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Relationship Between Schedule Delay Factors and Project Performance in Civil Engineering Works

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ABSTRACT

A schedule delay occurs when there is an event or condition that delays the project's commencement or progress. In this case, the completion and delivery of construction projects are deemed ineffective if they fail to satisfy the predetermined criteria, budget, schedule, and stakeholder expectations. As a result, early detection of delays is critical to minimizing their impact on construction project performance. Consequently, this research aims to investigate the relationship between schedule delay factors and project performance in civil engineering works. To achieve this, the contributing factors of schedule delays, the effects of schedule delays and ways that can be taken to overcome schedule delays were identified using questionnaire surveys. The surveys were distributed to G7 civil engineering contractors and 144 were returned. Then, the data collected were analysed using descriptive statistics, Cronbach's alpha and Kruskal-Wallis test statistics. Based on the research, the study reveals that weakness in the operational system, contractors' lack of capability in terms of finances and lack of experience of the contractor are the major factors resulting in the delayed completion of civil engineering projects. The findings of the study are intended to offer those involved in civil construction projects appropriate solutions for countering schedule delays.

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INTRODUCTION

A schedule delay refers to an unforeseen delay due to circumstances hindering the project's initiation or progress. In this case, the duration of a project is extended, and the fulfilment of objectives is disrupted due to the amount of time involved (Khalid, 2017). Delays may manifest either at the initial or later phases of project development. Nevertheless, delays may be effectively reduced only when their underlying causes are accurately recognised. Project delays often arise due to various situations that give rise to obstacles in the initiation and subsequent execution of project operations (Javed et al., 2022). Delays in construction industry projects have long been a major problem, yet delay factors and their effect on the project performance, especially on civil engineering works, are still unclear.

The occurrence of construction delays may substantially influence the success of the overall goals (Khan et al., 2014). When a construction project is not delivered within the allotted time, budget, specification, and satisfaction of stakeholders, it is deemed unsuccessful. Hence, to lessen the impact on civil engineering projects, it is necessary to identify delays at an early stage (Samsudin et al., 2020). Consequently, delays can be addressed, and issues arising from the delay can be alleviated.

Several studies have highlighted that competent project teams and managers are the primary reasons for schedule delays, which further emphasises the vital importance of competent management in ensuring project success. Competent project teams can manage owner interference, postponed decisions, financial issues, inefficient planning, subcontractor delays, labour productivity issues, and inadequate contractor performance. However, due to the complex nature of schedule delays, emphasis on certain project management skills can effectively tackle these challenges, but these have yet to be uncovered in detail for civil engineering projects (Perrenoud & Sullivan, 2016).

Despite using high-tech systems and implementing innovative working methods in civil engineering projects, they are still plagued with problems (Durdyev & Hosseini, 2020). In this case, inefficient planning is the primary root cause of delays. Here, unrealistic project schedules may lead to inadequate planning, causing difficulty in reaching deadlines. However, knowledge of their effect on civil engineering projects is still limited.

Neglecting schedule delays may result in obstacles, including project completion interruptions, cost overruns, and substandard work. Here, greater planning and effective project management can reduce or eliminate these delays (Khalid, 2017). However, reducing schedule delays can be too generic for broad construction projects. In this case, emphasising civil engineering projects can help the project team to improve their decision in project scheduling. The objectives of this paper are 1) to identify the factors that contribute to schedule delays; 2) to determine the effect of the schedule delay factors on the performance; and 3) to find ways to reduce schedule delay, which can improve project performance in civil engineering projects.

LITERATURE REVIEW

Construction delays are widely recognised as a pervasive issue on a worldwide scale, with potential implications for the timely completion, budgetary considerations, and overall quality of building projects. The problem that often emerges in both private and public building projects, and is characterised by its prevalence, significant financial implications, and potential hazards, is the most prevalent concern (Romzi and Ing, 2022).

