

Discovering the Way Forward in Cost Management Research for Malaysia Rail Project: A Review

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ABSTRACT

Developing a robust rail network has always been a priority for countries, especially those in the process of development. The growth of the rail industry plays a crucial role in boosting a nation's economy and productivity. The purpose of this paper is to provide an in-depth review aimed at establishing a standardized framework for identifying and categorizing the factors affecting cost performance in rail projects. As the Malaysian government actively develops rail projects intending to transition public transport from road to rail, it is evident that the Malaysian railway industry lacks sufficient academic research on topics related to construction cost management, hence the performance of this study. To achieve this purpose, a Systematic Literature Review (SLR) was performed on multiple journal publications related to rail project management spanning from 2016 to 2023. Ultimately, 23 publications had been selected to be critically analyzed, focusing on research related to rail cost management. The analysis sheds light on current research trends, highlights gaps in existing knowledge, and suggests potential avenues for future research. A well-structured plan can enhance the expertise of cost managers by emphasizing essential requirements. Furthermore, the thorough examination of the literature delves into the fundamental concepts of this subject. Researchers can draw valuable insights from these assessments, guiding them towards areas where research is most needed and providing stakeholders and academics with discoveries for enhancing rail project cost management in the future.

Keywords: Construction Project Management, Cost Management, Cost Performance, Rail Infrastructure, Mixed-mode Analysis

INTRODUCTION

The growth of the rail industry has had a positive impact on the country's economy, primarily because people heavily rely on road transportation. According to data from the Ministry of Finance, there is a strong correlation between increased economic activity and both Gross Domestic Product (GDP) and Gross National Income (GNI) [1]. Consequently, starting in 1956 with the First Malaya Plan (1956-1960), Malaysia has continuously introduced initiatives to further develop its rail industry, including the Malaysia National Land Public Transport Master Plan (NLPTMP) in 2014 [2], the 10th Malaysia Plan (10MP) for 2011-2015, the Mid-term Review of the Eleventh Malaysia Plan for 2016-2020, the Malaysian Rail Supporting Industry Roadmap 2030, and the National Transport Policy 2019-2030. Additionally, the

Ministry of Higher Education (MOE) has established the Centre for Excellence in Rail Industry (ICoE-Rel) at Universiti Tun Hussein Onn Malaysia (UTHM), serving as a hub for research, in the rail industry.

A number of studies with an emphasis on the cost control of rail projects have also been carried out [3]. The Last Planner System [4] has been investigated to enhance the performance of rail projects in Malaysia, with the collected significant data to establish a new direction for cost management research in the rail industry [5]. In order to lessen ecological effects and build robust, inclusive, and sustainable railway infrastructure, stakeholders must play a significant role [6].

Despite the extensive research on rail project cost management, there is a significant gap when it comes to addressing the specific stakeholders in rail project development. The literature lacks information on the appointment of academicians and stakeholders in rail project cost management [7]. These studies emphasize the crucial role that key individuals play in rail project cost management processes and underscore that their involvement is essential to effectively manage rail project costs and ensure compliance with all parties involved. Based on the reviewed literature, the research discusses the following aspects:

1. The trend of railway research over the past ten years
2. The critical challenges in rail project cost management
3. The effectiveness of the current practice for developing the Malaysian rail project cost management framework
4. The research gaps that can be identified

This study pursues a Systematic Literature Review (SLR) of publications over the past ten years on the major contributions of various stakeholders and academicians to the cost control of the Malaysia Rail Project.

METHODOLOGY

Systematic reviews are effective at collecting, assessing, and analyzing every one of the publications on a specific research topic through extensive literature searches [8]. For papers that were published between the year 2018 and 2023, a Systematic Literature Review was carried out. The SLR procedure is illustrated in Fig.1 and there are five main steps to the review process:

1. The research database used is SCOPUS, as the largest and most complete database for research publications [9].
2. Finding keywords.
3. Establishing criteria to gather publications that meet the requirements and excluding those that don't.
4. Analyzing and discussing results.
5. Finding research gaps.

