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Assessment of Cost Influences in Rail Projects from Contractor's Perspectives

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ABSTRACT

Rail transportation had been receiving more attention in the Government's effort to enhance the Malaysian economy internationally. Nevertheless, rail projects involve various stakeholders, massive budgets and are susceptible to cost overrun. This paper aims to evaluate the cost influences concerned with rail projects in a developing nation from contractors' perspectives. The existing studies lack the consideration of the correlation and relationship between the cost influences, which this paper emphasizes. The data collection was performed by distributing questionnaires to 200 cost managers which are quantity surveyors, project managers, and contract executives across the rail projects in Malaysia. The data analysis uses Statistical Package for Social Sciences Version 27 (SPSS V27) and Structural Equation Modelling (SEM). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy showed appropriate internal consistency of the research instrument, whereas the Confirmatory Factor Analysis (CFA) showed acceptable Goodness-of-Fit Indices (GFI) within the constructs of the structural model. The SEM calibration resulted in 23 significant cost influences which were clustered into five groups of cost influences. Each of the five groups is associated with different parties in construction projects. A notable causative direction was observed in the relationship between the cost influences. Each cost influence can be connected to each project phase based on the PMBOK Guide. This study adds to the various cost management research along the project management of rail construction. It is able to contribute to the policymakers and consultants in strategizing their cost management plans which is crucial, especially in developing countries such as Malaysia. Emphasizing the critical particulars of cost management in rail projects, this paper also delivers its finding based on stakeholder and system aspects in relation to cost management, which can be referred to by any developing country.

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1. Introduction

Rail system is the earliest transport network in Malaysia. It has a massive influence on economic performance, especially as a significant public transportation mode for inter-state and inter-city travel (Fariq & Ab Rani, 2020). The Malaysian railways have significant potential to play an important role in developing a sustainable transportation system.

Rail transport has received the most attention in the national plan as an alternative to road transport which has accounted for almost 90% of public transportation in Malaysia (Jaafar, 2018). Consequently, many rail projects were launched in Malaysia such as the Mass Rapid Transit (MRT), Light Rail Transit (LRT), Electrified Double Tracking Projects (EDTP), Express Rail Link (ERL), Rapid Transit System (RTS), and the East Coast Rail Line (ECRL) (Ministry of Economic Affairs, 2018). Other than that, there are many projects under development in the urban area such as the latest LRT3, MRT2, and KVDT2 as well as the Johor Bahru – Singapore RTS (Chen et al., 2018).

In the rapid development in the rail industry, there is a need to realize the significant challenge of delivering rail projects successfully (Sadullah et al., 2018). Rail projects are known for their high uncertainties, complexity, and cost, which involve a massive amount of taxpayers' money (Olawale & Sun, 2015). Cost overrun had been identified to be a severe issue in construction projects worldwide (Ullah et al., 2017). In the Asian region, Park & Papadopoulou (2012) found an average of 13.46% cost overrun specifically in rail projects while in China, 30.6% of rail projects suffered a cost overrun. The metro rail of India suffered an average of 31% cost overrun. Andrić et al. (2019) established a 48% average cost overrun in Asian rail projects while stating that rail projects are most inclined to face cost overruns.

There had been no study focusing specifically on the cost performance of Malaysian rail projects. Nevertheless, Malaysian construction projects have suffered cost overrun for years (Olawale & Sun, 2010). Shehu et al. (2014) identified cost overrun in more than 50% of Malaysian projects while Rahman & Abdullah (2016) found that 89% of projects faced cost overruns in the southern Peninsular. Cost overrun denotes the phenomenon when the project's actual cost exceeds the estimated cost (Invernizzi et al., 2017), especially in mega projects due to the significant costs incurred. Prominent researchers such as Flyvbjerg established the root causes of cost overrun and stated that the root causes need to be addressed at an early stage to avoid a huge loss (Flyvbjerg et al., 2018).

Cost overrun had been reported to occur in a few rail projects in Malaysia. The EDTP Ipoh-Padang Besar was reported to incur RM1.5 billion in Variation Order claims, MRT had a 15% cost overrun (Tee Lin, 2012), EDTP Ipoh-Rawang had RM1.14 billion cost overrun (Lee Yuk, 2009) and the ERL extension had RM29 million cost overrun (AG Report, 2015). The indications of cost overrun had been advertised to the public however they were not discussed in detailed research.