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Types of Delay in Construction Projects

Construction delays may be categorised into excusable, non-excusable, compensable, non-compensable, or concurrent (Masood et al., 2015; Ghenbasha et al., 2016). Excusable delays are those allowed by the construction contracts, which give the contractor an extension of time for the delay. Non-excusable delays result from contractors, subcontractors, or material suppliers' carelessness and the contractor is not eligible for additional compensation in the form of time or money (Masood et al., 2015). Next, compensable delays are situations made by clients like design changes or late drawing submissions (Elawi et al., 2016). The contractor is entitled to additional compensation, which may consist of both monetary reimbursement and a time extension. Non-compensable delays are beyond the contractor's control and not due to negligence (Pinamang et al., 2018). This occasion may request extensions of time but is not eligible for any monetary compensation. Concurrent delays arise when several delays occur concurrently or partly overlap (Danish & Ahmad, 2019).

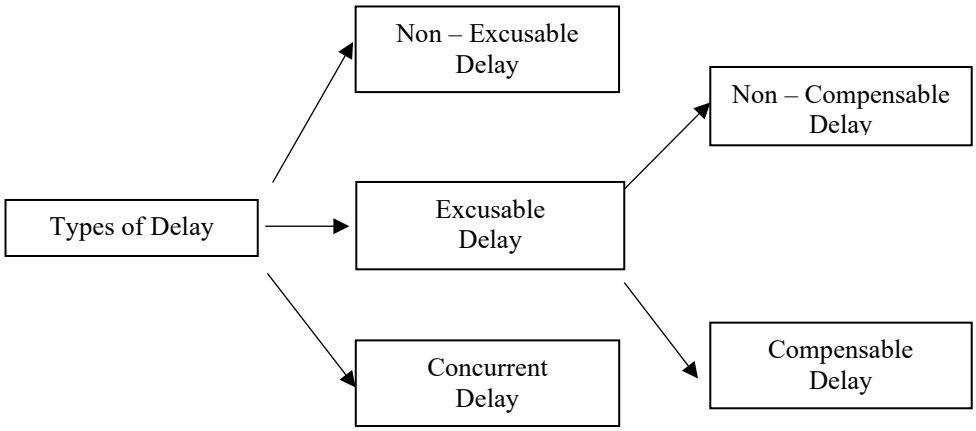

Fig. 1. Diagrammatical Representation of Main Delay Types in Construction

Source: Ghenbasha et al. (2016)

Factors Contribute to Schedule Delay in Construction Projects

Factors that contribute to schedule delays in construction projects for civil engineering works come from different factors that can be classified into seven (7) major groups which are contractor, client and consultant, labour and equipment, material, design, contract, and external factors.

Client and consultant

Client and consultant-related delays in Nigeria's construction projects are lack of experience of clients in construction, change orders, client interference, lack of capable representatives, lack of communication and coordination and improper project feasibility study (Obodoh & Obodoh, 2016). Taher & Pandey (2013) reveals that changes in client requirements are the main causes of delays in both the planning and design phases. This finding is similar to Yap et al. (2021) study on revisiting critical delay factors for construction projects in Malaysia by acquiring the views of construction practitioners and the results indicate that too many change orders by clients are top factors contributing to delay in construction projects.

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Contractor

Mahamid's (2017) studies on factors affecting schedule delay in road construction projects in Saudi Arabia, found that lack of contractor experience contributes to the top five (5) severe factors affecting schedule delay in road construction projects. Besides, Alsuliman (2019) argued that awarding contractors' projects beyond their financial and technical potential and selecting contractors are some of the factors in construction delay. Moreover, contractors often fail to come out with a well-planned work program at the initial planning stage due to a lack of systematic site management and a lack of experience. According to Masood et al. (2015), sometimes the contractor does not follow the specifications in an attempt to save money, so work has to be redone to rectify it accordingly which causes delays in projects.

External Factors

External factors of delay include inclement acts of nature, law and order, war and inflation. Mydin et al. (2014) in their study about causes of delays from the developers' point of view found that weather conditions on the site were the main contributor to the delay factors. Masood et al. (2015) prove that external factors like poor weather conditions also delay the project, especially in the monsoon season. The unpredictability of weather poses challenges to project planning and execution. Construction schedule delays can also be substantially affected by political factors such as changes in regulations, government policies, or political instability that can impact project timelines. Ntshangase & Tuan (2019) highlight delays in progress payments by the owner as a major source of delay in South African electricity distribution projects.