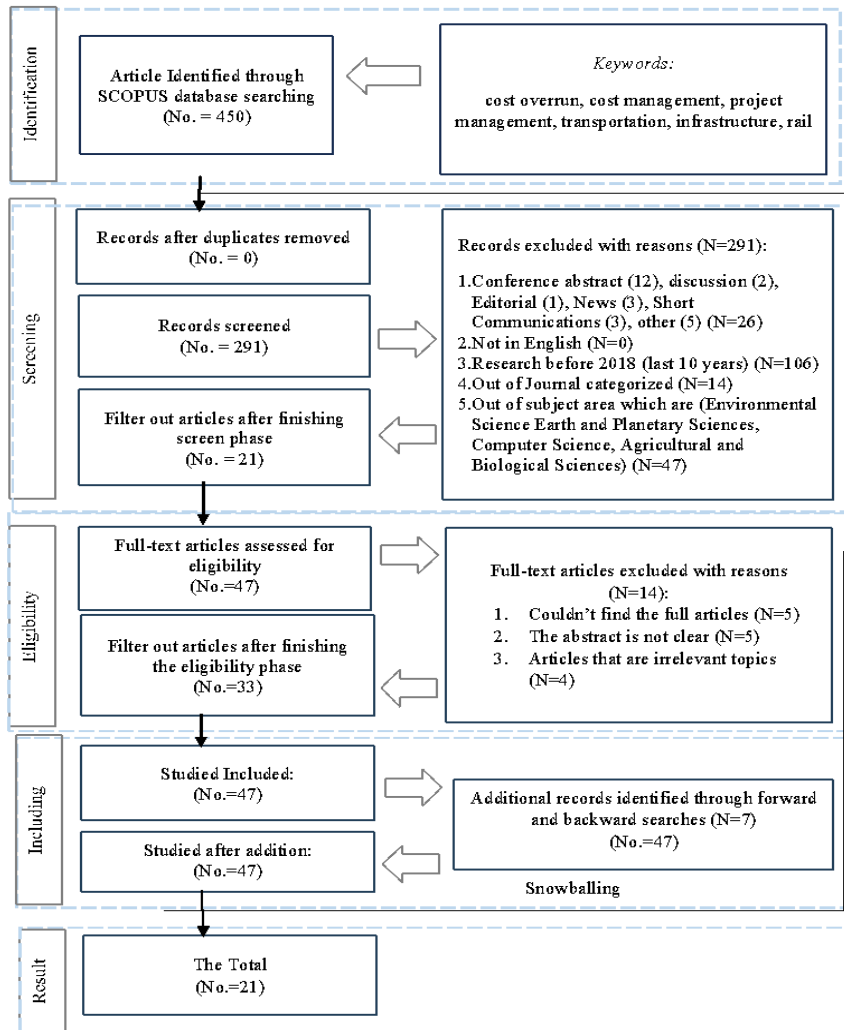


Fig. 1 Flow Diagram of Articles collection. Source. Authors

Fig. 1 Flow diagram of journal articles selection

The search is based on the terms specified in the title and consequently includes Boolean Operators, as indicated in Table I.

TABLE I Boolean Operators

Boolean Operators	
	‘stakeholder’ AND
	OR
‘Cost AND Overrun’ AND	‘government’ AND
OR	OR
‘Transportation’	‘Professional’
OR	OR
‘Infrastructure’	‘decision-making’
OR	OR
‘Rail’	‘Management’
	OR
	‘policy’

By using the Boolean Indicators, the Scopus database initially produced 450 results. Following that, this search is focused on using established criteria, as indicated in Table II. Eventually, twenty-one items emerge after thorough filtering process as shown in Fig.1.

TABLE II CRITERIA OF SELECTION

Num	Filter Category	Criteria
1	Keyword	Cost Overrun' OR 'Transportation' AND 'Infrastructure' OR 'rail' AND 'stakeholder
2	Language	English
3	Document Type	Research or review articles
4	Subject area	Engineering or Social Science

REVIEW OF FINDINGS

A Distribution of Article

Referring to Fig.2, the distribution of article records reveals that analyses of cost overruns in urban rail projects began in 2003 and have continued consistently from 2004 to the present year, 2023. However, it's worth noting that there was limited research on this topic before 2011, with only five articles published in 2012. Nevertheless, it remained an active and important subject of study. Interestingly, there were no articles published in 2005, 2009, 2010, 2014, and 2015, but there was a sudden increase in publications after 2016.