A few studies have gone at length to establish the main factors of cost overrun in rail projects. However, a major gap is identified whereby most of the studies lack the identification of correlation among the various factors involved in the cost management of rail projects. Such factor correlations can help identify the structure that lies beneath these cost influences which would be beneficial in decision-making by project managers in rail projects. Furthermore, many studies on cost influences for rail projects overlook the importance of the contractor's perspective in evaluating the cost influences. The contractor's perspectives should be taken seriously as they are directly employing and engaging construction workers or managing the construction work. In mega-projects such as rail projects, contractors hold the most crucial influence on project cost performance. Thus, an empirical study on the quantitative assessment of the correlation among various cost influences in rail projects through contractors' perspectives is needed.

Reflecting on the high impact of the cost influences, such assessment is even more critical for mega-projects in developing countries during each phase of the project. The existing literature lacks exploration of the contractor's viewpoints and the underlying correlations in their understanding of cost influences in rail project planning and construction. Existing researches have not identified the critical cost influences relative to the contractor's viewpoint. This research attended to this need by performing a systematic correlation study of rail projects and contractors' perspectives, using Structural Equation Modelling. The aim is to assess the cost influences associated with rail projects in Malaysia and identify the correlational structure that exists among the cost influences.

2. Literature Review

Cost overruns in rail projects persist mainly due to the cost it incurs (Narayanan et al., 2019). Researchers have revealed that cost overruns in multiple rail developments such as the Edinburgh tram system, which was completed 100% over the budget (Love et al., 2017). In the United States (US), cost overrun had been found in the Central Link Light-Rail project in Seattle (38%), the East Valley light-rail project in Phoenix (31%), the Airport Heavy-Rail project in San Francisco (30%), and heavy-rail red line project (47%) in Los Angeles. Meanwhile, Cantarelli et al. (2012) found cost overrun averaging in 10.6% in the rail projects of the Netherlands.

This should become a major concern not just in developed countries but also in developing countries, as rail projects consume a massive capital (Ismail et al., 2021). To illustrate the detrimental impact of cost overrun, a 1% cost overrun in a US$10 billion project shall amount to US$100 million loss in budget and profit.

A significant study by Love et al. (2017) has explored the probability of cost overrun between 1% to 30%, however it needs to attend to the non-linear perspective which can reveal the causal influences among the factors influencing rail project cost performance. Other researchers by Flyvbjerg et al. (2004), Hwang et al. (2020), and Ismail et al. (2021) have also studied cost overrun causation in rail projects but without considering the dynamic causative interaction.

The analysis of this study aims to fill in this gap in research. Drawing on this knowledge background, this study analyses the cost influences associated with rail projects through a Structural Equation Modelling approach. Assessing various factors that can impact project performance can belong to the risk management area of study. In various studies, risk assessment of transportation megaprojects uses the Relative Importance Index (RII) that uses a numerical calculation to place values on each risk factor, however this method cannot quantify the correlation between the factors (Yan et al., 2019).

Structural Equation Modelling is employed in this study to remove this problem, as it incorporates various factors into a structured model of causations. Cui et al. (2022) developed a structural model for the impact of social responsibility programs on the efficacy of urban rail projects. Mesbah et al. (2022) used SEM to explore the quality of rail services to passengers and trip characteristics. Liu et al. (2018) used SEM to assess multiple factors to identify if urban rail transit in China discourages people from using cars. Niu et al. (2022) uses SEM to assess the relationships of coopetition between international joint ventures for High-Speed Rail projects. Shaaban & Hassan (2014) produced a structural model of factors that affect the propensity of commuters to use the new rail service in Doha. However, these studies are not focused on project cost performance.

Competent project cost management is important to avoid detrimental cost overrun. Unfortunately, the evidence gathered has led to cost overruns being a regular occurrence in rail projects (Love et al., 2016). This paper discusses the non-linear causal relationship among the cost influences in rail projects. Based on the data collected, the analysis is aspired to generate information that can be useful in understanding the dynamic causal relationship among multiple cost influences in rail projects.