Materials, Labour, and Equipment

According to Mahamid (2017), poor labour productivity affects the activity duration and consequently the total project duration. Poor productivity increases the actual time of a specific activity hence the project will be delayed. In terms of equipment, delays in the acquisition of materials and equipment were identified as organisational deficiencies, supplier non-compliance, government requirements, and transportation disruptions. Furthermore, technical issues and lack of construction materials, equipment, and manpower are common factors of delay in Nepal (Bhattarai, 2023).

Based on the contractors' viewpoint in Sri Lanka, delays in delivering materials to the site were seen as important contributing to project delays (Abeysinghe & Jayathilaka, 2022). Masood et al. (2015) found that factors that contribute to schedule delays include material, equipment and tool shortage on site, equipment breakdown, delay in procurement of equipment, low productivity from the equipment, unskilled staff and less use of mechanical machines. Moreover, Mahamid (2017) points out that escalation in material prices is a key contributor to delays and cost overruns in construction projects. Fluctuations in material prices can lead to disputes among project stakeholders, prolonging project timelines (Melaku Belay et al., 2021). Contractors may face challenges in managing project schedules efficiently when material prices are volatile, as they may need to wait for better prices or adjust their procurement strategies, causing delays in execution.

Design

Modifications to the design are normally required by the owner or other relevant parties and can result in project delays (Patasik et al., 2022). As a result, the modifications may change the construction drawings and require additional materials, and revisions to the building timeline. Research by Musa et al. (2016) indicates that the time allocated for the creation of a comprehensive collection of design documents is limited. The primary focus should not be on the duration of time, but rather on the level of excellence in the design.

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Contract

A study by Alshihri et al. (2022) on factors leading to time and cost overruns of building projects in Saudi Arabia indicates contributing to project delays include contractor financial difficulties, delays in progress payments by owners, contracts awarded to the lowest bidder, change orders during construction, ineffective project planning and scheduling, shortage of manpower, and poor site management by contractors. Arof et al. (2018) show that delay is related to change orders and discrepancies in contract documents were important. Saeed (2018) surveyed cost and time risk management in construction projects and found that inadequate contract management is a significant factor contributing to project delays, cost overruns, and subsequent conflicts. According to Yusof et al. (2007), delay due to breach of contract is the lowest, with 90% of them considering it to be non-significant. This phenomenon probably may be attributed to the rare occurrence of clients breaching contracts within the Malaysian construction sector.

Effects of Schedule Delay Factors on Civil Engineering Project Performance

Delays cause an extension of the project's duration beyond the originally scheduled timescale, resulting in a time overrun (Obodoh & Obodoh, 2016). Owolabi James et al. (2014) claimed that it has the potential to influence the whole project timeline and impede the project's progress. Hisham and Yahya (2016) found that contractor-related, material-related, labour equipment-related, and external-related factors have an impact on time overrun. Furthermore, land acquisition, contractors' lack of expertise, re-designing, and line services (haphazard underground utilities) could also contribute to time overruns (Elawi et al., 2016).

Danish & Ahmad (2019) indicate that factors that are related to cost overrun are the contract that has occurred when the time of a project is extended, resulting in increased expenditures. Alenazi et al. (2022) emphasised client-related delays in Saudi construction projects, showing that clients' sluggish decision-making might have a big influence on project timelines. Here, the delays may result in poor time and cost management, which may generate time overruns and cost escalation. This highlights the correlation between client delays in decision-making processes and increased project duration and expenses. According to the study conducted by Ali et al. (2010), it was determined that delays in projects might result in higher expenses due to the rise in labour prices and the need to lease more equipment and supplies.

The occurrence of delays has the potential to significantly impede the workflow and productivity of the construction workers. Princy and Shanmugapriya (2017) found that the combination of working overtime and a lack of overall completion time is a contributing reason to the reduction in productivity, particularly in India where labourers often work more than 8 hours each day. According to Webb et al. (2015), the occurrence of delays may result in several adverse consequences such as the need for workers to speed up their tasks, thus raising levels of stress, and increased weariness. These factors, in turn, can elevate the incidents of accidents and injuries.

Schedule delays have a significant impact on rework, resulting in rising expenses and adverse environmental outcomes (Forcada et al., 2017). Rework, a common consequence of delays, often entails wastage of resources, materials, and energy, exacerbating environmental degradation. Ma et al. (2019) in their study stated the occurrence of rework in construction projects has the potential to generate supplementary material waste, increase energy consumption, and contribute to pollution, hence posing a harmful impact on the environment. In addition, Abdelghani et al. (2019) noted that poor communication and insufficient information flow, which are often made worse by delays, may lead to poor performance in construction projects in terms of cost, schedule, and quality expectations.