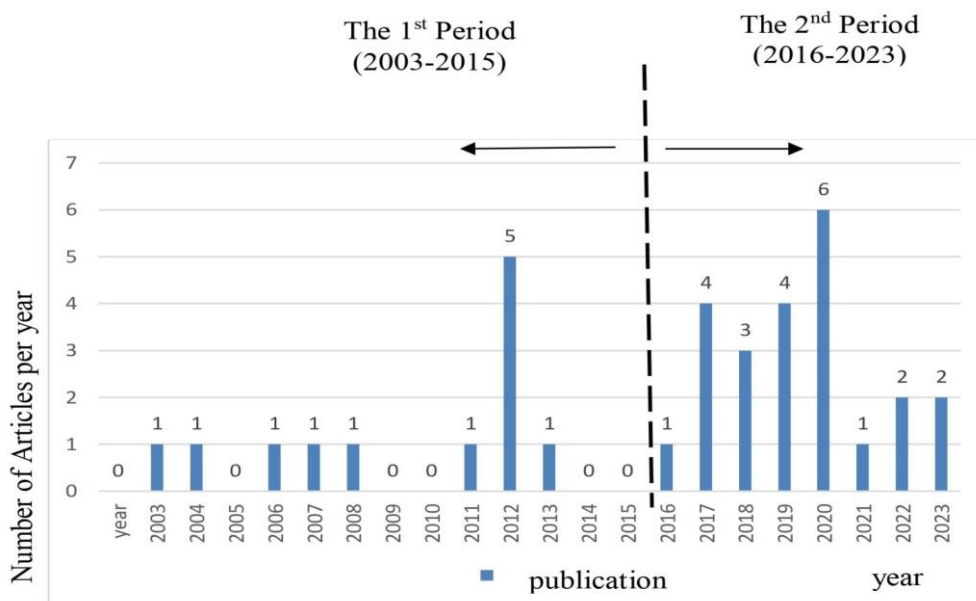


Fig. 2 Articles related to rail cost overrun (2016 to 2023)

Furthermore, it's worth highlighting that the 23 publications in the second period (2016–2023) were roughly on par with the 12 articles published in the first period (2003–2015). This implies that this rise in research activities could be attributed to the respective countries' desire to expand its rail system. In contemporary project management, advancement is anticipated to yield knowledge-based economic growth [10]. Additionally, technical risks associated with railway construction projects should be thoroughly understood to be managed effectively, particularly those involving cost impact [11].

B. Top journals in discussing rail project cost management

The study identified the five most significant journals that published academic articles related to the research topic. These journals were sourced from Google Scholar (85%) and the SCOPUS databases (15%), as outlined in Table IV.

With two publications each, the most active journals among them were the Journal of Transport Reviews and the Journal of Transportation Research Part A: Policy and Practice. The journals that contributed one article each to the topic were Journal of Infrastructure System, Research in Transportation Economics, and Journal of Construction Engineering and Management – ASCE. The most active journal was Journal of Transport Reviews, with publications showing Quartile Q1 results, the greatest Impact Factor (IF) record at 11.3, and the highest CiteScore at 20.5 in 2022. 6.4 IF and 12.4 CiteScore are obtained from the Journal of Transportation Research Part A: Policy and Practice. These suggest that these subject areas are dominated by one or two highly referred periodicals. Nowadays, most articles are published in the first and second quartiles (Q1 and Q2), where there has been a significant increase in publishing [12]. The ASCE Journal of Construction Engineering and Management is the next with 5.213 and 3.8 IF and 8.0 and 6.6 CiteScore. Journal of Infrastructure System continuously logs Quartile 2 with 5.6 CiteScore and 3.462 IF. The WOS and Scopus databases rate journals primarily using the impact factor (IF) of the journal [13].

TABLE IV Top Journals that published relevant articles

Source	Total	Impact Factor (IF)	CiteScore (2022)	Quar tile
Journal of Transport Reviews	2	11.3	20.5	Q1
Journal of Transportation Research Part A: Policy and Practice	2	6.4	12.4	Q1
Journal of Construction Engineering and Management – ASCE	1	5.213	8.0	Q1
Research in Transportation Economics	1	3.8	6.6	Q1
Journal of Infrastructure System	1	3.462	5.6	Q2

C. Countries under investigation

Most of the studies were conducted within a single geographic setting, with only one study conducting a comparative analysis between countries. The geographical areas covered in this review is shown in Fig.3.

