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Published in:
Alexandria Engineering Journal

DOI:
10.1016/j.aej.2020.11.021

Alexandria Engineering Journal (2021) 60, 1717–1729

HOSTED BY

Alexandria University

Alexandria Engineering Journal

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Revisiting critical delay factors for construction: Analysing projects in Malaysia

Jeffrey Boon Hui Yap [a,*], Pei Ling Goay [a], Yoke Bee Woon [a], Martin Skitmore [b]

[a] Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, 43000 Kajang, Malaysia
[b] School of Built Environment, Science and Engineering Faculty, Queensland University of Technology (QUT), Brisbane, Australia

Received 23 September 2019; revised 9 September 2020; accepted 14 November 2020
Available online 2 December 2020

KEYWORDS

Construction industry;
Developing countries;
Project management;
Schedule delays;
Delay factors

Abstract Although construction delays have been subjected to a considerable amount of research, this perennial problem continues to plague the construction industry globally. For this reason, this study contributes to the theory and practice of construction schedule management by identifying the primary delay causes of construction projects and uncovering the underlying factors involved. Following a *meta*-analysis of 52 common causes of delay identified from the literature review, 20 highly-cited causes are categorised under client-, contractor-, consultant-, labour and equipment-, material- and others-related. A field survey was employed to acquire the views of 148 Malaysian construction practitioners from client, consultant and contractor organisations. These causes are prioritised according to an importance index that integrates both frequency and severity indices, identifying the five leading causes as lack of proper planning and scheduling, too many change orders by clients, lack of competent site management and supervision, lack of competent sub-contractors and financial problems of contractors. Spearman's rank correlation tests reveal a good consensus between the respondent groups to further corroborate the findings. A factor analysis identifies the five principal managerial capabilities influencing schedule delays to be competency management, communication and coordination management, financial management, risk management and site management. These findings are helpful for the praxis of critical reflection in the planning and management of production in construction. This study provides the international construction community with valuable insights to revaluate delay factors and realign project management strategies to ensure the timely delivery of projects.

1. Introduction

The unnecessary delay of project delivery is a frequent root cause of complications in construction projects, particularly in developing countries [16,23,55,57] and Malaysia is no exception [87], where almost 80% of traditionally procured projects experience time overruns [76]. A comparable situation also occurs in

* Corresponding author at: Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, Sungai Long Campus, 43000 Kajang, Malaysia.
E-mail addresses: bhyap@utar.edu.my (J.B.H. Yap), woonyb@utar.edu.my (Y.B. Woon), rm.skitmore@qut.edu.au (M. Skitmore).
Peer review under responsibility of Faculty of Engineering, Alexandria University.

https://doi.org/10.1016/j.aej.2020.11.021

Saudi Arabia, for instance [16]. Previous research indicates that the reasons for schedule delays are similar to those of cost overruns [65,89]. Delays adversely undermine the production planning and control dimension of operations [94], particularly in construction projects [75], regardless of the socio-economic status of the country involved [31]. Delays can cause such predicaments as increased construction costs, loss of profits due to low productivity, lawsuits between contracting parties and contract termination [19,36,70]. According to Alsuliman [16], a contractor will suffer a loss of output and revenues due to missed opportunity costs. In Nigeria, the two most frequent effects of delays are cost overruns and time overruns [8]. In South Africa, the leading effects of schedule delays are extensions of time, cost overruns, loss of profits, disputes and substandard quality of work attributable to hastily performed tasks to complete the project [59]. Along these lines, the negative repercussions of schedule pressure can be attributed to out-of-sequence work, cutting corners and poor worker motivation, resulting in further losses in productivity and quality [61,86].

The Business Dictionary [26] defines delay as the "unplanned deferment of a scheduled activity because of some thing or occurrence that impedes its commencement or continuation". Agyekum-Mensah and Knight [7] simply define delay as "the inability to meet the scheduled time". Assaf and Al-Hejji [21] further articulate delay as being "the time overrun either beyond the completion date specified under a contract, or beyond the date that the parties agreed upon for delivery of a project" and Hanks et al. [40] simplistically interpret a delay as "a period of time by which something is late or postponed". More recently, Arantes and Ferreira [20] note that the "timely completion of a project is usually regarded as the major parameter for measuring the success of a project". Thus, completing a project behind schedule is undesirable and unwarranted [23,31], justifying the need for revisiting the delay factors for the better understanding of the causal factors involved so that effective measures can be devised for their containment.

Although construction projects worldwide have analogous characteristics, some remain very much country-specific [65]. Against this background, Mpofu et al. [57] opine that delay factors are country-specific and influenced by socio-economic and cultural backgrounds. In contrast, Toor and Ogunlana [80] observe that an analogous list of issues bring about construction delays in the developing world.

Despite being a popular academic area of research, however, the problem of poor project schedule management remains [31,63]: late completion continues to plague Malaysian projects, for example [87]. Given the persistence of the problem, the present study seeks to revisit the major delay causes and uncover the underlying dimensions of delays in the construction industry. Most importantly, this Malaysia-based study sheds light on the salient issues adversely undermining the timely delivery of construction production. The findings provide an opportunity for global construction project management practitioners to revaluate and modify work practices to redress the current shortcomings.