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RESEARCH METHOD

The data for this research were collected from targeted G7 contractors that work in civil engineering works in Selangor. The questionnaire survey investigates the factors, effects and ways to reduce schedule delay in civil engineering projects that can help to improve project performance. The questionnaire comprises multiple-choice responses to obtain the respondents' opinions. The Likert Scale provides participants with the opportunity to indicate their degree of agreement or disagreement on a specific statement.

The questionnaire uses a 5-point Likert scale from “Strongly Disagree”, “Disagree”, “Neutral”, “Agree” and “Strongly Agree”. A total of 144 valid questionnaires were returned. A higher number of returned questionnaires, may provide reliability and reflect the perspective of construction personnel targeted in civil engineering construction firms.

Most construction personnel who participated in this study had at least five (5) years of experience. Amongst them were project managers, senior executives, executives and supervisors. The data were then tabulated and analysed using IBM SPSS (Version 29). The analysis of the data includes descriptive statistics, Cronbach’s Alpha and Kruskal-Wallis.

Cronbach’s Alpha

Cronbach's Alpha is a metric used to evaluate a level of correlation among items in a scale, which indicates the overall reliability of the instrument (Bonett & Wright, 2014). This guarantees that all questions on the scale consistently assess the same underlying concepts (Taber, 2018). For instance, it is used to assess the reliability of surveys that utilise a multiple-question Likert scale. Cronbach's Alpha values vary from 0 to 1, with higher values suggesting more dependability. If the coefficient is less than 0.6, it suggests removing certain factors to enhance the general dependability of the material (Moss et al., 2002).

Kruskal-Wallis (KW)

The Kruskal-Wallis (KW) test is a non-parametric statistical method used to compare the median values of two or more independent samples if there are statistically significant variations. It serves as an alternative to the one-way analysis of variance (ANOVA) involving more than two (2) independent samples (Meléndez Surmay et al., 2024). It is a reliable tool for identifying variations in medians across groups, even when the data does not match parametric assumptions (Dini & Hanggana, 2020).

RESULTS AND DISCUSSION

The following are the results and discussion:

Factors of Schedule Delay in Civil Engineering Projects

The Cronbach’s alpha was conducted to identify factors contributing to schedule delay exhibiting a high-reliability value ($\alpha = 0.87$). Then, the effects of schedule delay factors on the performance of civil engineering projects have an acceptable reliability threshold of ($\alpha = 0.70$). Finally, ways to reduce schedule delays in civil engineering indicate the highest reliability value ($\alpha = 0.93$), indicating strong internal consistency. Overall, it suggests that the questionnaire prepared is robust for exploring the aim of the study.

Table 1 examines the contractors’ opinions regarding the factors that contribute to schedule delays in civil engineering projects. It shows that the top factor is the weakness in the operational system (4.21).

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Weak operational systems cause schedule delays by creating workflow inefficiencies, resulting in bottlenecks and slowdowns. Followed by the contractor's lack of capability in terms of financials (4.09) as the second-ranked factor. According to Vu et al. (2018) in their study found that financial risks influence the schedule delay in civil engineering projects. The lack of experience of the contractor (4.07) and design changes during construction (4.06) come in the third and fourth ranking, Poor labour productivity ranked fifth despite sharing the same mean value with factors like design changes. The smaller standard deviation is considered more reliable and consistent, as it shows less fluctuation in values. The sixth-ranked factor is the shortage of materials, which causes contractors to struggle to adhere to timetables and disrupt task progress. The seventh-ranked factor is the delay in equipment mobilisation, followed by the client's failure to make timely payments, slow decision-making, and the contractor's lack of technical capability.