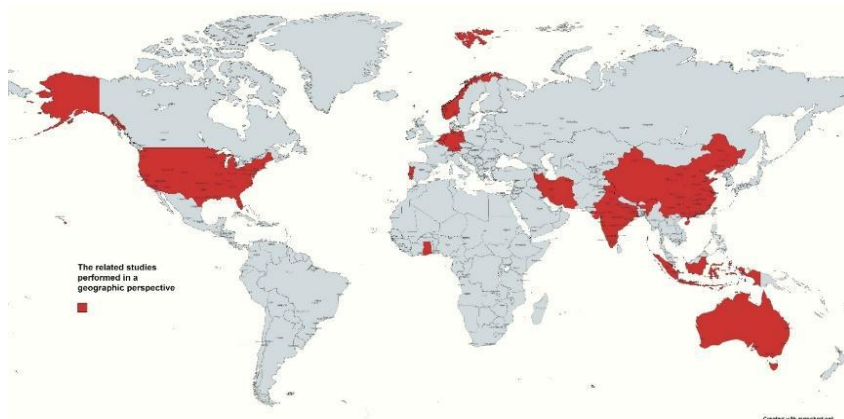


Fig. 3 Countries with literature associated in the review

As shown in Fig.3, the study samples were distributed across various countries, with the highest number in the United Kingdom (n = 6; 22%), followed by India (n = 4; 15%), China (n = 3; 11%), the USA (n = 2; 7%), and the remaining are Australia, Netherlands, Germany, Norway, Belgium, Africa, Ghana, Portugal, Iran, Hong Kong, Indonesia, and Malaysia with 1 literature (4%) for each nation. For further investigation, there are significant cost overruns and project management issues in those various countries. The Addis-Djibouti railway project in Ethiopia is impacted by risks associated with construction and design, which lead to delays and cost overruns. In Stuttgart 21 Railway in Germany, inflated planning time estimates and fluctuating material costs resulted in unfinished projects since the project's early inception. Table III depicts that, after filtering based on certain criteria, only countries in Germany, the Netherlands, Africa, and Ethiopia mentioned the involvement of stakeholders in the road and rail project globally.

TABLE III stakeholders involved in the rail project worldwide

Country	Sector	Reference
Germany	Railway	Steininger et al. (2021)
Netherlands	German Federal Railway	Abbas et al. (2022)
Africa	Railway	M. Bouraima et al. (2023)
Ethiopia	Railway Construction Project	Gashaw et al. (2022) Fentahun Kassa (2020)

D. Thematic analysis

Study keywords are terms used to locate studies in libraries that reflect the topic content of the study [14]. As shown in Fig.4, the VOS viewer tool uses text mining algorithms on the study titles and abstracts to build and visualize bibliometric networks

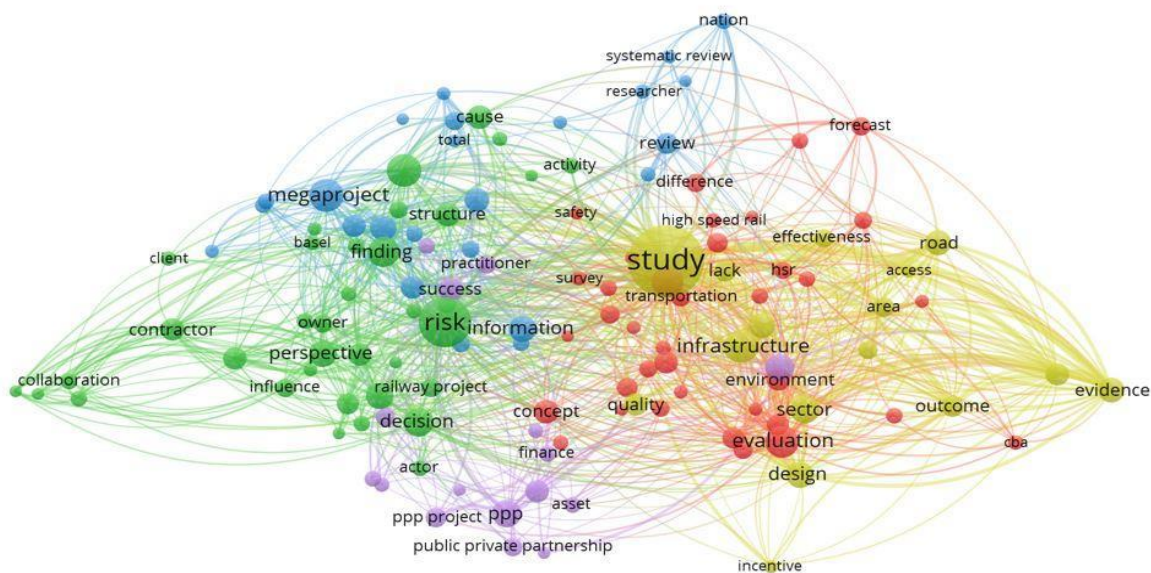


Fig. 4 The network visualization map (title and abstract) of the assessment literature using the VOS Viewer software

The foundation for constructing the visualization of thematic research is established using key phrases found in the titles and summaries of 26 papers. This phase is considered critically important in the thematic research creation process. Initially, 750 key terms are identified, but with the application of a threshold criterion (requiring a term to occur at least 5 times), the number is reduced to 25. These 25 terms are grouped into five clusters representing the most frequently occurring keywords in the articles, as depicted in Table IV.