2. Literature review

More than a decade ago, Sambasivan and Soon's [71] examination of the association between causes and effects of the incidences of delays revealed the ten most influential factors of delay perceived by Malaysian construction practitioners. This was one of the earliest studies that established the association between each cause and effect empirically. In a separate study in the same year, Alaghbari et al.'s [13] investigation of the causal delay factors found the leading causes to be the owner's financial complications due to economic problems, financial problems affecting contractor, consultants' slowness in supervising works and decision-making, consultants' inefficiency in issuing instructions and market shortage of materials. While these studies provide an increased understanding of the issues contributing to delays in Malaysia, they took place over a decade ago, when the construction industry's maturity was at a lower level. Moreover, they only consider the causes using a single scale of either agreement or frequency, which may limit the reliability of their results. It is also worth noting that these studies only aimed to identify the significant causes and stopped short of analysing the underlying factors involved. To bridge these gaps, the present study revaluates the causes of delays by appraising importance indices that also take account of frequency and severity. Additionally, uncovering the principal dimensions of delays is useful to better understand the underlying factors affecting schedule performance.

Later, in Vietnam, the primary reasons for delays concern personnel and managerial predicaments [52]. In Egypt, the financial problems of a contractor is the most critical [33]. Over in the Gaza Strip in Palestine, a dissimilar set of causes are identified, namely incursions, closure of checkpoints at the border and inadequacy in the supply construction materials, which may be attributable to the political environment in the region [34]. Analysing construction projects in India, Doloi et al. [30] reported that one of the most critical factors of project delay is the lack of commitment. In 2013, Akogbe et al. [10] prioritised the delay causes peculiar to Beninese construction projects by considering their severity and frequency of occurrences as evaluated by the respondents. The contractors' limited financial strength, owners' financial problems and subcontractors' poor performance were found to be the major time inhibitors. On the other hand, in Uganda, Muhwezi et al. [58] employed the relative importance index (RII) as a tool for their analysis, finding that consultant-related factors contributed substantially to delays. In 2014, investigating from the Malaysian housing developers' outlook, Mydin et al. observed that contractor-related causes are more significant compared to consultant-, client- and external-related causes. A similar observation was also reported earlier by Abdullah et al. [6] of Majlis Amanah Rakyat (MARA) management procurement projects *(MARA is a government agency that aids, trains and guides Malays and other indigenous Malaysians)*. This is also consistent with other similar studies in Egypt where a contractor-related group of delay factors was most critical with RII = 79.91% [22], as well as in Pakistan with the leading cause being 'difficulties in financing project by the contractor' [45].

During the last five years, Larsen et al. [50] underscore that major factors impeding project schedule performance are consultant-related in Denmark, further demonstrating that delays also inflated costs and impeded project quality. In a Vietnamese study, Nguyen and Chileshe [62] reported that scanty planning and the incompetence of project personnel significantly contribute to project failures. The following year, another empirical study in low-income Burkina Faso observed

technical incapacity, inexperience and financial weakness of contractors as being the leading inhibitors of time performance [24]. For Egyptian road construction projects, the five leading delay causes are related to financing, equipment, the contractor and materials [23]. In the case of the United Arab Emirates, delay causes are associated with the hereditary adversarial practices of the primary stakeholders [57]. In Morocco, Bajjou and Chafi [25] classified the causes according to nine categories, the leading three deferred progress payments, deficient training and competency of project personnel and a poor waste management strategy. In China, variations, delayed progress payments, aggressive competitive bidding, poor performance of sub-contractors and communication breakdowns are the most common causes of delays [83]. In the same year, Zidane and Andersen [96] highlighted ten critical delay factors in Norway, in which frequent changes of design during construction, deferment of interim payments to contractors and ineffective planning and poor scheduling rank the highest.

Most recently, based on Zidane and Andersen's [96] 10 universal causes of delays, Arantes and Ferreira's [20] study in Portugal reported that 6 of the 10 most significant causes are akin to the top 10 universal delays in construction projects. Their exploratory factor analysis manifested six underlying causes relating to inadequate planning, unsatisfactory consultant performance, disorganised site management, owner's interference, bureaucratic red tape and substandard contracts. Toor and Ogunlana [80] proclaim that most delays are due to the failure to anticipate issues and procrastination in solving problems once they are identified. Moreover, they also observe a comparable pattern of problems across developing countries in many parts of the world.

To facilitate the investigation into the principal delay causes, the present study first involves a thorough literature review of 26 selected studies (Table 1) to shortlist 52 delay causes relating to client (10 causes), contractor (9 causes), consultant (11 causes), labour and equipment (3 causes), material (5 causes) and others (14 causes), as shown in Table 2. The five most highly-cited causes include 'low productivity' (19), 'lack of proper planning and control' (18), 'incompetent sub-contractors' (17), 'inadequate skilled labour' (16) and 'weather conditions' (16). Upon further *meta*-analysis, the twenty (20) most prevalent delay causes are then selected as a basis for the empirical analysis.

Table 1 Summary of previous studies of the causes of construction project delays.

Countries	Previous literature
Malaysia	[2,13,39,42,48,60,66,71,74]
Burkina Faso	[24]
Developing countries	[81]
Egypt	[56]
Jordan	[12,64,79]
India	[68]
Iran	[69]
Nigeria	[9]
Pakistan	[32]
Saudi Arabia	[18]
Thailand	[80]
Turkey	[47]
Uganda	[14,58]
Vietnam	[52]
United Kingdom	[44]

3. Research methodology

3.1. Questionnaire design

A primary questionnaire was drafted containing the 20 most common delay causes emerging from the systematic review of the literature obtained by searching academic databases using relevant keywords to pinpoint studies examining project delays (time overruns) as well as other salient issues undermining project performance. The finalised questionnaire contains three parts. Part I is used to collect demographic details of the respondents, such as their type of organisation, age, education background, working experience, nature of projects and type of procurement regularly involved.

