



GLOBAL JOURNAL OF RESEARCHES IN ENGINEERING: E
CIVIL AND STRUCTURAL ENGINEERING
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Causes of Delays in Road Construction Projects in Laos

By Bounthipphasert Soumphonphakdy, Shozo Nakamura,
Toshihiro Okumatsu & Takafumi Nishikawa

Nagasaki University

Abstract- One of the most important sectors in infrastructure development in Laos is road construction. However, many road construction projects in Laos suffer from extensive delays. This causes damage such as recurring problems in the road construction industry, and has a negative effect on the success of road construction projects in terms of schedule, cost, quality, safety and the amenity of road users. The goal of this study is to determine the main causes of these delays and to offer remedies. To identify the causes of delays, a questionnaire is designed by modifying one used to measure causes of delays in road construction projects in the West Bank in Palestine and in consultation with engineering experts with more than 10 years of experience in Laos road construction projects. A total of 53 causes of delay are identified as important in Laos. Questionnaire respondents included 35 contractors, 31 owners and 24 consultants in total. The survey results indicate that the five top factors causing road construction delays are: Contractor cash flow; Delayed payment by owner; Difficulties in financing project by contractor; Financial issues related to owner; and Insufficient equipment and vehicles for the work.

Keywords: *causes of delay; road construction projects; severity index; laos.*

GJRE-E Classification: *FOR Code: 090502*



Strictly as per the compliance and regulations of:



© 2020. Bounthipphasert Soumphonphakdy, Shozo Nakamura, Toshihiro Okumatsu & Takafumi Nishikawa. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License (<http://creativecommons.org/licenses/by-nc/3.0/>), permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Causes of Delays in Road Construction Projects in Laos

Bounthipphasert Soumphonphakdy^α, Shozo Nakamura^σ, Toshihiro Okumatsu^ρ & Takafumi Nishikawa^ω

Abstract- One of the most important sectors in infrastructure development in Laos is road construction. However, many road construction projects in Laos suffer from extensive delays. This causes damage such as recurring problems in the road construction industry, and has a negative effect on the success of road construction projects in terms of schedule, cost, quality, safety and the amenity of road users. The goal of this study is to determine the main causes of these delays and to offer remedies. To identify the causes of delays, a questionnaire is designed by modifying one used to measure causes of delays in road construction projects in the West Bank in Palestine and in consultation with engineering experts with more than 10 years of experience in Laos road construction projects. A total of 53 causes of delay are identified as important in Laos. Questionnaire respondents included 35 contractors, 31 owners and 24 consultants in total. The survey results indicate that the five top factors causing road construction delays are: Contractor cash flow; Delayed payment by owner; Difficulties in financing project by contractor; Financial issues related to owner; and Insufficient equipment and vehicles for the work.

Keywords: causes of delay; road construction projects; severity index; laos.

I. INTRODUCTION

Laos is a landlocked developing country located in the heart of the Indochina Peninsular. It shares borders with five other countries (namely China, Myanmar, Thailand, Vietnam and Cambodia). Based on its strategic location, Laos has the potential to transform itself into a land-linked country developing connections with its neighbors through the road network and railways. Thus, development of the transportation infrastructure is one of the most important means of promoting the country's economic development. In the decades since independence in 1975, the Lao Government has invested significantly in infrastructure development, especially expanding and improving the road network.

The total length of the road network in Laos is over 60,340 km, including 552 km of reinforced concrete (RC) roads, 1,203 km of asphalt concrete (AC), 9,973

km of double bituminous surface treatment (DBST), 23,179 km of gravel and 25,433 km non-paved. There is still a lack of annual budgets for road maintenance, rehabilitation and upgrading to ensure standards and improved road safety.

As in many countries, road construction projects often fall behind schedule in Laos. In fact, 36 of 59 ongoing projects in January 2020 had been behind schedule. This is an important issue affecting the management of road construction projects. There is a need to study the main causes of such delays and search for solutions that improve the situation. Delays in road construction have many negative impacts, such as budget over-runs and effects on the economy, the environment and other areas. They particularly affect those who use the roads and/or live near roads under construction, both directly and indirectly. The causes of road construction delays vary by country. Thus, it is important to determine the main common causes of delay in road construction projects in Laos.

In this study, a questionnaire survey was carried out. The questionnaire was designed by modifying one used to measure causes of delays in road construction projects in the West Bank in Palestine [1] and in consultation with engineering experts with more than 10 years of experience in Laos road construction projects, and sent to contractors, owners and consultants.

The main objectives of this study are the following:

- To identify the causes of delays in road construction projects in Laos;
- To rank the causes of delays in road construction projects in Laos;
- To identify the severity of delay causes from the perspective of contractors, owners and consultants;
- To test agreement on the ranking of the severity of delay causes among contractors, owners and consultants;
- To find ways to eliminate the causes of delays in road construction projects in Laos;
- To provide this research data to owners, consultants, contractors and designers for use in preparing and planning road construction; and
- To provide knowledge for engineers and the general public interested in the analysis of factors that cause problems due to delays in road construction projects in Laos.

Author α: Graduate School of Engineering, Nagasaki University, 1-14, Bunkyo-machi, Nagasaki 852-8521, Japan.

e-mail: soumphonphakdy_1011@yahoo.co.jp

Author σ: Department of Civil and Environmental Engineering, Nagasaki University, 1-14, Bunkyo-machi, Nagasaki 852-8521, Japan.

e-mail: shozo@nagasaki-u.ac.jp

Author ρ ω: Department of Civil and Environmental Engineering, Nagasaki University, 1-14, Bunkyo-machi, Nagasaki 852-8521, Japan.