The current literature on rail project cost management also needs a fresh viewpoint from contractors towards the cost influences. Contractors are the major stakeholders in mega projects such as the rail project as they are not only involved in project management but also the design and cost management as stipulated in the contract agreement. The aim of this study is to elaborate on the gap in current researches by providing a comprehensive analysis of cost influences on rail projects in developing countries from the perspectives of contractors. This paper also aim to add to the body of knowledge with a detailed structural model of the causative cost influences of rail projects in Malaysia. In this structural model, the cost influences are structured according to different project phases as well as different project parties (the client, main contractor, consultants, and sub-contractors).

3. Methodology

Stratified random probability was used as the sampling approach for data collection. The instrument for data collection consists of respondents' demographic profiles and measures of constructs. The responses for demography were collected in nominal and ordinal values while the constructs were measured by a five-point Likert scale. A pilot survey was conducted before the instrument was administered using a small group of experienced cost managers and academicians. The selection of pilot respondents was by convenience to validate the survey instrument. The feedbacks were used to enhance the instrument quality in regards to the question style, language, ambiguity, and related statements. After that, 200 questionnaires were given out to cost managers (quantity surveyors, project managers, and contract executives) in rail projects across Malaysia. The respondents were selected from the main contractors in the rail industry. In total, 51.50 percent of the questionnaires were filled and given back. The results were then coded and inserted into the Statistical Package for Social Sciences Version 27 (SPSS V27). The analysis starts by performing the normality test referring to the skewness and kurtosis to verify the normality of the data. The reliability of the instrument was also examined to confirm the understanding of the respondents as they respond to the questionnaire (Vaske et al., 2017). Cronbach's α coefficient was used to test the reliability of the data collected.

Then using the SPSS V27, Exploratory Factor Analysis (EFA) was performed to discover the underlying structure within the variables. Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity were utilized to validate the sampling adequacy and multivariate normality within the variables. After that, Confirmatory Factor Analysis (CFA) was conducted by the AMOS software to establish the measurement models and validated by the acceptable goodness-of-fit (GFI) indices among the variables. Results from the CFA shall then be the basis of the Structural Equation Modelling (SEM).

4. Results and Discussion

4.1 Demographic of Respondents

The research uses questionnaire as a method for data collection. The data collection resulted in 103 respondents from multiple range of experience and professional qualifications as shown in Figure 1 and Figure 2.

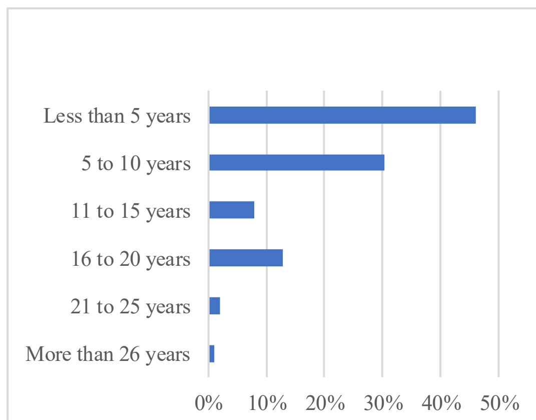

Figure 1 Respondents' working experience

The data from Figure 1 shows that all the respondents have had the necessary experience and knowledge in the construction industry to provide a quality response to the research instrument. From the 103 responses received, 54 percent had at least five years of experience, while the other 46 percent had less than five years of experience in the construction industry.

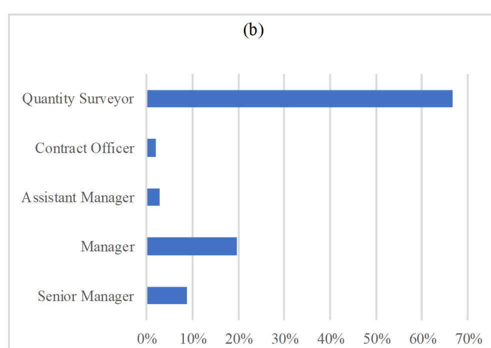

Figure 2 Respondents' positions

The data in Figure 1(b) indicates the respondent's career position in the rail industry. Due to the cost-focused nature of this study, it is apparent that 69 percent of the respondents are quantity surveyors and contract officers. The other 31 percent are managers and assistant managers. The data shows that the respondents are selected from the domain area of study in this research which is cost management in rail projects. This provides credibility to the data that is to be analysed in the later phase of the research.