Parts II and III entail appraising the viewpoints of key construction stakeholders, comprising representatives from client, consultant and contractor organisations of the 20 delay causes according to their frequency of occurrence and degree of severity during the construction stage using a five-point Likert scale as adopted in previous delay studies (e.g., [21,52,24]. For the frequency of occurrence, the numerical values allotted are 1 = *never happened* to 5 = *always*; whereas, for degree of severity, the numerical values allotted are 1 = *not at all* to 5 = *extremely severe*.

Being the research instrument, the questionnaire was piloted with 35 construction practitioners from client, contractor and consultant organisations to gauge its quality in terms of comprehensibility and unambiguity. All the pilot respondents had a tertiary education while approximately 60% had over 5 years' construction experience. The majority were involved in privately-funded traditionally procured projects. Cronbach's alpha values of 0.88 (frequency of occurrence) and 0.90 (degree of severity) were computed, all of which were higher than the threshold value of 0.70 [38] needed to ascertain the internal consistency of the questionnaire.

3.2. Data collection

In the main survey, non-probability sampling techniques of convenience and snowballing [24,87] were used to distribute the questionnaire. Using email addresses obtained from the LinkedIn professional social media platform and personal contacts, a total of 2380 electronic questionnaire forms were disseminated to construction practitioners nationwide, comprising clients (property developers), consultants (architects, engineers and quantity surveyors) and contractors (main and sub-contractor companies). One hundred and forty-eight (148) valid questionnaires were collected, recording a response rate of 6.2%. The low response rate is expected as studies by Abdul-Aziz [1] and Yong and Mustaffa [93] also had response rates less than 10% among Malaysian construction practitioners due to work commitment and lethargy towards research. Nonetheless, a sample size of >100 with a subjects-to-variables ratio exceeding five is considered sufficient for statistical testing and acceptable for factor analysis [35,87].

Table 2 Overall delay causes mentioned in the literature review.

No	Description of causes	Category	Frequency
1	Non-payment or delay of completed work	Client	15
2	Too many change orders by clients		13
3	Slow in making decisions		13
4	Ineffective communication with others		12
5	Financial difficulties and economic problems		8
6	Changes in the type of materials and specifications during construction		6
7	Complexity of the project		5
8	Unrealistic contract duration		3
9	Lowest bidder		1
10	Approval of design documents by the owner		1
11	Lack of proper planning and scheduling	Contractor	18
12	Incompetent sub-contractors		17
13	Construction mistakes and defective works		14
14	Incompetent site management and supervision		13
15	Financial problems of contractors		13
16	Inadequate coordination with other parties		12
17	Inadequate contractor experience		8
18	Slow preparation of shop drawings and samples of materials		1
19	Delay in site mobilization		1
20	Slow in implementing inspections and testing	Consultant	11
21	Slow in approving scope changes		11
22	Slow preparation and approval of drawings and specifications		9
23	Design errors		9
24	Lack of communication between parties		6
25	Lack of consultant's experience		5
26	Mistakes and discrepancies in the contract		4
27	Inadequate budget estimation		4
28	Slow to give instructions		3
29	Unclear and inadequate details in drawings		1
30	Requirements not understood by designers		1
31	Low productivity	Labour and equipment	19
32	Inadequate skilled labour		16
33	Improper or insufficient plant and equipment selection		14
34	Material shortages	Material	14
35	Price escalation		11
36	Delays in transportation		10
37	Poor material quality		5
38	Unreliable sources of materials on the local market		1
39	Weather conditions	Other	16
40	Change in government policies and leadership		11
41	Poor/unforeseen site conditions		10
42	Interference by political leaders		10
43	Accidents during construction		5
44	Problems with neighbours		5
45	Natural disasters		3
46	Effective monitoring and feedback processes		2
47	Corruption		1
48	Lack of information given during schedule time		1
49	Traffic congestion		1
50	No tag system established to identify components		1
51	Inexperienced manufacturing operators		1
52	Lack of a quality check mechanism		1

3.3. Respondent demographics

Table 3 summarises the respondents' backgrounds. The response rate from clients, consultants and contractors are 11.5%, 46.6% and 41.9%, respectively. Table 3 reveals that almost 60% of the respondents are 31 years or older, 44% have over 10 years of construction experience, while 39% have five years or less working experience. These ratios reflect the current situation in the Malaysian construction industry where a large number of young professionals are employed to meet the vast demand for construction work. Likewise, similar observations are reported by Le-Hoai et al. [52] and Nguyen

Table 3 Respondents' background.