Table 1. Descriptive statistics on factors that contribute to schedule delays in civil engineering projects

Statement	Mean	Std. Dev.	Mean Rank	KW's Chi-Square
Lack experience of contractor	4.07	0.95	3	2.220
Weakness in operational system	4.21	0.77	1	2.015
Contractor's lack of capability in terms of financial	4.09	0.94	2	12.714*
Contractor's lack of capability in terms of technical	3.87	0.80	10	7.589*
Lack of communication between client and consultant	3.76	1.00	12	0.893
Design changes during construction	4.06	0.82	4	1.101
Slow decision-making by clients	3.93	0.99	9	2.984
Client's failure to make timely payment	3.94	0.96	8	1.534
Poor labour productivity	4.06	0.85	5	0.566
Delay in mobilisation of equipment	3.96	0.88	7	0.883
Shortage of material	3.98	0.96	6	3.513
Price fluctuation of material	3.80	0.90	11	1.350
Mistakes and discrepancies in contract document	3.66	1.04	13	0.365
Contracts awarded to the lowest bidder	3.56	1.17	15	1.552
Weather conditions	3.56	1.03	14	0.570
Political instability or changes in policy	3.46	1.00	16	0.704
Natural disaster	3.41	1.18	17	1.129

***** *$p<0.05$ (level of significance)*

Source: Authors (2024)

Kruskas-Wallis results show significant differences in views, with a significance value of $p<0.05$. The respondents who gained 80% of revenues from government projects tended to strongly agree that the contractor's lack of finances contributes to schedule delays, while those involved within 30–80% indicated significant disagreement. Probably, they are likely to have a mix of project types that include private projects or have better management. This makes them less likely to see financial problems as a major cause of delays. Contractors who gain revenues within 30–80% of government projects disagree that technical capability is important. On the other hand, people who were involved less than 30% and more than 80% showed they believed technical issues were significant causes for delays. These variations may be caused by a variety of expectations and standards in public and private projects.

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Effects of Schedule Delay Factors on Civil Engineering Project Performance

Table 2 shows the effects of schedule delays on the performance of civil engineering projects. The analysis highlights that time overrun is the most frequent effect ranked by the contractors (4.34). Delays in activities disrupt the project's planned sequence, leading to subsequent tasks starting later than scheduled, which progressively delays project deadlines and milestones. The second-ranked effect is the cost overrun (4.29). Ali et al. (2010) found the costs went up because of higher labour costs and the need to lease additional supplies and equipment than planned. Environmental issues rank third (3.83), reflecting concerns about the impact of delays on environmental compliance and sustainability. Poor quality of work is ranked fourth, (3.69) indicating a perceived compromise in work quality due to delays. Finally, health and safety ranked the lowest (3.43), highlighting the least agreement among respondents regarding this aspect.

Table 2. Descriptive statistics on the effects of schedule delay factors on civil engineering project performance

Statement	Mean	Std. Dev.	Mean Rank	KW's Chi-Square
Time overrun	4.34	0.79	1	5.575
Cost overrun	4.29	0.83	2	11.942*
Ruin health and safety	3.43	0.91	5	0.420
Poor quality of work	3.69	1.00	4	1.619
Environmental issue	3.83	4.82	3	2.217

***** *$p<0.05$ (level of significance)*

Source: Authors (2024)

The Kruskal-Wallis test revealed that varying degrees of seniority had very different opinions with a significance value of $p<0.05$ on how cost overruns affect schedule delays. Junior-level respondents, those aged 21 to 35, believed that cost overruns were directly caused by schedule delays while Senior-level respondents (46 years of age or older) did not. In this case, junior-level respondents may frequently engage in hands-on work and be impacted by cost overruns on project schedules. They encounter budget and planning issues in every aspect of their work, they see cost overruns as evidence. On the other hand, senior-level professionals often have managerial or monitoring roles like strategy planning, managing stakeholders, and finishing the project as a whole rather than on temporary cost impacts. They may prioritise risk mitigation and project sustainability above short-term cost implications on schedules.