4.2 Identification of Cost Influences

Studies on cost management have explored the factors influencing cost performance of projects. Unfortunately, there has been no study that assesses the relationship between cost influences and the project cost specifically in rail projects. Therefore, in this research, the cost influences in rail projects are assessed by the respective professional construction cost managers. The cost influences are listed in Table 1.

Table 1 Identified cost influences from literature

Studies identified cost influences	References
• Extensiveness of feasibility study	• Famiyeh et al. (2017); Mohammad et al. (2016)
• Accuracy in estimation of project duration	• Olawale & Sun (2010)
• Accuracy in estimation of risks	• Flyvbjerg (2014); Sarmento & Renneboog (2017)
• Adequacy of site investigation	• Hingham (2016); Shibani (2015)
• Changes in design & specifications	• Abbas & Painting (2017)
• Clarity of contract provisions	• Shane & Molenaar (2009)
• Sufficiency of project preparation	• Peters (2010); Sarmento & Renneboog (2017)
• Error/defect in works	• Park & Papadopoulou (2012)
• Clearness of project management process	• Venkateswaran & Murugasan (2017)
• Applicability of construction method	• Potty & Irdus (2011)
• Efficiency in management of works	• Potty & Irdus (2011); Ullah et al. (2017)
• Proficiency in monitoring of works	• Cárdenas et al. (2018)
• Effectiveness in work scheduling	• Al-hazim et al. (2017)
• Delay in project implementation	• Cantarelli et al. (2012)
• Financial condition of client	• Gunduz & Maki (2018); Cárdenas et al. (2018)
• Financial condition of contractor	• Vaardini et al. (2016); Abbas & Painting (2017)
• Proficiency in work schedule management	• Potty & Irdus (2011)
• Effectiveness of material planning	• Adam et al. (2017)
• Productivity of cost planning and monitoring	• Vaardini et al. (2016); Ullah et al. (2017)
• Competence of risk management	• Olawale & Sun (2010)
• Dependency on specialist works	• Potty & Irdus (2011)
• Experience of contractor organizations	• Lu et al. (2017)

Studies identified cost influences	References
• Experience of design consultants	• Lu et al. (2017)
• Experience of technical consultants	• Lu et al. (2017)
• Experience of personnel in supervisory duties	• Mohammad et al. (2016)
• Experience of executives in organization	• Mohammad et al. (2016)
• Efficacy of communication contractor and client	• Adam et al. (2017)
• Efficacy of communication between designer and contractor	• Alghonamy (2015)
• Availability of materials	• Famiyeh et al. (2017); Venkateswaran & Murugasan (2017)
• Size of project	• Park & Papadopoulou (2012); Catalao et al. (2019)
• Length of project implementation	• Cantarelli et al. (2012); Sarmento & Renneboog (2017)
• Complexity of design	• Shibani (2015); Zhang et al. (2017)
• Difficulty of construction procedures	• Mevada & Devkar (2017)
• Relocation of existing services	• Kim et al. (2017)
• Relocation of existing infrastructure	• Adam et al. (2017); Venkateswaran & Murugasan (2017)
• Inconsistent scope changes in construction	• Love et al. (2017); Ullah et al. (2017)

Referring to PMBOK Guide, these cost influences are associated with four (4) phases of construction projects which are initial, planning, execution, monitoring, and control (PMBOK Guide, 2021) and they were extracted from the literature review and preliminary survey . The influences were then enhanced by considering the judgments from multiple cost management professionals in the rail industry through the process of interview and pilot study. Initially, the cost influences were drafted into a preliminary questionnaire and went for a pilot study with twenty (20) professionals. The dataset were ensured to have normal distribution and reliability before the actual survey were performed for data collection.

Cost influences are essentially the elements or conditions related to rail projects for which money must be spent and this study intends to identify the correlation between them in influencing the project cost. As shown in Table 1, a number of academics looked into the cost influences of construction projects for different objectives, hence generating multiple outcomes. Other scholars are interested in figuring out the cost factors that have the most effects on certain construction project aims. However, the cost factors differ from one nation to another.

Therefore, by referring to the judgements of competent professionals in cost management in Malaysia, the factors that are crucial for effective cost performance in rail projects were distinguished. This study recognizes and prioritizes the cost influences for effective cost management in rail projects in Malaysia, and collects the data from literature and pilot survey to derive the cost influences.