Demographic characteristics	Frequency (N = 148)	Percentage (%)
Type of organisation		
Client	17	11.5
Contractor	62	41.9
Consultant	69	46.6
Age		
20–30	63	42.6
31–40	33	22.3
> 40 38	52	35.1
Education		
Master/MBA/MSc	36	24.3
Degree	89	60.1
Diploma	18	12.2
High School	5	3.4
Working experience		
less than 5 years	57	38.5
6–10 years	26	17.6
11–15 years	17	11.5
16–20 years	14	9.5
> 20 years	34	23.0
Characteristics of project		
Public	29	19.6
Private	119	80.4
Type of procurement		
Traditional	71	48.0
Design and build	44	29.7
Management contracting	5	3.4
Construction management	25	16.9
Turnkey	3	2.0

and Chileshe [62] in Vietnam and Yap et al. [86] in Malaysia. The majority has had a tertiary education (97%) and is currently involved in traditionally-procured private projects. The demographic profile of the respondents is therefore considered sufficiently representative of construction practitioners in Malaysia.

3.4. Index analysis approach

Following Assaf and Al-Hejji [21], Bagaya and Song [24] and Yap et al. [87], the survey data are analysed using three sets of indices. The delay causes are prioritised using occurrence, severity and importance founded on frequency, severity and importance indices, respectively.

The frequency index (F.I.), which gauges the rate of recurrence of each cause, is given by

$$F.I. = \sum_{1}^{5} \frac{a_i n_i}{5N} \quad (1)$$

where a denotes a constant expressing the degree of frequency (ranges from 1 for *never happened* to 5 for *always*), n is the frequency of each response and N is the total number of responses.

The severity index (S.I.) measures the gravity of each delay factor and is given by

$$S.I. = \sum_{1}^{5} \frac{b_i n_i}{5N} \quad (2)$$

where b denotes a constant expressing the degree of severity (ranges from 1 for *not at all* to 5 for *extremely severe*).

The importance index (IMP.I.) which expresses the significance of each delay factor as a function integrating frequency of occurrence and degree of severity is given by

$$\text{IMP.I} = \text{F.I. x S.I.} \quad (3)$$

4. Ranking of delay causes

Tables 4 to 6 present the frequency, severity and importance indices along with the ranking of delay causes in descending order according to the clients, consultants and contractors. Overall, IMP.I ranges from 0.261 to 0.539. A close examination of Table 6 reveals the five most significant causes of delays, after taking into account the rate of recurrence and severity of each cause, to be:

(1) lack of proper planning and scheduling (IMP.I = 0.539)
(2) too many change orders by clients (IMP.I = 0.537)
(3) incompetent site management and supervision (IMP.I = 0.519)
(4) incompetent sub-contractors (IMP.I = 0.512)
(5) financial problems of contractors (IMP.I = 0.502).

Of the causes examined, contractor-related causes have the most significant effect on project delays overall (combined IMP.I. = 2.072); this is consistent with the findings of such studies in the developing world as Egypt [22] and Jordan [79]. The classification of delay causes according to group categories are contractor (35%), client (23%), labour/equipment (14%), consultant (9%), material (7%) and others (12%), from which it can be inferred that contractor-related causes have a significant effect on project delays. A similar trend is also observed by Hisham and Yahya [42], Mydin et al. [60] and Rao and Camron [68].

The clients and contractors viewpoints of delay causes differ as they tend to blame each other for unfavourable incidents [11,22,89]. For instance, the clients attribute the top five delay causes to the contractors' poor financial, competency and site management. On the other hand, contractors perceive deferred payments by clients to be a major concern. On the issue of change orders, contractors and consultants share a similar perspective. Despite some differing perspectives in the ranking of the top five delay causes, there is an overall similar consensus among the three parties in the ranking of the five least critical delay causes.

Additionally, the main problem delaying construction projects, rated the highest on the severity scale, is the lack of proper planning and scheduling by contractors. Against this backdrop, it can be determined that the higher the frequency of occurrence, the higher the severity of the impact on the original completion date. These results show that contractors acknowledge their shortcomings in planning and scheduling.

While the frequency of contractors' financial problems is ranked ninth, it is ranked third in terms of severity of delay causes. An inadequate cash flow can significantly undermine the progress of work, as contractors may not be able to carry out construction activities according to schedule, causing the

Table 4 Frequency index and ranking.

No	Causes	Overall (N = 148)		Client (N = 17)		Contractor (N = 62)		Consultant (N = 69)		Group
		Rank	F.I.	Rank	F.I.	Rank	F.I.	Rank	F.I.	
1	Lack of proper planning and scheduling	1	0.718	3	0.765	1	0.697	5	0.693	Contractor
2	Incompetent sub-contractors	2	0.716	2	0.776	3	0.684	6	0.687	Contractor
3	Too many change orders by clients	3	0.715	9	0.706	3	0.684	1	0.757	Client
4	Incompetent site management and supervision	4	0.705	1	0.800	11	0.642	8	0.672	Contractor
5	Slow in making decisions	5	0.703	3	0.765	6	0.668	7	0.675	Client
6	Ineffective communication with others	6	0.701	6	0.741	9	0.652	3	0.710	Client
7	Inadequate coordination with other parties	7	0.694	9	0.706	7	0.655	2	0.722	Contractor
8	Construction mistakes and defective works	8	0.680	8	0.729	14	0.613	4	0.699	Contractor
9	Financial problem of contractors	9	0.679	3	0.765	5	0.677	14	0.594	Contractor
10	Inadequate skilled labour	10	0.668	6	0.741	12	0.632	12	0.632	Labour/ equipment
11	Low productivity	11	0.666	9	0.706	7	0.655	9	0.638	Labour/ equipment
12	Non-payment or delay of completed works	12	0.662	12	0.682	2	0.690	13	0.614	Client
13	Slow in approving scope changes	13	0.647	13	0.659	10	0.645	9	0.638	Consultant
14	Unforeseen site conditions	14	0.620	14	0.612	14	0.613	11	0.635	Others
15	Weather conditions	15	0.607	14	0.612	13	0.619	15	0.591	Others
16	Slow in implementing inspections and testing	16	0.595	14	0.612	16	0.584	16	0.588	Consultant
17	Improper or insufficient plant and equipment selection	17	0.554	14	0.612	19	0.506	17	0.545	Labour/ equipment
18	Material shortages	18	0.544	18	0.576	17	0.552	19	0.504	Material
19	Price escalation	19	0.540	19	0.553	18	0.532	18	0.533	Material
20	Change in government policies and leadership	20	0.479	20	0.506	20	0.439	20	0.493	Others