The Ways to Reduce Schedule Delay Factors in Civil Engineering Projects

Table 3 emphasises the most effective ways to reduce schedule delay factors in civil engineering projects. Making proper plans before the commencement of the project was ranked first (4.46), highlighting the significance of this activity. According to Okereke et al. (2022), proper planning before the commencement of a construction project is crucial in reducing schedule delay as it is an integral part of project management and essential for the success of the project. Monitoring the progress of the work and paying progress payments on time, came in second (4.45) and third (4.44). Jacob-Loyola et al. (2021) and Petimani et al. (2019) emphasised the critical role of closely monitoring work progress to mitigate construction delays. They highlight the importance of real-time observations of cost, time, materials, and

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physical progress. Paying progress payments can be a way to alleviate construction project delays (Islam & Trigunarsyah, 2017). These top three (3) strategies are very close to each other. Additionally, ensuring the timely delivery of materials and equipment is ranked fourth (4.37). Other notable strategies based on the ranking also include awarding contracts to capable contractors and consultants, clear communication between the parties and ensuring an adequate and available source of finance until project completion. The systematic application of risk management, although ranked last with a mean value (4.22), remains a significant factor.

Table 3. Descriptive statistics on ways to reduce schedule delay factors in civil engineering projects

Statement	Mean	Std. Dev.	Mean Rank	KW's Chi-Square
Proper planning before the commencement of the project	4.46	0.73	1	1.649
Clear communication between the parties	4.27	0.82	7	4.740
Awarding contracts to the capable consultant	4.27	0.77	6	6.930*
Awarding contracts to the capable contractor	4.35	0.74	5	3.052
Pay progress payment on time	4.44	0.70	3	3.900
Ensure adequate and available source of finance until project completion	4.22	0.84	8	2.901
Application of systematic risk management	4.11	0.79	9	6.415*
Ensure timely delivery of materials and equipment	4.37	0.79	4	4.679
Close monitoring of the progress of work	4.45	0.74	2	1.963

* *$p<0.05$ (level of significance)*

Source: Authors (2024)

The Kruskal-Wallis test shows that respondents had distinct opinions, with a significance value of $p<0.05$ about how effectively awarding contracts to capable consultants helps mitigate schedule delays. The junior-level respondents, who were between the ages of 21 and 35, strongly believe that awarding contracts to capable consultants can successfully reduce schedule delays. This group probably values competency as an important way to make sure that projects run smoothly and quickly. Respondents in the middle-level group (aged 36 to 45) and the senior-level category (aged 46 years and above), on the other hand, see things differently, Junior respondents may find it useful to hire skilled experts who can help with complicated projects. Senior professionals with a lot of experience might place more emphasis on established relationships or internal knowledge within their own companies because they believe these are sufficient to handle and reduce project delays internally.

According to junior-level respondents, using a systematic approach to risk management may significantly reduce project delays in civil engineering projects. They might witnessed how forecasting probable obstacles may help projects function successfully. Meanwhile, senior-level professionals, who have more experience, are less persuaded. Therefore, while juniors can see the benefits in some cases, seniors might think that it is not always easy to manage risks in real-world situations. They have developed their point of view through several years of experience which frequently involve unforeseen difficulties and uncertainty.

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CONCLUSION AND RECOMMENDATIONS

The results show that the top contributing factors to schedule delays in civil engineering projects are weakness in the operational system, contractor's lack of capability in terms of finances, lack of experience of the contractor, design changes during construction, poor labour productivity, shortage of materials, delay in mobilisation of equipment, client's failure to make timely payments, slow decision-making by the client and contractor's lack of capability in terms of technical.

The effect of schedule delay factors on the performance of civil engineering projects found that the most significant effects of schedule delay factors are time overruns, cost overruns and environmental issues if schedule delay factors are not overcome at the early stage. Based on the analysis, to reduce schedule delay factors contractors should have proper planning before the commencement of the project, close monitoring of the progress of work, pay progress payments on time, ensure timely delivery of materials and equipment and awarding contracts to the capable contractors,

Based on this study, determining the underlying reasons for delays, projects may be finished promptly and within the budget that was allocated. These research findings benefit both academics and practitioners in the factors that contribute to schedule delays, particularly for civil engineering projects. The recommendation for future research is to investigate the use of risk management systems as a strategy for reducing schedule delays in civil engineering projects since risk management has the potential to manage risks involved in schedule delays. By comprehending these factors, it will be possible to develop more effective risk management strategies that can be implemented by contractors, resulting in fewer project delays and less costly project outcomes.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Nurul Mahirah Sharuddin carried out the research and wrote the article. Mohd Azrai Azman conceptualised the research framework and supervised the research progress. Zulkiflee Abdul Samad and Rodziana Mohd Rodzi anchored the review, prepared revisions and approved the article submission.

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