II. LITERATURE REVIEW

Many articles have reported studies on the causes of delay in construction projects. For example, Mahamid et al. [1] found that there are 52 possible causes of delay in road construction projects. Among these, 18 had a severity index (see eq. (1)) of over 60%, indicating a high or very high impact. A.M. Odeh and H.T. Battaomeh [2] used a survey to study the delays arising in construction projects with traditional contracts from the viewpoint of construction contractors and consultants. Results indicated that there was agreement among contractors and consultants that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top ten most important factors. Y. Frimpong et al. [3] found that delays and cost overruns are common in construction projects and groundwater development projects in Ghana. Their survey included personnel from owners, consultants and contractors involved in groundwater-related projects. The main causes of delays and cost overruns included difficulty in obtaining monthly payments from agencies; poor contract management; material procurement; poor technical performance; and material price inflation. The study concluded that effective project planning, control and monitoring should be established to enhance project performance in order to minimize or avoid delays and cost problems in groundwater-related projects. J.A. Alsuliman [4] investigated the causes of delays in Saudi public construction projects and categorized them based on the various stages of a project, namely (1) factors before the award of tenders, (2) factors during the award of tenders, (3) factors after the award of tenders, and (4) general factors. Through the use of a focus group, this study identified 50 delay factors. A questionnaire was administered and distributed to 211 people involved in the construction industry. From the results, the top 20 causes of delay were identified. A final simplified formula was developed to calculate the effect of each cause of delay on site. A case study was carried out to determine the percent time delay compared with the master schedule using the developed simplified formula. Banobi E.T.B. and W. Jung [5] investigated 82 owner-side experts and 106 contractor-side experts in Tanzanian power construction projects. In successful projects (less than 10% time delay), the owners and contractors gave weight to similar causes, including vandalism and permits from authorities. Both suggested similar mitigation strategies such as close supervision, capacity building training, and proper logistics management. On the other hand, in the case of unsuccessful projects (more than 10% time delay), they exhibited many different responses. In particular, contractors gave more weight than contractors to causes such as changes in scope, poor

supervision by the owner, delays in approval, planning failures, and design risks. Owners on the other hand gave more weight to mitigation strategies such as top management support and timely procurement. R.F. Aziz and A.A. Abdel-Hakam [6] investigated strategies to effectively overcome road construction delays in developing countries, concluding with suggestions for fundamental and large-scale reform of procurement systems and stakeholder management. Khatib, B.A., Poh, Y.S. and El-Shafie [7] conducted fourteen interviews with project managers, construction managers, and senior site engineers to identify the factors they faced that led to delays in a reconstruction project. The identified factors were divided into two groups: one related to the demolition phase (five factors) and the second related to reconstruction work (nine factors). The supply of building materials during the reconstruction phase was considered one of the major delaying factors and 14 delay factors were identified that should be carefully considered to assure the sustainability of the main objective during reconstruction activities. A. Orangi et al. [8] found that delays could lead to some serious time and/or cost overrun issues, thereby adversely affecting contractors, clients and other stakeholders to different degrees. They concluded that consolidating knowledge from related research and lessons from recent projects would be beneficial for rationalized project management. In particular, identifying significant root causes of delays and then developing suitable management methods (e.g. prevention measures) are essential to effectively ensuring successful project outcomes.

M.H. Fallahnejad [9] set out to identify and rank the causes of delays in gas pipeline projects in Iran. 24 completed gas pipeline projects were studied and the extracted delay factors were discussed with 10 experts from several disciplines. The result was a 43-item list of factors, which were then ranked by means of a questionnaire survey. The 10 major delay factors were found to be the following: imported materials, unrealistic project timescale, client-related materials, land expropriation, change orders, contractor selection methods, payments to contractor, obtaining permits, suppliers, and contractor's cash flow". Majed Alxara et al. [10] studied the issues faced by Saudi Arabia in completing construction projects on time and on budget. It has been documented that 70% of public construction projects are delayed in the country. A case study was performed at a university campus in northern Saudi Arabia, identifying the major causes of project delays. The university had experienced delays ranging from 50% to 150%. The study proposed solutions for minimizing the nine major delay factors. A literature research identified one construction management method, the Performance Information Procurement System (PIPS), that has been documented multiple times to improve project performance and minimize

delays. B.-G. Hwang et al. [11] looked at reducing wait times for future public housing owners, which requires such projects to be completed on time. A survey of 36 industry experts revealed that “site management”, “coordination among various parties”, and “availability of laborers on site” were the top three factors affecting the schedule performance of public housing projects in Singapore. In findings from a case study, Raj Shah [12] clarified that the most influential factors in Australia are (1) planning and scheduling deficiencies, (2) methods of construction, (3) effective monitoring and feedback processes, which contrasts with Ghana where they were (1) delays in payment certificates (2) underestimating of project cost, (3) project complexity. On the other hand, in Malaysia the most influential factors are (1) improper planning by contractors, (2) poor site management, and (3) inadequate contractor experience. It is clear that the factors causing project delays and cost overruns are diverse and vary from one country to another. N.D. Long et al. [13] presented problems with large construction projects in Vietnam. Data analysis revealed that the problems could be grouped under five major headings: (1) incompetent designers/contractors, (2) poor estimation and change management, (3) social and technological issues, (4) site related issues, and (5) improper techniques and tools. Michałuszek and Agnieszka Leśniak [14] carried out a survey and multivariate statistical analysis of client’s ideas about construction delays in Poland. They found that timely implementation of construction work (at the scheduled time) is vital for both the investor and the contractor. Even perfectly planned and organized projects run the risk of delays. Despite many tools supporting construction management, delays keep occurring in construction projects. S.O. Ogun Lana et al. [15] took

the view that construction industry problems in developing economies can be nested in three layers: (a) problems of shortages or inadequacies in industry infrastructure (mainly supply of resources); (b) problems caused by clients and consultants and (c) problems caused by contractor incompetence/inadequacies.