4.3 Factor Analysis

The Kaiser-Meyer-Olkin (KMO) examines the adequacy of the sample as well as the multivariate normality of the influences in the dataset. It is calculated to substantiate the validity of the survey instrument. Meanwhile, Bartlett's test of sphericity checks if the correlation matrix is an identity matrix (Cho & Kim, 2015). The results show a KMO value of 0.81, which is over the required minimum of 0.6, and Bartlett's tests of sphericity are significant. Additionally, the extraction of the latent influences within the whole cost influences was built on the total variance explained which produced eigenvalues of 1 and above. Thus, the five components of the cost influences justify the total variance of 57.15 percent.

Oblique (Promax) rotation was selected where the correlations among variables and loadings among the latent variables are indicated. The variable loadings carried to the CFA represent the correlation coefficient to its latent variables. Meanwhile, the loading of each variable displays the variance that is explained by the variables correlated to it.

There is no cross-loadings found, however according to Tabachnick et al. (2019), cut-offs can be used from 0.32 (very poor), 0.45 (poor), 0.55 (acceptable), 0.63 (good), or 0.71 (very good). The EFA indicated five cost influences that have loadings below 0.55 which are B6 (0.30), G3 (0.36), G4 (0.42), H2 (0.36), and C5 (0.51), hence removed from further analysis. Modification indices were also referred to solve the discrepancies that exist in the model (Hermida, 2015). Four variables which are D5, E3, E4, and E11 have error terms among variables across different factors, which gives a negative effect on the model fit. Therefore, they are removed from the model. Standardized Residual Covariance (SRC) indicates discrepancies between the proposed and estimated models. SRCs with an absolute value of more than 2.58 is considered significant and reduces model fit (Hildreth, 2013). Four variables with significant SRCs, A1 (2.62), D8 (2.53), I4 (-2.56), and I2 (many SRC values above 1) were removed to increase the model fit.

Referring to the result of factor analysis, the cost influences of rail projects are categorized into five: Project Planning (PP), Project Complexity (PC), Project Management (PM), Technical Expertise (TE), and Project Estimating (PE).

4.4 *Reliability of Instrument*

According to Wasiu (2018), in order to ascertain the understanding of the respondents, instrument reliability should be employed to evaluate the study variables effectively. Hence the use of Cronbach's α to identify the internal consistency within the dataset. The Cronbach's α values of the cost influences are: PP =0.04; PC=0.92; PM=0.90; TE=0.88; and PE=0.85. As the values obtained are above the suggested minimum of 0.70, the results are deemed highly significant (Pallant, 2020).

The tenacity of establishing the causal influence of the cost influences and rail project cost performance is to develop a structural model of the cost influences that will aid the effort of stakeholders to improve the performance of rail projects in Malaysia. The measurement model in Figure 2 indicates the relationship strength between the constructs. It shows that PC has a strong correlation with PE (0.55), and PE has a strong correlation with PP (0.32). TE has a strong correlation with PP (0.33) while PP correlates with PM (0.52). These correlations form the basis of the modelling which is adapted to the stages of a construction project from the PMBOK Guide.