TABLE IV Literature themes analysis

Theme	Color	References
C1: Cost Performance in infrastructure and railway	Blue	Love et al. (2017) Beria et al. (2018) Andic' et al. (2019)
C2: Cost Overrun and demand	Orange	Huo et al. (2018) Ismail et al. (2021) Steininger et al. (2021) Omotayo et al. (2022) Rustandi et al. (2022) Hussain et al. (2023) Molinari et al. (2023)
C3: Critical Risk Factor, and study of risk	Grey	Sharma and Newman (2017) Yang (2018) Shrivastava et al. (2019) Ghosh and Sar (2020)
C4: Economic Growth and Sustainability	Yellow	Abd Aziz et al. (2018) Dwiatmoko et al. (2020) Mustafa et al. (2021) Yusoff et al. (2021) Matahir et al. (2022) Bouraima et al. (2023)

C5: Stakeholders, Implication Policy, Investment, and Policy	Green	Devi and Jegan (2017) Ahmed et al. (2018) Zhao et al. (2019) Fentahun Kassa (2020)
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E. Methodological Paradigms

The quantitative analysis methodology has been the main tool employed by researchers to examine cost management practices in the rail industry globally, accounting for 15 cases (65.21%). This is followed by the utilization of conceptual methodology with 4 cases (17.39%), mixed methods and the qualitative methodology represented 2 cases (8.695%) each as illustrated in Fig.5.

The five paper publications under *Theme C1: Cost performance in infrastructure and railways* consist of one conceptual and four quantitative analyses. When compared to *Theme C3: Critical Risk Factor*, the research on risk has consistently produced two publications in conceptual analysis, six in quantitative analysis, and one in qualitative analysis. In the end, there are no published records for each theme in mixed-mode analysis. *Theme C4: Sustainable Development and Economic Growth* is documented in one conceptual study and one qualitative paper. *Theme C2: Cost Overrun and Demand* has two quantitative publications, whereas *Theme C5: Stakeholders, Implication Policy, Investment, and Policy* records have three quantitative articles. Ultimately, both theme records one publication each in mixed-mode analysis. It is apparent from the study theme analysis using methodological paradigms that the global scholars are still not exploring mixed-mode analysis in the context of development cost management frameworks for the Malaysian rail project.

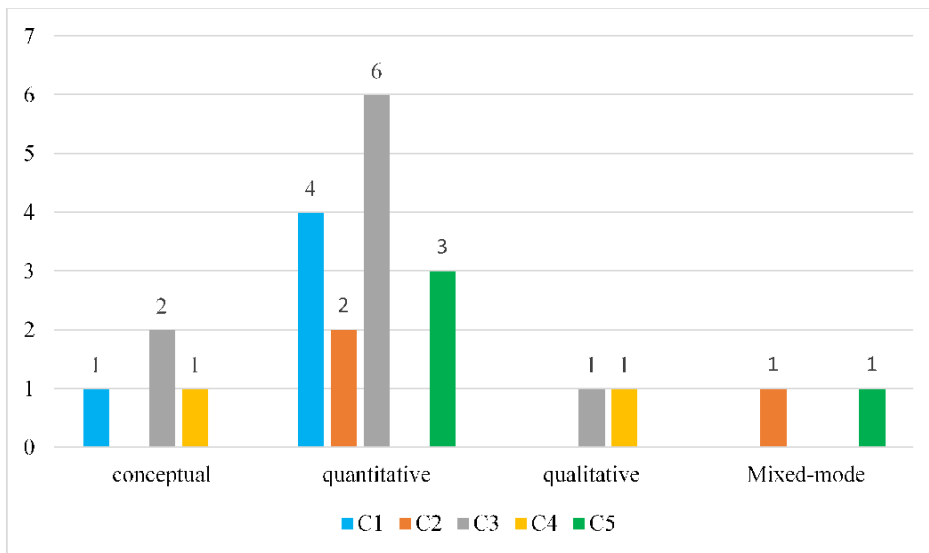


Fig. 5 Differentiating Research methodology among the assessed literature

F. Discussion of findings

This study adopts a Systematic Literature Review (SLR) approach to address questions pertaining to cost management in railway projects. Constantly considering the impact of stakeholder participation in the creation of the framework for cost management in Malaysian rail projects. In this section, the literature

reviewed were discussed based on four research focus.

i. The trend of railway research in past ten years

The review takes on the analysis of 23 research papers from various countries, as shown in Fig.6.