III. RESEARCH METHODOLOGY

a) Questionnaire Design

In this paper, based on work in the literature [1], a questionnaire was developed in consultation with civil engineers who had more than 10 years of experience in road construction projects in Laos. Final modifications were made to accommodate the whole range of information about effective causes of delay in road construction projects in Laos. A total of 53 possible causes were included in the questionnaire.

In terms of structure, the questionnaire was designed to have two main parts. Part I is related to respondents’ personal information, including whether they are contractors, owners or consultants. It includes questions pertaining to their experience in the construction industry. Part II includes the list of the identified causes of delay in road construction projects in Laos. These causes are classified into eight main groups as shown in Table 1 according to the source of delay: project, owner, contractor, consultant, design, laborers, materials and equipment, and external. For each cause a question was asked about its degree of severity in terms of contributing to project delay. Severity was categorized into six-levels as follows: level 0 = no influence; level 1 = very low; level 2 = low; level 3 = moderate; level 4 = high; and level 5 = very high.

Table 1: List of Possible Delay Causes and Groupings

Main group	Causes under each group
1. Project group	1 Low project bid price
	2 Construction area restricted
	3 Inconvenient site access
	4 Poor ground conditions
	5 Poor soil quality
	6 Poor terrain conditions
2. Owner group	7 Delayed payment by owner
	8 Delayed decision by owner
	9 Coordination between owner and contractor.
	10 Unreasonable project timeframe
	11 Financial issues related to owner
	12 Project delayed by owner
	13 Delayed approval of materials
	14 Not well-defined scope of work
	15 Delayed land expropriation by owner
	16 Change order from owner during construction
	17 Late issue of approval documents by owner.
	18 Unclear assignment of responsibility near province boundaries

3. Contractor group	19	Difficulties in financing project by contractor
	20	Poor communication between contractor and other parties
	21	Conflict between contractor and other parties
	22	Poor resource management
	23	Necessity to re-do work due to contractor failings
	24	Ineffective planning management by contractor
	25	Insufficiently skilled technical staff
	26	Insufficient equipment and vehicles for the work
	27	Poor quality control
	28	Improper construction method
4. Consultant group	29	Contractor cash flow
	30	Consultant too lenient
	31	Poor coordination between the consultant and contractor(s)
	32	Delay in implementing inspection by consultant
5. Design group	33	Poorly qualified inspector
	34	Insufficient inspectors
	35	Delayed design work
6. Laborers group	36	Mistakes in design
	37	Inappropriate design
	38	Low labor productivity
	39	Insufficiently skilled equipment operator
7. Materials and equipment group	40	Insufficient laborers
	41	Personal conflict between laborers and management team
	42	Personal conflict among laborers
	43	Lack of equipment efficiency
8. External group	44	Shortage of equipment
	45	Changes in material types and specifications during construction
	46	Shortage in materials
	47	Political situation
	48	Exchange rate fluctuation under contract
	49	Change in loans policy by bank
	50	Weather conditions
	51	Monopoly market
	52	Oil price increase
	53	Public events

b) Data Analysis

i. Ranking of Delay Causes

The suggested delay causes were ranked by severity index. The following formula was used to rank them on the basis of impact level as identified by the participants:

$$\text{Severity index (\%)} = \sum a(n / N) * 100 / 5 \quad (1)$$

where a = severity level, which ranges from 0 for no influence up to 5 for very high, n = frequency of response and N = total number of responses.

Accordingly, if all participants respond that a particular cause has no influence, then that cause gains a severity index of 0, meaning that it is not relevant to project delays and ranks last. Conversely, if all respond that it has a very high influence, then the severity index is 100, meaning that this cause is very highly relevant and is the first in rank. Table 2 shows the possible ranges for the severity index and the corresponding impact level.

Table 2: Severity Index and Corresponding Impact Level

Severity index (%)	Impact level
0	No influence
0-20	Very low
20-40	Low
40-60	Moderate
60-80	High
80-100	Very high

The severity index for each cause was calculated according to Eq. (1) from the individual contractors', owners' and consultants' responses as well as from the combined responses.

A group index was calculated by using the average of the severity indexes of the causes in each group such that

$$\text{Group severity index (\%)} = \sum_{i=1}^n X_i/n \quad (2)$$

where X_i = severity index of cause i in the group and n = number of causes in the group.

ii. Rank Correlation

The Spearman rank correlation was used to measure the correspondence between pairs of rankings in the sample observations, thereby comparing how well the contractors, owners and consultants agree on the causes of delay. A perfect positive correlation ($r_s = +1$) indicates that the object is ranked identically in the compared samples, whereas a perfect negative correlation ($r_s = -1$) indicates that the rankings have an exactly inverse relationship. This means that sample correlations close to unity in magnitude imply a good correlation, whereas values near 0 indicate low or no

correlation. The Spearman rank correlation formula is as follows:

$$r_s = 1 - \left[\frac{6 \cdot \sum d^2}{n^3 - n} \right] \quad (3)$$

Where r_s = Spearman rank correlation coefficient between two parties, d = difference between ranks assigned to variables for each cause and n = number of pairs of rankings.

IV. RESULTS AND DISCUSSIONS

a) Respondent Personal Information

The questionnaire was sent to a total of 50 contractors, 40 owners and 30 consultants. A total of 35 contractors (70.0%), 31 owners (77.5%) and 24 consultants (80.0%) completed the questionnaire as shown in Table 3. All of the respondents were engineers. Among them, 30 had between 5 and 10 years of experience, 18 had 10 to 15 years of experience and 42 had over 15 years of experience. The average was approximately 16 years' experience.

