, traffic congestion, change of road network and overloaded freight transportation, which could cause damage to the road surface and hence affecting the operation of a particular highway.

4.3. Factors influencing Cost Risks

Table 5 indicates that the respondents ranked service relocation as the first position with the mean value of 4.42, followed by removal and replacement of material due to changes in design which ranked 2nd with 4.38 mean value and 3rd in ranking is design changes with a mean value of 4.34.

Table 5 - Data analysis and finding on factors influencing cost risk in highway construction

Factors influencing cost risks	Frequency (%) of the respondents					Total (%)	Mean Value	Classification	Ranking
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
1.13 Service relocation	0	0	6	46	48	100	4.42	High	1
1.11 Removal and replacement of material due to changes in design	0	1	2	54	43	100	4.38	High	2
1.7 Design changes	0	0	3	60	37	100	4.34	High	3

Factors influencing cost risks		Frequency (%) of the respondents					Total (%)	Mean Value	Classification	Ranking
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
1.2	Additional works	0	0	3	63	34	100	4.31	High	4
1.12	Design changes due to environmental issues	0	0	4	68	28	100	4.23	High	5
1.1	Price fluctuation	0	0	8	55	37	100	4.21	High	6
1.6	Inaccurate estimates	0	0	18	71	11	100	3.92	High	7
1.9	Increase in quantity measure	0	1	17	74	8	100	3.88	High	8
1.4	Low professional ethics	0	9	32	25	34	100	3.83	High	9
1.3	Delays	0	2	46	26	26	100	3.77	High	10
1.8	Contract tender price changes	0	7	65	23	5	100	3.25	Moderate	11
1.5	Shortens of contract period	2	20	54	21	3	100	3.05	Moderate	12
1.10	Latent condition	7	59	20	14	0	100	2.40	Moderate	13

Results as shown in both Table 5 was consistent with Creedy (2005), where the design changes and service relocation are ranked in the top of the factors of cost risk in highway construction. The results were diverse with the findings from the other research where it was identified that the most significant factors of cost risks/overruns were fluctuation of material prices, cash flow and financial difficulties, and poor site management and supervision (Abdul Rahman, Hameed Memon & Abd Karim, 2013). The effect of factors of cost risks is project cost overrun. Cost overrun are defined as actual cost over budget, sometimes referred to rising costs, increased costs or budget overrun (Vu, Wang, Min, Mai, & Nguyen (2016). Understanding of risk factors can help the parties involved in highway construction projects to reduce their negative effects on the cost overrun. Inadequate finance and poor financial planning by the contractors will have an impact on project implementation which would include delays and poor quality of work (Ariyanto, Purba & Purba, 2020).

4.3. Factors influencing Time Risks

Table 6 - Data analysis and finding on factors influencing time risk in highway construction

Factors influencing time risks		Frequency (%) of the respondents					Total (%)	Mean Value	Classification	Ranking
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree				
3.10	Permit approval	0	0	4	11	85	100	4.80	High	1
3.12	Weather condition	0	1	5	20	74	100	4.66	High	2
3.18	Low worker's productivity	0	0	4	25	71	100	4.66	High	3
3.1	Slow preparation and drawings approval	0	0	5	35	60	100	4.55	High	4
3.3	Design changes and error	0	0	0	68	32	100	4.32	High	5
3.4	Shortage of worker	0	0	16	38	46	100	4.31	High	6
3.11	Poor design	0	0	6	71	23	100	4.17	High	7
3.14	Site condition	0	0	12	60	28	100	4.15	High	8
3.16	Inadequate planning	0	0	8	72	20	100	4.12	High	9
3.13	Material deliveries	0	0	10	68	22	100	4.11	High	10
3.8	Project management issues	0	0	6	83	11	100	4.05	High	11
3.17	Decision making problem of the owner	0	3	23	46	28	100	3.98	High	12
3.7	Contractual relationship	1	11	34	49	5	100	3.89	High	13
3.2	Payments delay	0	4	40	34	22	100	3.72	High	14

3.6	Financial issues of the owner	0	3	51	35	11	100	3.54	Moderate	15	
Factors influencing time risks		Frequency (%) of the respondents						Total (%)	Mean Value	Classification	Ranking
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree					
3.9	Financial difficulties of the contractor	0	2	55	34	9	100	3.51	Moderate	16	
3.15	Lack experience of the owner	0	11	61	23	5	100	3.22	Moderate	17	
3.5	Poor workmanship	0	32	45	22	1	100	2.92	Moderate	18	

The respondents were responding to a question based on their involvement and experiences towards the factors affecting the time risk in highway construction. There were 18 factors affective time risks that were analysed and ranked accordingly. Table 6 indicates that the respondents ranked permit approval as the first position with the mean value of 4.80, followed by weather condition which ranked 2nd with 4.66 mean value and 3rd in ranking is low worker's productivity with a mean value of 4.66. The results revealed from this research relatively different as found by Kaming, Olomolaiye, Holt & Harris (2010) which are the critical factors affecting time risk are design changes and inadequate planning. However, one of the factors found similar to Kaming, Olomolaiye, Holt & Harris (2010) is poor labour productivity. Meanwhile as found by Sy, Likhitrungsilp, Onishi and Nguyen (2016), approval of permit became the important factor that mostly affect the time risk in highway construction and thus significantly in line with this research. Hameed Memon, Abdul Rahman, Abdullah & Abdul Aziz (2011) indicates that cash flow and financial difficulties faced by contractors is very critical besides other causes such as contractors poor site management, shortage of site workers and ineffective planning and scheduling. Other researchers supported that there are more than fifteen (15) factors that can affected the time risk in highway construction (Assaf et.al, 2006; Faridi & El-Sayegh, 2006). Results of the research done by Mahmoud Sharaf & Abdelwahab in 2015, indicate that the most significant risk factors affecting highway construction in Egypt are delay in making decision and land acquisition. It was also similar to what discovered by Tawalare in 2019 where the critical risk factors in Indian highway constructions are as follows: change of scope of work, land acquisition delay, poor preliminary soil information and investigations, schedule delay caused by rejection of unqualified materials and change orders by political pressure. All these factors were very common in influencing the time risks in highway construction.

5. Conclusion

This research has successfully achieved its aim and objectives. It has analysed and explored the potential risks involved in highway construction, identified the factors affecting project risk and measured the criticality of factors affecting project risk for highway construction project. In a nutshell, at the end of this research paper, the impact of factors influencing cost risk and time risk in relation to project objectives, finally serve as a framework and initiative and also strategies to promote and contribute to the highway construction sector. This classification of risks will be beneficial to contractors, clients and other project participants of highway projects to decide appropriate risk mitigation strategies for each category of risk particularly time and cost risks. In addition to providing additional insights into the existing highway construction body of knowledge, the findings of this study also offer references for assisting researchers and practitioners in promoting highway construction project success by understanding the critical factors of time and cost risks.

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