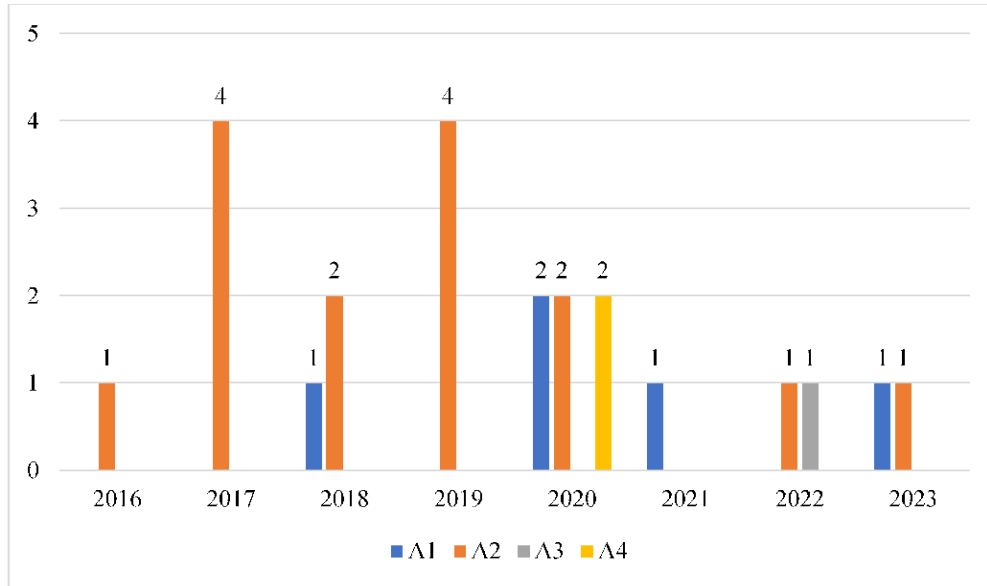


Fig. 6 Annual publication trend of rail project cost management (2016 to 2023)

Analyzing countries, relevant journals, and research volumes over the last decade reveals several insights:

A1. There has only been a slight rise in the number of research publications published by researchers over the last three years, and only, Germany, the Netherlands, Africa, and Ethiopia, among other countries, discussed the engagement of stakeholders and educators in rail project cost management. A conceptual paper analysis is typically chosen to explore the chosen topic in connection to relevant paper publications and to identify research gaps.

A2. Fig.6 shows a discernible rise in research articles released between 2016 and 2023. According to Shrivastava et al. (2019), poor evaluation of total cost performance methods and a lack of recognition of stakeholder engagement pose significant obstacles to rail project management. Research on the topic has shown that quantitative analysis is the most effective technique for delving further into the crucial component assessment of cost performance in Malaysian rail projects.

A3. This analysis provides insight into the major players and developments in the field of cost management in railway projects throughout the previous ten years. As the foundation for more detailed improvement strategies, qualitative analysis is an appropriate technique when trying to understand the issue of project cost overruns [15].

A4. There has been very little research collaboration in this area between developed and underdeveloped countries; at least six research papers involving the UK have been published. Consequently, encouraging cooperation with developed countries may improve railway project cost management. Merely two articles in mixed-mode analysis demonstrate that further investigation should be undertaken, as Fig.6 implies. Integrating mixed methods can also be advantageous for researchers with varying methodological preferences and areas of interest, as each approach can yield insights that other approaches can build upon (reflectiveness) [16].

ii. The critical challenges in rail project cost management

A thorough examination of 23 articles has identified three overarching categories that encapsulate the primary challenges hindering the effectiveness of cost management in rail projects. These categories include:

- a. **Cost Performance and Cost Overrun.** This category encompasses issues related to budget overruns, delays, and overall cost performance issue during pre-construction and construction phase. The following factors contributed to project cost overruns wholly linked to planning activities: (1) improper internal company planning; (2) disregard for supporting materials; and (3) overestimation of material quantities [15]. The consequences of poor cost performance in building projects lead to significant cost overruns [17].
- b. **Project Management and Characteristics:** It covers challenges associated with project management practices and project-specific characteristics. At LRS, project management, cost control, and monitoring are all done continuously throughout the execution process [15]. It is anticipated that incorporating cutting-edge project management techniques into cost-management practices will have a major effect [18]. For example, a different approach to support client satisfaction is by rendering documents easy to read and understand [14].
- c. **Stakeholders, Implication Policy, Investment, and Policy:** This category encompasses a wide range of factors, including stakeholder involvement, policy implications, and investment considerations. Lessons from big EPCM firms reveal that managing project stakeholders in Africa is occasionally challenging [19]. Research indicates that an organization's potential to create meaningful value is contingent upon its capability to strengthen relationships among important persons [20][21]. Consequently, decision-making by policymakers would be greatly facilitated and alleviated.

iii. The effectiveness of the current practice for developing the Malaysian rail project cost management framework

The outcomes of the analysis ignited a comprehensive qualitative discussion aimed at addressing this subject. The discussion was guided by the co-occurrence network of terms and focused on summarizing the key themes that emerged from the study. More importantly, the research themes that had been explored involved the participation of key stakeholders in the rail development. There are contractors, government, consultants, suppliers, and project managers. Fig.7 highlights the themes that were chosen from the literature to summarize the current practice in emphasize the challenges encountered in controlling rail costs and to optimize stakeholder involvement in the Framework's creation.