Table 3: List of Responses (percent)

Respondents	Questionnaire distributed	Responses returned	Percentage of responses
Contractors	50	35	70.0%
Owners	40	31	77.5%
Consultants	30	24	80.0%
Total	120	90	75.0%

b) Ranking of Delay Causes by Group

i. Project Group

Six delay causes are listed in this group. Table 4 shows the severity index and ranking of each one from the viewpoint of contractors, owners and consultants, as well as the combined viewpoint (the combination of contractor, owner and consultant views). It is clear that

the most severe cause of delays from the combined viewpoint is "Low project bid price". However, the rankings from the individual viewpoints are quite different.

The results also show that the difference between the most and least severe causes in this group is 37.22%.

Table 4: Ranking of Delay Causes in Project Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Low project bid price	60.00	1	76.57	1	39.35	5	62.50	1
Poor soil quality	46.89	2	43.43	6	47.10	1	51.67	2
Poor terrain conditions	46.22	3	48.00	4	45.81	2	44.17	3
Poor ground conditions	45.11	4	47.43	5	45.81	2	40.83	4
Inconvenient site access	43.78	5	50.86	2	40.65	4	37.50	6
Construction area restricted	42.67	6	49.14	3	38.71	6	38.33	5

ii. Owner Group

This group includes twelve causes. Table 5 presents the rankings from each viewpoint, showing that the most severe cause from all viewpoints is "Delayed payment by owner".

The most severe causes in the rankings by contractors, owners, consultants and the combined view are quite similar, with 1 to 3 in the rankings being "Delayed payment by owner", "Financial issues related to owner" and "Delayed decision by owner",

respectively, except in the case of owners and consultants.

The results also indicate that the most severe causes in this group are quite distinct. In the combined

view, for example, there is a wide span of severity ranging from 38.00% to 81.56%, a difference of 43.56%.

That is, the causes range from low to very high severity and the difference in its severity index.

Table 5: Ranking of Delay Causes in Owner Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Delayed payment by owner	81.56	1	91.43	1	73.55	1	77.50	1
Financial issues related to owner	75.11	2	85.71	2	68.39	2	68.33	2
Delayed decision by owner	57.33	3	71.43	3	48.39	4	48.33	4
Change order from owner during construction	51.33	4	57.71	8	45.81	5	49.17	3
Coordination between owner and contractor.	49.78	5	60.00	6	43.87	6	42.50	8
Late issue of approval documents by owner.	49.56	6	61.14	5	40.65	8	44.17	6
Unreasonable project timeframe	49.33	7	50.86	10	52.26	3	43.33	7
Not well-defined scope of work	48.00	8	58.86	7	41.94	7	40.00	11
Delayed land expropriation by owner	47.11	9	53.14	9	40.65	8	46.67	5
Delayed approval of materials	46.89	10	63.43	4	37.42	10	35.00	12
Project delayed by owner	41.33	11	48.00	11	32.90	11	42.50	8
Unclear assignment of responsibility near province boundaries	38.00	12	44.57	12	28.39	12	40.83	10

iii. Contractors Group

There are eleven causes in the contractors group. Table 6 shows that the cause with the highest severity from the combined, contractors', owners' and consultants' views is "Contractor cash flow". The top

and second ranked causes from all viewpoints are quite similar. In the combined view, the range of severity for all causes is narrow, ranging from 46.22% to 84.22%, meaning that the effect on delays is moderate to very high.

Table 6: Ranking of Delay Causes in Contractor Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Contractor cash flow	84.22	1	88.00	1	78.71	1	85.83	1
Difficulties in financing project by contractor	77.11	2	82.29	2	75.48	2	71.67	3
Insufficient equipment and vehicles for the work	70.89	3	77.71	3	61.29	3	73.33	2
Poor quality control	63.11	4	71.43	4	54.19	6	62.50	5
Insufficiently skilled technical staff	59.78	5	61.14	5	57.42	4	60.83	6
Ineffective planning management by contractor	57.33	6	52.00	7	57.42	4	65.00	4
Improper construction method	56.00	7	58.29	6	49.68	8	60.83	6
Poor communication between contractor and other parties	52.00	8	49.71	9	52.90	7	54.17	8
Necessity to re-do work due to contractor failings	49.78	9	50.29	8	46.45	10	53.33	9
Poor resource management	46.44	10	49.71	10	41.94	11	47.50	11
Conflict between contractor and other parties	46.22	11	42.86	11	47.74	9	49.17	10

iv. *Consultant Group*

Table 7 shows the severity index and ranking of each cause under the consultants group. five causes are identified under this group.

Table 7 shows the results that the most severe cause from the combined view, owners' view and

consultants' view is "Insufficient inspectors". It is clear from the results that the severity index ranking from the combined view has a narrow span, with severity indexes ranging from 41.33% to 52.00%. That is, all causes in this group have a moderate effect on road construction project delays.

Table 7: Ranking of Delay Causes in Consultant Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Insufficient inspectors	52.00	1	68.00	2	43.23	1	40.00	1
Delay in implementing inspection by consultant	50.44	2	70.86	1	39.35	4	35.00	3
Poor coordination between the consultant and contractor(s)	47.78	3	61.71	4	40.65	2	36.67	2
Poorly qualified inspector	47.78	3	65.71	3	38.71	5	33.33	4
Consultant too lenient	41.33	5	52.00	5	40.65	2	26.67	5

v. *Design Group*

Table 8 shows the severity index and ranking of each cause in the design group. The most severe of the three causes in this group is "Delayed design work" for all viewpoints. The rankings from the contractors',

owners', consultants' and combined views are all similar. The span of severity values in the combined view is quite narrow, ranging from 44.22% to 48.22%. That is, all causes in this group have a moderate effect on road construction project delays.