Table 5 Severity index and ranking.

No	Causes	Overall (N = 148)		Client (N = 17)		Contractor (N = 62)		Consultant (N = 69)		Group
		Rank	S.I.	Rank	S.I.	Rank	S.I.	Rank	S.I.	
1	Lack of proper planning and scheduling	1	0.751	2	0.765	3	0.716	1	0.771	Contractor
2	Too many change orders by clients	2	0.750	5	0.729	1	0.761	2	0.759	Client
3	Financial problem of contractors	3	0.735	1	0.800	4	0.713	10	0.693	Contractor
4	Incompetent site management and supervision	4	0.734	3	0.753	6	0.694	3	0.757	Contractor
5	Non-payment or delay of completed works	5	0.727	5	0.729	2	0.748	8	0.704	Client
6	Incompetent sub-contractors	6	0.714	4	0.741	5	0.706	9	0.696	Contractor
7	Slow in making decisions	7	0.700	8	0.694	7	0.690	6	0.716	Client
8	Ineffective communication with others	8	0.695	8	0.694	9	0.674	6	0.716	Client
9	Construction mistakes and defective works	9	0.695	5	0.729	13	0.635	5	0.719	Contractor
10	Inadequate coordination with other parties	10	0.693	10	0.671	8	0.677	4	0.730	Contractor
11	Slow in approving scope changes	11	0.662	10	0.671	10	0.671	14	0.643	Consultant
12	Inadequate skilled labour	12	0.661	10	0.671	12	0.639	11	0.672	Labour/ equipment
13	Low productivity	13	0.648	15	0.635	11	0.661	13	0.646	Labour/ equipment
14	Unforeseen site conditions	14	0.639	15	0.635	16	0.616	12	0.667	Others
15	Material shortages	15	0.633	13	0.659	15	0.623	15	0.617	Material
16	Slow in implementing inspections and testing	16	0.612	17	0.612	14	0.626	17	0.597	Consultant
17	Improper or insufficient plant and equipment selection	17	0.610	13	0.659	19	0.558	16	0.614	Labour/ equipment
18	Weather conditions	18	0.595	18	0.576	17	0.613	18	0.594	Others
19	Price escalation	19	0.583	19	0.565	18	0.597	19	0.588	Material
20	Change in government policies and leadership	20	0.543	19	0.565	20	0.519	20	0.545	Others

Table 6 Importance index and ranking.

No	Causes	Overall (N = 148)		Client (N = 17)		Contractor (N = 62)		Consultant (N = 69)		Group
		Rank	IMP. I.	Rank	IMP. I.	Rank	IMP. I.	Rank	IMP. I.	
1	Lack of proper planning and scheduling	1	0.539	3	0.585	3	0.499	2	0.534	Contractor
2	Too many change orders by clients	2	0.537	7	0.515	1	0.521	1	0.575	Client
3	Incompetent site management and supervision	3	0.519	2	0.602	7	0.445	3	0.509	Contractor
4	Incompetent sub-contractors	4	0.512	4	0.576	4	0.483	7	0.478	Contractor
5	Financial problem of contractors	5	0.502	1	0.612	5	0.483	13	0.412	Contractor
6	Slow in making decisions	6	0.492	6	0.531	6	0.461	6	0.484	Client
7	Ineffective communication with others	7	0.487	8	0.514	8	0.439	4	0.508	Client
8	Non-payment or delay of completed works	8	0.482	9	0.498	2	0.517	9	0.433	Client
9	Construction mistakes and defective works	9	0.475	5	0.532	13	0.389	5	0.502	Contractor
10	Inadequate coordination with other parties	10	0.462	10	0.497	11	0.428	8	0.462	Contractor
11	Inadequate skilled labour	11	0.442	10	0.497	12	0.404	10	0.425	Labour/ equipment
12	Low productivity	12	0.431	12	0.448	9	0.433	12	0.412	Labour/ equipment
13	Slow in approving scope changes	13	0.428	13	0.442	10	0.433	14	0.410	Consultant
14	Unforeseen site conditions	14	0.396	15	0.389	15	0.378	11	0.423	Others
15	Slow in implementing inspection and testing	15	0.364	17	0.374	16	0.365	16	0.351	Consultant
16	Weather conditions	16	0.361	18	0.353	14	0.380	15	0.351	Others
17	Material shortages	17	0.345	16	0.380	17	0.343	19	0.311	Material
18	Improper or insufficient equipment selection	18	0.340	14	0.403	19	0.283	17	0.335	Labour/ equipment
19	Price escalation	19	0.315	19	0.312	18	0.318	18	0.314	Material
20	Change in government policies and leadership	20	0.261	20	0.286	20	0.228	20	0.269	Others

project to be delayed [22,67]. Contractors and clients share the same view of the consequence caused by incompetent sub-contractors, ranking cash flow and sub-contractors incompetency second and third, respectively. Hence, the method of contractor or sub-contractor selection is crucial for ensuring their competency to complete the work in both a satisfactorily and timely manner.