T1: Theme 1: Cost Management and Cost Performance Constraints.

Examining cost reduction and its relevance to the global rail sector was the focus of these subjects. Research results confirmed that:

1. The research revealed that cost management challenge and procurement method under the **T1: Theme 1**. Cost management challenge has been most records in the literature, reports, in incomplete cost estimation, faulty in incomplete design, an appropriate forecasting method and at the planning stage including structure, appraisal process/design stage. Traditional project management methods (word, spreadsheet, etc.) were used, but there was little cooperation and uniformity, which led to many violations being discovered in the database [22]. Cost management services, which are mostly performed by project managers as part of their portfolio of services, are not widely acknowledged, especially in Europe [22]. Therefore, to bridge the knowledge-practice gap in rail project cost management, the participation of a quantity surveyor or project team is essential.
2. Procurement method mainly discussed in lack of cost-control skills and poor material, management

and logistic. The entire performance of PPP projects depends greatly on the Critical Success Factors (CSFs) identified during the project procurement stage [23]. While researchers acknowledge that one of the most essential components in a project's success is collaboration between the participants and stakeholders [24] It has been shown that with the presence of experience in cost control in the cost management framework, it is an effective strategy to lower project expenses in the future as well as tight cost control, a long-term vision, and budget planning.

T2: Theme 2: Project Management Characteristics.

Project management is the important technical knowledge characteristic that shall be implemented in rail project cost management:

1. Two challenges have been identified under **T2: Theme 2**, which are Project Management and Project Environment. For instance, the Stuttgart 21 Railroad Construction Project had delays and cost overruns due to changes in scope, price overruns, geological conditions, and low participations. [24]. According to Kassa [18] and Ismail [5], the primary causes of delays in construction projects which is the poor implementation practice in cost management. A lack of coordination or oversight could cause the entire rail project construction development process to lag behind schedule in meeting operational efficiency targets. The efficacy of cost management frameworks is a precise, rigorous, and comprehensive approach that recognizes every challenge throughout the project life cycle through interactions with people and professionals. [25].
2. Project Environment challenge has been discussed by scholars, in cost-influencing factors include local regulations, weather conditions, technical challenges, and environmental protection [26]. For instance, the management opportunity of the fluctuating market conditions with contractors being proactive in the project development environment [27]. By promoting information sharing, the expertise, contractor, clients and related parties involved can enhance project cost management [26].

T3: Theme 3: Stakeholder Implication (Project Integration, Improvements and Framework)

The framework for making decisions in managing the costs of rail projects. This topic discusses the prior approaches applied and their implications for the decision-making process. Research results confirmed that:

1. Stakeholder implication in two main factors, focus on Project Integration and Project Management improvement. The traditional method of decision-making, which depends on human participation, and project integration discussed in simulation model components have major limitations that make it hard to predict events and processes. There are three main components to creating a simulation model: model formalism, which describes how entities interact and function, model architecture, which describes how model components are put together to create complex simulations, and data representation, which describes how data is perceived and shipped between various simulation model components. Another two key categories taken into account: are opinions about how project management is currently practiced and suggestions for future improvements. As the outcome, three perception category groups relating to project management practices were identified by the informants: positive perceptions, neutral perceptions, and negative perceptions [17][26][28]. Nvivo12 software, for instance, is applied because it is appropriate for undertaking qualitative data analysis such as coding and categorization. The Miles & Huberman interactive model and PLS-SEM are also used. A case study shows that combining quantitative and qualitative method analysis enhances cost management, notably in the area of project management [29][30][15].
2. Authors frequently employed the Exploratory Factor Analysis (EFA), SPSS tools, and PLS-SEM to conduct assessments in their study field surveys. A quantitative approach to cost performance provides quick, targeted, scientific, and understandable results while facilitating the target compound's good solubility. Accessible of data gathered from rail projects through questionnaire

surveys [31]. However, the goal of the qualitative technique is to quantify the characteristics of a specific target population [32]. The investigational analysis of the fundamental components of qualitative research may assist readers assess qualitative work as being of high quality.