Table 8: Ranking of Delay Causes in Design Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Delayed design work	48.22	1	46.29	1	47.74	1	51.67	1
Mistakes in design	46.22	2	44.57	2	45.16	2	50.00	2
Inappropriate design	44.22	3	44.57	3	44.52	3	43.33	3

vi. *Laborers Group*

Table 9 shows the severity index and ranking of each cause in the laborers group. Five causes are identified in this group. All viewpoints except owners find that "Insufficient laborers" is the most severed delay cause; this ranks second for owners.

All of the rankings in Table 9 are quite similar. The severity index from the combined view ranges from 39.78% to 63.33%, meaning that these delay causes have an impact ranging from low to high.

Table 9: Ranking of Delay Causes in Laborers Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Insufficient laborers	63.33	1	68.57	1	50.97	2	71.67	1
Insufficiently skilled equipment operator	61.33	2	68.57	2	52.90	1	61.67	2
Low labor productivity	58.22	3	68.00	3	50.97	2	53.33	3
Personal conflict between laborers and management team	43.11	4	44.00	4	41.94	4	43.33	4
Personal conflict among laborers	39.78	5	40.00	5	36.77	5	43.33	4

vii. *Materials and Equipment Group*

The material and equipment group comprises four delay causes. Table 10 shows that the most severe cause in the combined view is "Lack of equipment efficiency". The rankings from the contractors', owners' and combined views are quite similar, while consultants rank "Lack of equipment efficiency" third. However, first,

second and third most severe causes are all grouped together.

The range of severity index values from the combined view is narrow, with values from 55.11% to 65.33%. That is, their impact on project delays ranges from moderate to high.

Table 10: Ranking of Delay Causes in Materials and equipment Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Lack of equipment efficiency	65.33	1	74.86	2	56.77	1	62.50	3
Shortage of equipment	65.11	2	75.43	1	52.26	2	66.67	1
Shortage in materials	58.22	3	61.71	3	48.39	3	65.83	2
Changes in material types and specifications during construction	55.11	4	61.14	4	44.52	4	60.00	4

viii. *External Group*

Seven delay causes are listed in the external group. Table 11 shows that the most severe cause from all viewpoints is "Oil price increase". There is no significant difference in the ranking of causes among the

viewpoints. There is a wide span of severity index in the combined ranking, ranging from 30.00% to 64.67%. This indicates that these delay causes have an impact ranging from low to high.

Table 11: Ranking of Delay Causes in External Group

Cause	Combined' view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Oil price increase	64.67	1	80.00	3	55.48	1	54.17	1
Change in loans policy by bank	64.22	2	80.57	1	55.48	1	51.67	2
Exchange rate fluctuation under contract	58.44	3	80.57	1	44.52	4	44.17	3
Monopoly market	53.33	4	78.29	4	37.42	6	37.50	5
Weather conditions	46.22	5	48.57	5	45.16	3	44.17	3
Public events	42.22	6	45.14	6	42.58	5	37.50	5
Political situation	30.00	7	40.57	7	22.58	7	24.17	7

c) *Overall Ranking of Delay Causes*

The severity index and ranking of all investigated 53 causes of delay in road construction projects from the four viewpoints are listed in Table 12.

There are two causes with a severity index above 80% in the combined viewpoint: "Contractor cash flow" and "Delayed payment by owner". There are also three causes with a severity index above 70%: "Difficulties in financing project by contractor", "Financial issues related to owner" and "Insufficient equipment and vehicles for the work". A discussion on these top five delay causes from combined viewpoint can be made as follows.

- Contractor cash flow

The issue of contractor cash flow is found to be the top cause of delays in road construction projects in Laos. Many contracting companies in Laos are not only

involved in road construction projects, so they have many other activities going on and may have taken on more contracted projects than cash flow can support. As a result, many contractors have put revolving money into other projects. Further, this problem commonly results from the second-ranked cause of delays according to the combined viewpoint: "Delayed payment by owner". Payments may be overdue for a particular project or, in some cases, payments from previously completed projects for the same owner are delayed [16]. These are important causes of "Contractor cash flow".

- Delayed payment by owner

"Delayed payment by owner" is the second-ranked cause of project delays. It has a number of causes, including: project cost exceeds original estimate; payments are staged and payment approval is

slow; lack of clear payment guidelines; and increased project cost because of loan interest. Especially, disaster-recovery projects often cost more than the initial estimate.

Late payment appears to be a critical cause of delays in other countries, such as the West Bank in Palestine [1] (rank 4), Saudi Arabia[17][18] (rank 2 in both studies), Kuwait [19] (rank 2), Malaysia [20] (rank 4), Ghana [3] (rank 1), and Nigeria [21] (rank 2).

- Difficulties in financing project by contractor

Many contractors have difficulties in financing projects in Laos. This has some connection with the second-ranked cause of delays: "Delayed payment by owner". Also, contractors may be taking on business projects beyond their capability to invest because of insufficient financial resources; they may have poor cash flow management; and most road construction projects in Laos require the contractor to cover the investment required until the project is accepted by the owner (generally the Laos government), after which payment is made according to the contract. The owner usually pays in stages for 3 to 7 years after completion depending on the size of the project and annual budget plan.

- Financial issues related to owner

There are a number of factors relating to the financial status of the owner that can cause problems,

such as: approvals of additional projects not included in the original annual master plan; the project has a much higher value than originally estimated; and payment approvals from owner delayed, so interest accrues on project cost. Also, in many cases of disaster-recovery projects, the quantity of work turns out to be higher than originally estimated.