It is worth mentioning that all parties agree on price escalation, and changes in government policies and leadership are the least important causes of delays. This is most likely due to Malaysia's politically stable environment.

5. Comparison with selected countries

The objective of drawing comparisons with selected countries is to consolidate the findings between this empirical study and studies in other developed and developing countries, in addition to validation purposes.

Of the selected studies as shown in Table 7, it is evident that 'financial problems of contractors' and 'lack of proper planning and scheduling' are not only evident in Malaysia. It also manifests in many African and Asian countries such as Burkina Faso, Benin, Egypt, Jordan, Uganda and Vietnam, recording an occurrence percentage of 27.8% of the top five delay causes (see Fig. 1). The next leading factor is 'incompetent sub-contractors' with 22.2%. However, it is interesting to note these leading delay causes are not significant in the UK. In agreement with Toor and Ogunlana [80], prevailing managerial problems regarding the contractor's competence and client interference issues persistently undermine project schedule performance. These findings suggest a failure to capitalise on past project experiences and recognise current flaws in the planning and control of projects. According to Love et al. [54], despite the plethora of studies on rework, the inability to critically reflect on the prevailing norms is resulting in recurring problems within the construction industry. This reinforces Alsehaimi et al.'s [15] view that descriptive and explanatory research approaches are inadequate to contain delays in developing countries. Capacity-building efforts through project learning [82,84] and best value [18,17]are possible changes needed to transform the industry towards an improved schedule performance.

6. Agreement analysis

Spearman rank correlation coefficient is used to ascertain the concordance between pairs of parties. Table 8 presents the results, showing that the level of agreement between three respondent groupings in ranking the frequency, severity and IMP.I. of each delay cause is relatively good. Even though there are slight differences in opinion between clients and contractors, their level of agreement is the highest – the lowest level of agreement is between the clients and consultants.

7. Exploratory factor analysis

The principal groupings of the 20 delay causes is uncovered by factor analysis. The Kaiser-Meyer-Olkin (KMO) test and Bar-

Table 7 Major delay factors in other countries/regions.

Selected countries	Top five delay factors in Malaysia (2019)				
	Lack of proper planning and scheduling	Too many change orders by clients	Incompetent site management and supervision	Incompetent sub-contractors	Financial problem of contractors
Burkina Faso[24]	√			√	√
Benin[10]				√	√
Egypt[56]	√	√		√	
Jordan[79]	√	√			√
Malaysia[71]	√		√	√	
Uganda[58]					√
Vietnam[52]			√		√
United Kingdom[44]					
Australia [74]	√				
Total frequency	*5*	*2*	*2*	*4*	*5*

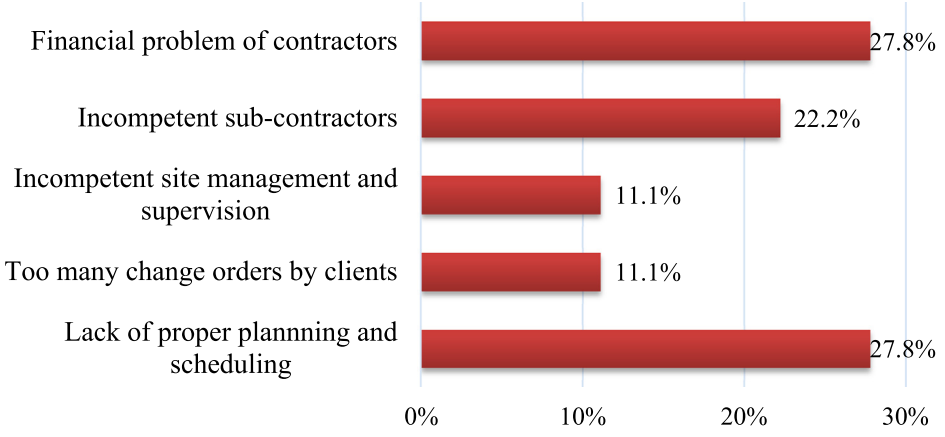

Fig. 1 Percentages of the top five ranking delay causes in nine countries.

Table 8 Spearman's rank correlation of delay causes.

	Frequency index		Severity index		Importance index	
	r_s	α	r_s	α	r_s	α
Clients - Contractors	0.711	0.01	0.859	0.01	0.808	0.01
Contractors - Consultants	0.678	0.01	0.813	0.01	0.795	0.01
Clients - Consultants	0.683	0.01	0.840	0.01	0.758	0.01

Note: $r_s$indicates Spearman's rank correlation coefficient and αindicates the significance level.

tlett's test of sphericity is used to determine the suitability of the variables for factor analysis [78,86]. The result of the KMO test is 0.816, whereas Bartlett's test of sphericity is 1254.3 ($\rho = 0.000$) – both satisfying the aptness criteria for factor analysis (Table 9).