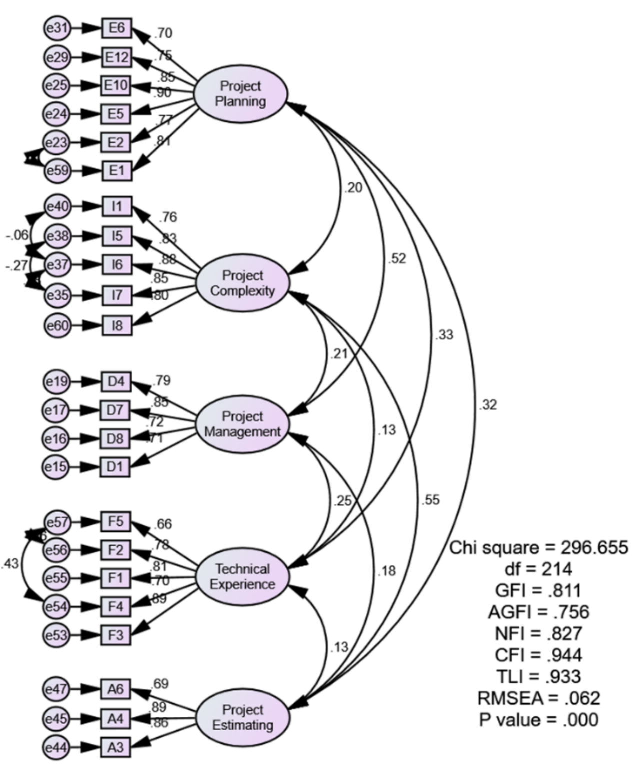

Figure 3 Measurement model

CFA is used to assess whether the constructs are consistent with the research understanding. The consistency of the data with the theoretical findings in construction cost management was constantly deliberated throughout the refinement process of the model. In evaluating the data fit indices, the base limits as specified by Hair et al. (2017), Kline (2016), and Massey & Miller (2016) were utilized. The p-value is stipulated as $p<0.05$, Comparative Fit Index (CFI) ⩾ 0.90, Goodness of Fit Index (GFI) ⩾ 0.90, Root Mean Square Error of Approximation (RMSEA) ⩽0.05–0.80 and CMIN ($\chi 2/\mathrm{df}$)<5.

As displayed in Figure 2, the p-value is at 0.00, the CFI is 0.944, and a GFI of 0.811, a $\chi 2/\mathrm{df}$ of 1.36, and an RMSEA of 0.062. The statistical result shows a sufficient fit within the outcome and under the acceptable range to establish the convergence validity of the measurement model. The GFI index also established the positively hypothesized covariance among the constructs.

Upon completing the measurement model, SEM was initiated to extract the causal relationships among the constructs which are the cost influences influencing cost performance of rail projects. The structural model presented in Figure 3 shows that the results have satisfied the acceptable bases on all of the statistical parameters for a good model fit. The model contains a p-value of 0.000, a CFI value of 0.946, a GFI of 0.810, a $\chi 2/\mathrm{df}$ value of 1.36, and an RMSEA of 0.06. The tested influence of each construct towards another construct in influencing the cost performance of rail projects has been validated by the results from data analysis. Therefore, the influence of the cost influences was validated by the measurement and structural models as shown in Figure 3 and Figure 4..

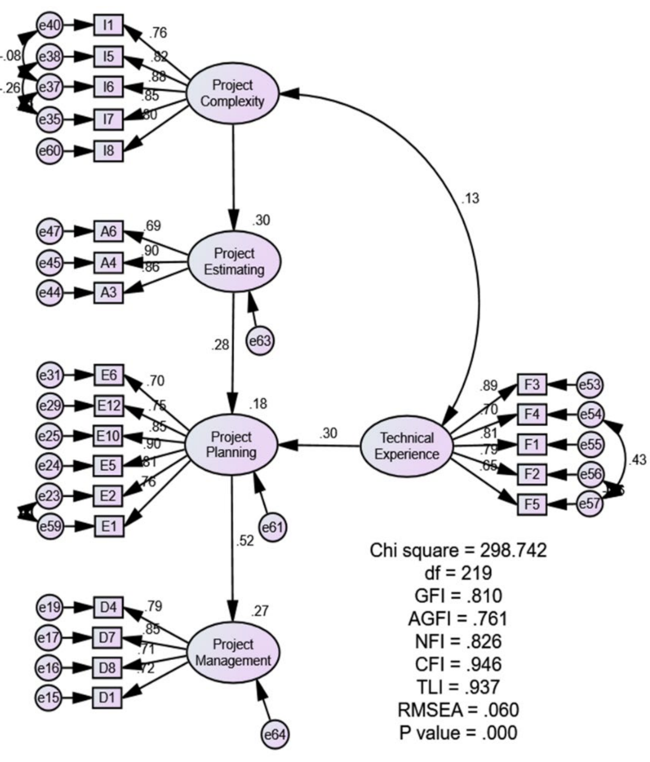

Figure 4 Structural model

The framework of cost influences influencing the cost performance of rail projects in Malaysia is presented in Figure 5. The framework was then validated by established cost managers in the Malaysian rail industry by responding to the questions below:

1. Is the framework easy to understand?
2. Does the sequence in the framework represents the actual rail projects?
3. Are the five elements in the framework compatible with the requirements of cost management in the rail industry?
4. Are the influences within the five elements well set up?
5. Does the framework show the process involved in carrying out cost management?
6. Does the framework highlight the future need to improve cost management in the rail industry?