- Insufficient equipment and vehicles for the work

Many road construction projects in Laos have to be carried out using less equipment and vehicles than initially specified in the contract. Further, the quality of equipment and/or vehicles is sometimes inadequate. The causes of this issue may be the insufficient examination of the contract documents. It is not unknown for a contractor to have another ongoing project at the same time and to move some equipment and/or vehicles to that project.

Only three causes have a severity index of less than 40% in the combined viewpoint, meaning that they have a low impact level: "Personal conflicts among laborers"; "Unclear assignment of responsibility near province boundaries"; and "Political situation".

Table 12: Overall Ranking of Delay Causes

Cause	Combined view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Contractor cash flow	84.22	1	88.00	2	78.71	1	85.83	1
Delayed payment by owner	81.56	2	91.43	1	73.55	3	77.50	2
Difficulties in financing project by contractor	77.11	3	82.29	4	75.48	2	71.67	4
Financial issues related to owner	75.11	4	85.71	3	68.39	4	68.33	6
Insufficient equipment and vehicles for the work	70.89	5	77.71	9	61.29	5	73.33	3
Lack of equipment efficiency	65.33	6	74.86	12	56.77	8	62.50	10
Shortage of equipment	65.11	7	75.43	11	52.26	14	66.67	7
Oil price increase	64.67	8	80.00	7	55.48	9	54.17	17
Change in loans policy by bank	64.22	9	80.57	5	55.48	9	51.67	21
Insufficient laborers	63.33	10	68.57	16	50.97	16	71.67	4
Poor quality control	63.11	11	71.43	13	54.19	11	62.50	10
Insufficiently skilled equipment operator	61.33	12	68.57	16	52.90	12	61.67	13
Low project bid price	60.00	13	76.57	10	39.35	44	62.50	10
Insufficiently skilled technical staff	59.78	14	61.14	24	57.42	6	60.83	14
Exchange rate fluctuation under contract	58.44	15	80.57	5	44.52	30	44.17	30
Low labor productivity	58.22	16	68.00	18	50.97	16	53.33	19
Shortage in materials	58.22	16	61.71	22	48.39	19	65.83	8
Delayed decision by owner	57.33	18	71.43	13	48.39	19	48.33	27

Ineffective planning management by contractor	57.33	18	52.00	32	57.42	6	65.00	9
Improper construction method	56.00	20	58.29	29	49.68	18	60.83	14
Changes in material types and specifications during construction	55.11	21	61.14	24	44.52	30	60.00	16
Monopoly market	53.33	22	78.29	8	37.42	48	37.50	45
Insufficient inspectors	52.00	23	68.00	18	43.23	34	40.00	42
Poor communication between contractor and other parties	52.00	23	49.71	37	52.90	12	54.17	17
Change order from owner during construction	51.33	25	57.71	30	45.81	25	49.17	25
Delay in implementing inspection by consultant	50.44	26	70.86	15	39.35	44	35.00	49
Coordination between owner and contractor.	49.78	27	60.00	27	43.87	33	42.50	38
Necessity to re-do work due to contractor failings	49.78	27	50.29	36	46.45	24	53.33	19
Late issue of approval documents by owner.	49.56	29	61.14	24	40.65	39	44.17	30
Unreasonable project timeframe	49.33	30	50.86	34	52.26	14	43.33	34
Delayed design work	48.22	31	46.29	44	47.74	21	51.67	21
Not well-defined scope of work	48.00	32	58.86	28	41.94	36	40.00	42
Poorly qualified inspector	47.78	33	65.71	20	38.71	46	33.33	51
Poor coordination between the consultant and contractor(s)	47.78	33	61.71	22	40.65	39	36.67	48
Delayed land expropriation by owner	47.11	35	53.14	31	40.65	39	46.67	29
Delayed approval of materials	46.89	36	63.43	21	37.42	48	35.00	49
Poor soil quality	46.89	36	43.43	50	47.10	23	51.67	21
Poor resource management	46.44	38	49.71	37	41.94	36	47.50	28
Weather conditions	46.22	39	48.57	40	45.16	28	44.17	30
Mistakes in design	46.22	39	44.57	46	45.16	28	50.00	24
Conflict between contractor and other parties	46.22	39	42.86	51	47.74	21	49.17	25
Poor terrain conditions	46.22	39	48.00	41	45.81	25	44.17	30
Poor ground conditions	45.11	43	47.43	43	45.81	25	40.83	40
Inappropriate design	44.22	44	44.57	46	44.52	30	43.33	34
Inconvenient site access	43.78	45	50.86	34	40.65	39	37.50	45
Personal conflict between laborers and management team	43.11	46	44.00	49	41.94	36	43.33	34
Construction area restricted	42.67	47	49.14	39	38.71	46	38.33	44
Public events	42.22	48	45.14	45	42.58	35	37.50	45
Consultant too lenient	41.33	49	52.00	32	40.65	39	26.67	52
Project delayed by owner	41.33	49	48.00	41	32.90	51	42.50	38
Personal conflict among laborers	39.78	51	40.00	53	36.77	50	43.33	34
Unclear assignment of responsibility near province boundaries	38.00	52	44.57	46	28.39	52	40.83	40
Political situation	30.00	53	40.57	52	22.58	53	24.17	53

d) *Top Five Causes of Delay from each viewpoint*

The top five delay causes from each viewpoint are picked up from Table 12 and listed in Tables 13-15 with their related groups. They are similar, and three causes, "Delayed payment by owner", "Contractor cash flow" and "Difficulties in financing project by contractor", are included in all tables. "Insufficient equipment and vehicles for the work" is included in the tables from owners' and consultants' viewpoint, indicating that there

is only one cause different between them. It can be said that the recognition of the important causes of project delay is basically shared among contractors, owners and consultants. However, the level of the severity evaluated by contractors, owners and consultants is different. Severity indexes from the contractors' viewpoint are considerably higher than from the owners' and consultants' viewpoint. This fact can be also recognized from Table 12.