To determine the number of factors to retain, the cut-off value for eigenvalues is set at the conventional value of 1 [86,92]. The principal component analysis (PCA) yields five principal factors that account for 62.34% of the total variance explained, which is above the threshold of 60% needed to sustain validity [38]. 'Slow in making decisions' and 'materials storage' both have factor loadings below the usual threshold of 0.50 and are eliminated from further analysis. Varimax rotation is further applied for a higher explanatory power [88,92]. Table 10 presents the factor profile. Each factor is interpreted and named accordingly with their factor loadings. Generally,

Table 9 Results of the KMO and Bartlett's test.

Parameter	Value
Kaiser-Meyer-Olkin measure of sampling adequacy	0.816
Bartlett's test of sphericity	
Approximate chi-squared value	1254.3
Degree of freedom	190
Significance value	0.000

Table 10 Factor loading and variance explained.

Factors and causes of project delays	Factor loading	Variance explained %
Factor 1: Competency Management	–	16.160
Lack of proper planning and scheduling	0.817	–
Low productivity	0.722	–
Incompetent sub-contractors	0.695	–
Incompetent site management and supervision	0.691	–
Factor 2: Communication and Coordination Management	–	16.090
Inadequate coordination with other parties	0.801	–
Ineffective communication with other parties	0.755	–
Too many change orders by clients	0.695	–
Slow in approving scope changes	0.620	–
Slow in implementing inspection and testing	0.592	–
Factor 3: Financial Management	–	11.573
Non-payment or delay of completed works	0.777	–
Financial problem of contractors	0.601	–
Change in government's policies and leadership	0.557	–
Factor 4: Risk Management	–	9.395
Unforeseen site conditions	0.774	–
Price escalation	0.654	–
Factor 5: Site Management	–	9.117
Inadequate skilled labour	0.632	–
Weather conditions	0.605	–
Construction mistakes and defective works	0.596	–
Improper or insufficient plant and equipment selection	0.563	–

the variables with higher loadings are considered more important.

8. Discussion of factor analysis results

8.1. Factor 1: Competency management

Factor 1 accounts for 16.2% of the total variance explained. As Haron et al. [41] opine, the new and emerging criteria to ensure successful completion of construction projects in Malaysia are built upon the know-how of the project team together with the performance of sub-contractors/suppliers. On the other hand, the inefficiency and incapability of a project management team can result in project failure [55] – a dominating trend in most Arabic Gulf countries. Accordingly, capacity building with proper competency management can overcome low productivity and reduce the severity of contractor-related issues, and thus improving the quality of construction work. Another recent study by Yap et al. [85] concludes that most design changes during building production are attributable to inexperienced (ignorant, unlearned and uninformed) project personnel – resulting in extensive rework and an extended duration. This factor is associated with contractor and labour and equipment-related causes. Performance-related issues in construction projects often contribute to project delays [89]. Intrinsically, incompetent sub-contractors/suppliers and an unskilled workforce often lead to poor performance and can eventually result in project delays [25,46]. This factor evidently suggests the need to improve learning and engender capacity building to improve organisational and project performance. To raise productivity and improve performance, Love and Smith [53] propose cultivating a learning culture to transform experiences into reusable knowledge that can help prevent errors in the future. They propose a growth mindset for learning that integrates enacting behaviour with authentic leadership and coaching. According to Shi et al. [77], the competencies needed for sustainable construction relate to the quality of personnel and troubleshooting skills on site, as well as continuing professional development. In this sense, experiential project learning provides the preventive mitigation of time overruns, leveraging of accumulated experience and increased expert judgment [84].

8.2. Factor 2: Communication and coordination management

This second factor accounts for 16.1% of the total variance explained. Butt et al. [27] and Yap et al. [85] consider that communication and coordination management have a significant influence on project success. As such, collaboration in the supply chain is essential [49]. According to Zidane and Andersen's [96] systematic review of the extant literature, one of the leading factors of delay, as cited in 37 delay studies, is miscommunication and lack of coordination between contracting parties. The construction industry suffers from fragmentation, which frequently hampers effective communication, resulting in an adversarial 'them and us' attitude [89] as well as conflict and claims during the project [49]. A recent study by Bajjou and Chafi [25] in Morocco reported that the lack of collective coordination incapacitates planning and scheduling work. Communication and coordination management includes several processes, such as data generation, data collection, data distribution, data storage and data retrieval, to gather the project information required in an appropriate and timely manner [72]. This undertaking becomes more challenging when multiple tasks are outsourced to different sub-contractors. According to Laufer et al. [51], the intensiveness and extensiveness of on-site communications vary in dynamic conditions: they observe that most construction managers prefer informal interactions for sharing and gathering information. In this context, construction practitioners have a strong orientation toward

the verbal communication of information. However, rich project communications are essential for effective coordination whatever the medium of communication [73].

8.3. Factor 3: Financial management

This third factor accounts for 11.6% of the total variance. According to Zidane and Andersen [96], universal financially-related delay causes are deferred payments to the contractor, insufficient financial resources of the contractor and the owner's lack of sound financial management practices. Abdul-Rahman et al.'s [3] survey of key construction stakeholders and bankers in Malaysia reports the major financial-related delay causes to be poor cashflow management, late payments and deficient capital. Delays in progress payments is the leading cause of delays to Moroccan construction projects [25]. In another study, Enshassi et al. [34] emphasise that cashflow problems impede progress by deteriorating productivity, as contractors are incapable of purchasing the materials and equipment required to complete outstanding work. They further explain that these predicaments also extend to sub-contractors and suppliers – generating a vicious cycle of slow progress and ultimately project delays. In Turkey, poor financial management is the primary root cause of project delays, which needs to be taken into account by construction practitioners [47]. Hence, sound financial planning, management and control provide the basis for smooth implementation [95].