The validation survey was joined by 20 participants out of the 50 invitations sent with a response rate of 40 per cent. The participants have a minimum of ten years of experience in the rail industry. In total, 30 percent (6) of the experts are contract managers, 30 percent (6) are project managers, 20 percent (4) are project directors, and 20 percent (4) are the head of departments. Hence, indicating that all of the experts had a considerable position as cost managers. In terms of experience, 55 percent (11) of the participants had 10–15 years of experience, 25 percent (5) had 16-20 years of experience, while 20 percent had more than 20 years experience. The experts were then requested to share their thoughts on the framework to establish an adequate acceptance of the framework

The results showed that only one participant mentioned that the framework need to be simpler. Other than that, respondent's average response showed a convincing acceptance of the framework in terms of overall quality, content, and sequences of the framework-encapsulated cost management practices in Malaysian rail projects. Altogether, 92.31 percent (12) of the respondents comprehended the framework and agreed with the setup. And so, the overall experts in the study have agreed that the framework is suited to be applied.

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The respondents also agreed that the overall structure of the framework can highlight the future need to prevent cost overruns in Malaysian rail projects. However, there are moderate scores in content association with project parties while the sequence of project phases is coherent with the characteristics of complex rail projects, especially in terms of contractual obligations. However, due to the unique procurement system, project parties might have work scopes beyond the scope that is usually agreed (Love et al., 2017).

Respondents also were asked to give suggestions to improve the presentation or practicality of the framework. Despite the optimistic responses, the respondents suggested to include contract specialist/construction law practitioner/claims consultant as part of the respondents and to include risk management, project procurement methodologies, funding sources, and contracting plans in the framework. Other than that, six respondents have suggested to add new cost influences that are significant in their experience. The suggested cost influences are "compliance with authorities' requirements", "transfer of technology in projects", "compare cost structure against the base cost before identifying any cost variance", "unexpected factors i.e. government change / policy change / covid-19 pandemic" and "political stability". The suggestions had been recorded but not added to the framework to retain the statistical validity of the existing variables.