Table 13: Top Five Delay Causes and Related Groups from Contractors' Viewpoint

Cause	Related group	Severity index (%)	Rank
Delayed payment by owner	Owner	91.43	1
Contractor cash flow	Contractor	88.00	2
Financial issues related to owner	Owner	85.71	3
Difficulties in financing project by contractor	Contractor	82.29	4
Change in loans policy by bank	External	80.57	5

Table 14: Top Five Delay Causes and Related Groups from Owners' Viewpoint

Cause	Related group	Severity index (%)	Rank
Contractor cash flow	Contractor	78.71	1
Difficulties in financing project by contractor	Contractor	75.48	2
Delayed payment by owner	Owner	73.55	3
Financial issues related to owner	Owner	68.39	4
Insufficient equipment and vehicles for the work	Contractor	61.29	5

Table 15: Top Five Delay Causes and Related Groups from Consultants' Viewpoint

Cause	Related group	Severity index (%)	Rank
Contractor cash flow	Contractor	85.83	1
Delayed payment by owner	Owner	77.50	2
Insufficient equipment and vehicles for the work	Contractor	73.33	3
Difficulties in financing project by contractor	Contractor	71.67	4
Insufficient laborers	Laborers	71.67	4

e) *Ranking of Groups*

For this study, the causes of delay were classified into eight groups as described above. Here, these groups are ranked according to the grouped severity index of their causes as determined by contractors, owners, consultants. The results are presented in Table 16.

From the combined viewpoint, the three top groups are: Materials and equipment; Contractor; and Laborers. The range of severity index is narrow, from 46.22% to 60.94%. The top three groups from the

contractors' viewpoint are: Materials and equipment; External; and Consultant. Those from owners' and consultants' viewpoint are the same: Contractor; Materials and equipment; and Laborers. The group with the lowest severity index is the Project group from contractors' viewpoint, and the Consultant group from owners' and consultants' viewpoint. Again, the group ranking from owners' and consultants' viewpoint is quite similar.

Table 16: Group Ranking

Group	Combined view		Contractors' view		Owners' view		Consultants' view	
	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank	Severity index (%)	Rank
Materials and equipment	60.94	1	68.29	1	50.48	2	63.75	1
Contractor	60.26	2	62.13	5	56.66	1	60.26	2
Laborers	53.16	3	57.83	6	46.71	3	53.16	3
Owner	52.94	4	62.19	4	46.18	4	48.19	5
External	51.30	5	64.82	2	43.32	6	41.90	7
Consultant	47.87	6	63.66	3	40.52	8	34.33	8
Project	47.44	7	45.06	8	42.90	7	45.83	6
Design	46.22	8	45.14	7	45.81	5	48.33	4

f) Severity rank correlation

The Spearman rank correlation is used to measure the correspondence between contractors' and owners' responses, contractors' and consultants' responses, and owners' and consultants' responses. Equation (3) is used for this purpose. There is relatively good agreement (positive correlation) between contractors' and owners' rankings of delay causes, with $r_s = +0.474$. There is also good agreement between contractors and consultants, with $r_s = +0.465$. Between owners and consultants, the correlation is $r_s = +0.831$, which is a very good relative agreement between the two parties in the ranking of delay causes. This may be because the consultant is usually the agents acting owners' behalf.

V. RECOMMENDATIONS TO REDUCE DELAYS IN ROAD CONSTRUCTION PROJECTS IN LAOS

The following recommendations are made to all parties as ways to reduce and control delays in road construction projects:

The project owner, meaning the Laos government, should pay special attention to the following points:

- Making the required decisions on time so as to improve communications and coordination with other construction parties (donors, consultants and contractors).
- Making efforts to modify and improve regulations, contracts and laws related to road projects to address the causes of delay shown to have a high severity index.
- Implementing annual programs for continuous training in cooperation with the contractor's union as a way to improve managerial skills, the checking and repair of equipment and vehicles, site engineering ability and labor skills.
- Resolving the problem of delayed payments to ensure that staged payments are made to contractors on time, since late payments affect a

contractor's ability to finance the work. The result is time overruns and contracting companies may also use late payments as a reason to bargain with the Laos government (owner) in the case of delay.

- Allowing sufficient time to make adequate preparations for a project. This includes drawing up a planning schedule, particularly for the design phase to avoid the need for changes; detailed and comprehensive investigations of the site and site environment; and fully documenting all information before finally submitting the tender. This will help to avoid and later errors and thereby help avoid or minimize time and/or cost overruns.
- Re-checking the background, capabilities and resources of contracting companies before awarding the contract to the lowest bidder.

Contractors should consider the following:

- Ensuring the availability of sufficient resources in terms of budget, engineers, staff, laborers, equipment, vehicles and others that are necessary before bidding and making efforts to carry out projects at the specified time.
- Improving management of financial resources and cash flow by requesting staged payments.
- Ensuring that sufficiently skilled managers, engineers and staff are involved in the project.
- Providing expert training for laborers in relevant work practices so as to improve skills before beginning work, especially in the case of large projects or high-risk workplaces.
- Taking responsibility for the specified quality, cost and schedule.
- Improving communications and coordination with other construction parties (donors, owners, consultants and others) so as to obtain good results.

Consultants should look to the following:

- Providing all necessary information and documentation for the road construction project to other construction parties and, if possible, preparing sample documents and a recommended timeline for document processing.

- Providing owners and contractors with payment documents in a more timely way, because the severity index of “contractor revolving money” and “owner payment is postponing” are the top of causes of delays in road construction projects.