8.4. Factor 4: construction risk management

According to Zidane and Andersen [96], a delay is an unavoidable risk for construction projects. As Zarei et al. [94] opine, delays are related to the degree of uncertainty and complexity of projects. A construction risk can be described as "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality" [43]. Typical construction risks include escalation in material prices [34]and unforeseen site conditions [85]. By understanding the potential causes of delays, effective and proactive risk management measures can be developed to eliminate or minimise both their likelihood and impact [37]. A cause of concern is that the practice of risk management is generally lacking in Malaysia as its construction practitioners are ignorant of the risk management tools and techniques available [4]. Yaraghi and Langhe's [91] examination of the success dimension concerning risk management systems concludes that organisational culture and knowledge are crucial influential factors. Given this understanding, knowledge of construction risk management is becoming crucial for dealing with the complexity of projects at different phases of the project life cycle and the risk tolerances involved [28].

8.5. Factor 5: Site management

Poor site management contributes to project delays and leads to poor construction productivity [56]. Site management is concerned with project monitoring, distribution of resources, the commitment of site workers and communication and coordination between all parties [29]. Table 8 shows 'inadequate skilled labour', 'weather conditions', 'construction mistakes and defective works' and 'improper or insufficient equipment selection' to be the site management factors involved, and account for 9.1% of the total variance explained. With this in mind, well-organised site management and adequate supervision are of paramount importance for improving the schedule performance of construction projects [30].

9. Concluding remarks

As the ubiquitous nature of construction project delays continues worldwide, the causal factors involved have received considerable academic attention to date, although the descriptive and explanatory nature of the research conducted thus far has yielded little success in containing the problem. This study uses a Malaysian field survey to prioritise the 20 most prevailing causes of construction project delays with respect to the cognisance of key stakeholders from client's, contractor's and consultant's organisations according to the importance index (IMP.I.) – reflecting the combined effect of their frequency of occurrence and degree of severity. In the overall context, the five most critical causes are 'lack of proper planning and scheduling', 'too many change orders by clients', 'incompetent site management and supervision', 'incompetent sub-contractors', and 'financial problems of contractors'. The Spearman's rank correlation tests indicate a good agreement between the three respondent groups in relation to the frequency, severity and importance of the delay causes, further affirming the validity of the findings in revealing that contractor-related causes contribute the most to project delays.

A comparative analysis with selected countries indicates that most developing Asian and African countries face a similar situation, with the most prominent reason being a lack of contractor competencies and awareness, and an industry-wide inability to deal with the many flaws in project management practices. As mentioned in several recent studies, the long-running tenacity of the problem and failure to find any practical solutions of note point to what Love et al. [54] term the 'praxis of stupidity' by reason of the inability to learn and thus repeating similar mistakes from one project to the other, with more attention being needed to create a mindfulness to learn from the recurring managerial problems involved – implying a radical change in terms of a shift towards transformative approaches such as project learning [5,90] and best value construction [18,17].

The factor analysis identified the five principal factors involved to be competency management, communication and coordination management, financial management, risk management and site management, indicating the importance of proper planning and scheduling, sufficient site management and supervision, employment of proper financial management, minimising the degree of change orders by clients and selection of qualified and eligible sub-contractors being the stakeholders' main focus before the commencement of any project procurement process.

These research findings benefit both academics and construction practitioners with deeper insights into the root causes of schedule delays, particularly to the construction industry in developing Asian and African economies. The continued expansion of knowledge and understanding regarding the importance (criticality) of these causes will help stakeholders reduce the incidences of delays and lead to appropriate strate-

gies to enhance project schedule performance and also guide future research in the industry. Furthermore, construction practitioners need to be cognizant of the five principal managerial capabilities influencing schedule delays in their projects to avoid their lack of knowledge and awareness undermining the delivery of projects. The principal factors uncovered can also be integrated into the education and training of construction professionals to enhance their ability to distinguish and address the primary causes of project delays.

While the study makes several contributions to construction schedule management, it is limited by the single data collection method using field survey possibly causing mono-method bias. Although the use of a structured questionnaire survey facilitates data collection from a large sample of practitioners for statistical analysis, unlike the interpretative approach using purposeful interviews it is unable to probe respondents for their rich experiences in confronting delay issues. Nevertheless, the results are largely substantiated by data triangulation in comparing them with previous studies. Further such comparative studies would be beneficial to explore the influence of procurement systems and level of experience of construction stakeholders on the perceptions of delay factors in other geographic and economic contexts. Future prescriptive research using action and constructive research approaches would also help examine the strategic mitigation measures needed to reduce and control the extent of schedule delays to deal with the managerial problems involved.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

Acknowledgements

This work was supported by the UTAR research fund grant through Universiti Tunku Abdul Rahman, Malaysia, under Grant IPSR/RMC/UTARRF/2019-C2/J01 and UTAR Financial Support for Journal Paper Publication scheme. The authors would like to sincerely thank the industry professionals who participated in this research and the support provided by UTAR Global Research Network Program (International Collaborative Partner). We would also like to thank the reviewers for their insightful and constructive comments, which have helped improve the quality of this manuscript.

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