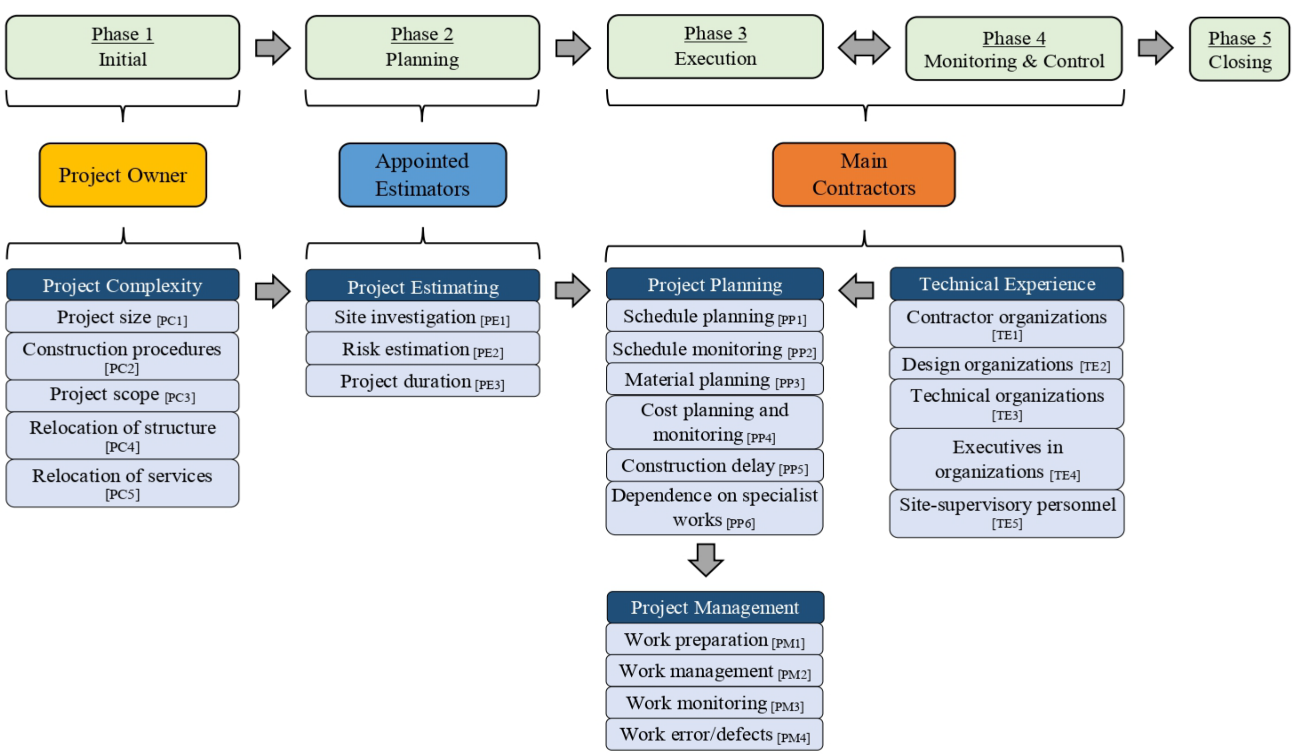

Figure 5 Framework of cost influences influencing the cost performance of rail projects in Malaysia

In summary, the proposed framework adequately unearthed the principle concerns regarding cost management in Malaysian rail projects. The feedback gathered from the verification interviews indicated that the proposed framework managed to capture positive reactions from the respondents, confirming the validity of the framework presented in this study. It asserts that a good congruity is managed to be documented between the framework developed and the respondent's perceptions in this study. Therefore, no substantial changes or improvements is needed to be introduced in its effect. For this reason, the proposed framework was taken as valid to be used as a basis to improve cost performance in Malaysian rail projects.

It is vital to observe that most of the researches on cost management in developed and developing nations did not focus specifically on rail projects. Therefore, this research assessed the key cost influences in rail projects. The study highlights the important aspects in cost management that need adequate attention by cost managers to ensure successful acheievement of rail projects.

5. Conclusion

This study seeks to identify the cost influences involved in rail projects specifically from contractors' perspectives in Malaysian conditions, using Structural Equation Modelling. The key conclusions of this research are as follows:

1. Upon ascertaining 78 cost influences of rail projects from literature, 37 are found to be significant factors influencing the cost performance of Malaysian rail projects based on the high frequency of occurrence and influence on the cost performance of rail projects.
2. Subsequently, the research established the relationships between the significant cost influences by following three different steps which are EFA, CFA, and finally SEM.
3. The EFA extracted five latent factors that grouped the 37 significant factors according to the factor loadings and correlations.
4. The CFA generated a measurement model with a good fit to validate the loadings and correlations between the factors and latent factors. Seven variables were eliminated due to the low loadings in correlation, four variables were eliminated due to the covariance between errors that cross different latent factors and three variables were eliminated due to their significant SRC.
5. Finally, SEM created a structural model that illustrated the causal relationships between the five latent factors influencing the cost performance of Malaysian rail projects.
6. The results focused on the relevant factors to implement effective management. This was to be construed according to the extracted latent factors and the causal influence between the factors influencing the cost of rail projects.

The findings can benefit the industry personnel to allocate their focus on managing the significant cost influences according to the groups with high correlations and loadings among each other. As the latent factors have been modeled with sequential causal influences, each latent factor represents different phases of the project delivery. Therefore, the information can be applied as early as the planning stage of rail projects while also making comprehensive contingency plans for the occurrence of unlikely events.

The findings from this study would help enhance the decision-making process at multiple phases of rail projects. As Malaysia is presently developing and planning to develop multiple rail projects for its connectivity enhancement. This research is critical for all the current and future rail projects in Malaysia as well as other developing countries.

6. Limitations and Recommendations

The primary limitation in this study is the absence of thorough validation of the cost influences. For an impactful finding, the cost influences that had been analyzed have to be evaluated on a case by case basis. Future research can be conducted by exploring data in rail projects from around or outside Malaysia. Researchers may perform a comparative analysis of the different cost influences based on developed and developing countries. To create a richer outcome, the data collection can be expanded to other associated parties such as designers, consultants, government bodies, and academicians.

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