VI. CONCLUSION

In this study, the causes of these delays are elucidated through a questionnaire survey, with the severity of each cause obtained from the viewpoints of contractors, owners and consultants. The 53 possible causes of delay included in the questionnaire were obtained through a detailed literature review and in consultation with expert civil engineers in Laos. The identified causes are combined into eight groups: project, owner, contractor, consultant, design, laborers, materials and equipment and external. The questionnaire was completed by 35 contractors, 31 owners and 24 consultants.

The top five causes of delay by severity index in the ranking obtained from the results are the following:

- Contractor cash flow;
- Delayed payment by owner;
- Difficulties in financing project by contractor;
- Financial issues related to owner; and
- Insufficient equipment and vehicles for the work.

The Spearman rank correlation showed that there is relatively good overall agreement between contractors and owners ($r_s = +0.474$), contractors and consultants ($r_s = +0.465$) and especially between owners and consultants ($r_s = +0.831$) as to the severity rank of delay causes.

Further analysis of the data obtained from the questionnaire showed the following:

- There are no causes of delay with a severity index less than 20%;
- Severity indexes from the contractors’ viewpoint are considerably higher than from the owners’ and consultants’ viewpoint. There are no causes with a severity index of less than 40% from the contractors’ viewpoint; and
- The group severity index from the combined viewpoint ranges between 46.22% and 60.94%. This indicates that all the identified causes are highly relevant to the problem of delays in road construction projects in Laos.

The results of this study suggest that a necessary future task is to use the severity index of delay causes as a baseline for improving rules, agreements, management, administration and planning. The modified processes should be tested and used, then checked against percentage delays to determine if there has been any improvement. This process should be iterated to make the project implementation process as good as possible.

REFERENCES RÉFÉRENCES REFERENCIAS

1. Ibrahim Mahamid; Amund Bruland; and Nabil Dmadi. Causes of Delay in Road Construction Projects. *Journal of Management in Engineering*, 2012, 28: 300-310.
2. Odeh, A.M.; Battaineh, H.T. Causes of construction delay: Traditional contracts. *International Journal of Project Management*. 2002, 20: 67–73.
3. Frimpong, Y.; Oluwoye, J.; Crawford, L. Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of Project Management* 2003, 21: 321–326.
4. J.A. Alsuliman. Causes of delay in Saudi public construction Projects. *Alexandria Engineering Journal*; 2019, 58: 801–808.
5. E.T. Banobi and W. Jung. Causes and Mitigation Strategies of Delay in Power Construction Projects: Gaps between Owners and Contractors in Successful and Unsuccessful Projects. *Sustainability* 2019, 11: 5973.
6. R.F. Aziz, A.A. Abdel-Hakam. Exploring delay causes of road construction projects in Egypt. *Alexandria Engineering Journal*; 2016, 55: 1515–1539.
7. Khatib, B.A.; Poh, Y.S.; El-Shafie, A. Delay Factors in Reconstruction Projects: A Case Study of Mataf Expansion Project. *Sustainability* 2018, 10: 4772.
8. Orangi, E. Palaneeswaran, J. Wilson. Exploring Delays in Victoria-Based Australian Pipeline Projects. *Procedia Engineering*; 2011, 14: 874–881.
9. M.H. Fallahnejad. Delay causes in Iran gas pipeline projects. *International Journal of Project Management*; 2013, 31: 136–146.
10. Majed Alzara, Jacob Kashiwagi, Dean Kashiwagi, Abdulrahman Al-Tassan. Using PIPS to minimize causes of delay in Saudi Arabian construction projects: university case study. *Procedia Engineering*; 2016, 145: 932 – 939.
11. B.-G. Hwang, Xianbo Zhao, Si Yi Ng. Identifying the critical factors affecting schedule performance of public housing projects. *Habitat International*; 2013, 38: 214-221.
12. Raj Kapur Shah, An Exploration of Causes for Delay and Cost Overruns in Construction Projects: Case Study of Australia, Malaysia & Ghana, *Journal of Advanced College of Engineering and Management*, 2016, Vol. 2
13. Long, N.D.; Ogunlana, S.; Quang, T.; Lam, K.C. Large construction projects in developing countries: A case study from Vietnam. *Int. J. Proj. Manag.* 2004, 22: 553–561.
14. Michał Głuszak and Agnieszka Leśniak. Construction delays in clients opinion – multivariate statistical analysis. *Procedia Engineering*; 2015, 123: 182–189.

15. Ogunlana, S.O.; Promkuntong, K.; Jearkjirm, V. Construction delays in a fast-growing economy: Comparing Thailand with other economics. *Int. J. Proj. Manag.* 1996, 14: 37–45.
16. Refer to the letter of Ministry of Public Works and Transport No.538/MPWT, Dated 31 May 2019. Page 2.2-3. (<http://www.mpwt.gov.la/attachments/article/1994/00538-MPWT,%20Hotline%20Govt%20to%20MPWT.pdf>).
17. Al-Khalil, M., Assaf, S., and Al-Hazmi, M.. Causes of delays in large building construction projects, *Journal of Management in. Engineering*, 1995, 11(2): 45–50
18. Assaf, S. A., and Al-Hejji, S.. Causes of delay in large construction projects, *International Journal of Project Management*, 2006, 24(4): 349–357.
19. Koushki, P., Al-Rashid, K., and Kartam, N.. Delays and cost increases in construction of private residential projects in Kuwait, *Constr. Manage. Econ.* 2005, 23(3): 285–294.
20. Sambasivan, M., and Soon, Y.W.. Causes and effects of delays in Malaysian construction industry, *International Journal of Project Management*, 2007, 25(5): 517–526
21. Aibinu, A. A., and Jagboro, G. O.. The effects of construction delays on project delivery in Nigerian construction industry, *International Journal of Project Management*, 2002, 20(8): 593–599.