In brief, the results underscore the necessity of increasing consciousness of the relevant stakeholders' participation in rail project cost management procedures, especially in the first phases. It emphasizes how crucial it is to conduct impartial and objective cost management evaluations to thoroughly examine issues and shortcomings. The study also emphasizes the lack of a precise structure for important stakeholders to participate in and a defined process for making decisions. This could entail a conventional construction method of comparing finished projects with early projections from project proposals [27][33][34][26].

Following the findings of past research studies, a study is necessary to provide a deeper knowledge of the efficacy of implementation project cost management practices, with a focus on rail projects in Malaysia, to prevent cost overruns. This emphasizes the value of contributions from all parties involved in the development of rail projects. The opinions of key participants involved are crucial in analyzing the planning stage and cost performance at the pre-construction and construction phases of a rail project. Furthermore, an extensive number of research studies have utilized structural equation modeling, or PLS-SEM, to model intricate study designs, validate hypotheses, examine intricate relationships, and assess measurement validity.

iv. The research gaps that can be identified

This study employs regional time zone analytics in conjunction with a review of frequently cited literature to identify existing gaps in the research. The identified gaps are as follows:

1. **Regional Focus:** The vast majority of the research that is currently available on rail projects in developing nations is regionally specific. This discussion about railway challenges hinges on the numerous, ongoing, and historical railway projects that countries around the world are currently dealing with. Although the research may limit the broader applicability of the findings, it is nevertheless interesting to explore the data in light of the daring findings.
2. **Absence of Clear Framework:** There is a lack of a clear framework surrounding the participation of key stakeholders and academician in the early stages of global rail project processes. Moreover, there needs to be more research on the significance of enrolling important individuals in the beginning phases of cost management. Further research is necessary in light of Malaysia's rail development.
3. **Deficiencies in Documentation and Reporting:** There are flaws and shortcomings in the reporting and documentation procedures, which are vital elements within a transparent procurement process that improves documentation reporting. The involvement of key personnel in monitoring is vital not only during the procurement phase but also during the construction, operation, and final transfer phases of overall projects.

CONCLUSIONS

Through a methodical review of the literature, this study seeks to enable significant participation of key stakeholders in the context of Malaysian rail project cost management. It summarizes earlier works on current cost management techniques in Asian and global rail projects. The report highlights important concerns and decision-making obstacles that can improve the effectiveness of developing a cost management framework for Malaysian rail projects by extracting lessons from current experiences. Between 2002 and 2023, the study employed a Systematic Literature Review (SLR) methodology to examine 23 research publications that were obtained from the SCOPUS database.

Study Limitations: The study acknowledges certain limitations, including:

- Inclusion of only papers and reviews from categorized journals.
- Reliance on publications exclusively from the SCOPUS database.
- Consideration of articles written solely in English.
- Focus on articles published between 2016 and 2023.

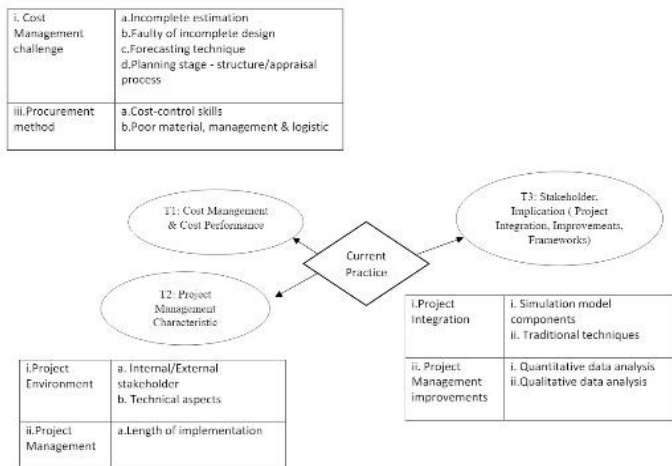


Fig. 7 Challenges associated with rail project cost management

Future Research Directions: Based on the identified limitations and observed gaps, the study suggests several future research directions:

1. Adopting a cost-management framework that encourages important players, stakeholders, and the project team to actively participate in ongoing rail projects in Malaysia, Asia, and worldwide.
2. Improves feedback and satisfaction among stakeholders, the project team, and any other parties involved in the rail projects about the cost management framework.
3. Bridging in knowledge and practice gaps by integrating stakeholders and project team members viewpoints with client perspectives and expectations.

DECLARATION OF INTEREST

The authors affirm that they have no known financial or interpersonal conflicts that would have appeared to have an impact on the research reported in this study.

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