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QUALITY-DRIVEN DECISION-MAKING BY MAIN CONTRACTORS FOR THE MRT2 ELEVATED PROJECT

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Abstract — This paper explores the factors that influence quality-driven decision-making by main contractors. The construction industry, especially in large-scale projects like the MRT2 Elevated Project, faces challenges in maintaining high-quality standards while managing time and cost pressures. These scenarios often lead to delays, cost overruns, and quality issues which may affect the overall success of a project. Despite the importance of quality-driven decision-making, there is limited understanding of the key factors that influence these decisions among main contractors. Therefore, the objective is to identify the key factors that impact quality-related decisions in the MRT2 Elevated Project in Klang Valley. Effective decision-making in quality is crucial for balancing time, cost, and quality in construction projects, particularly in large-scale projects like the MRT2, where delays and quality issues are common. Existing research highlights several important factors that help ensure projects meet quality standards. Using a quantitative approach, this study identifies fifteen (15) critical factors influencing quality-driven decision-making. Data were collected and analysed using Relative Importance Indices (RII) to rank these factors. The results show that the most important factors for major contractors are decision-making capability, balancing time, cost, and quality, and safety and health compliance. The study highlights the need to strengthen decision-making to align with these factors. The findings are significant, as they can lead to improved practices in quality assurance and quality control within the construction industry.

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***Keywords*:** decision-making, quality assurance and quality control, main contractor, construction, mass rapid transit

1.0 INTRODUCTION

The construction industry is unique and complex; decision-making in quality plays a big role in the success of the projects. For developing countries, the construction sector is essential for economic growth [1]. Construction projects move through design planning, construction, handover, and maintenance stages while balancing time, cost, and quality aspects, known as the "triple constraints" [2]. Quality control means meeting these constraints while ensuring compliance with standards, managing risks, and communicating effectively [3].

Decision-making in quality impacts all stages of a construction project and affects time, cost, and overall quality [4]. Therefore, decision-making factors in quality must address these three (3) areas to produce realistic results [2]. Compliance with industrial research and technology organisations, like SIRIM and CIDB Malaysia, highlights the industry's commitment to quality [5]. Previous studies have linked delays in construction to quality-related decisions, showing issues like regulatory challenges and contract disputes [6].

Focusing on the MRT2 Elevated Project in Klang Valley, this study looks at the complex nature of large-scale projects. MRT projects typically comprise elevated works, underground works, tunnelling works and system works. Main contractors commonly face issues such as slow decision-making, quality assurance, and quality control challenges [7]. The study aims to identify the key factors that influence how main contractors make quality-related decisions in the project. Specifically, the study seeks to understand what factors are most important to main contractors when they make decisions to ensure quality in the MRT2 Elevated Project in Klang Valley. Timely and informed decisions are important to mitigate delays, quality lapses, and budget overruns in the project [8]. Table 1 shows challenges and issues in decision-making from previous studies.

Table 1 Challenges and Issues in Decision-Making

Author	Factors
[9]	There are three crucial elements in planning and controlling construction projects; they are time, cost, and quality. Achieving a harmonious balance among these factors, optimising project duration and total cost while maximising quality, is essential for determining the success of the projects.
[10]	In construction projects, decision-makers often encounter complex scenarios where they must thoroughly assess different options to determine appropriate solutions while balancing competing objectives.
[11]	The existing emergency response system demonstrates limited flexibility in decision-making, as it predominantly relies on predefined work processes and implementation procedures outlined in the emergency plan.
[12]	Neglecting to analyse market needs, engineering aspects, regulatory requirements, or available resources can lead to poor decision-making, resulting in conflicts, chaos, and project failure.

2.0 LITERATURE REVIEW

2.1. Overview of Construction Industry

The construction industry relies on careful coordination, where quality assurance and quality control decision-making are crucial for project success. In Malaysia's Fourth Industrial Revolution (IR 4.0), construction faces challenges like project failures and the need to adapt to new technologies [13]. Large-scale infrastructure projects, like the Mass Rapid Transit (MRT), showcase the complexity and high-quality standards needed for success, which involve many stakeholders [14]. Effective decision-making in quality-related matters, supported by leadership and continuous communication, helps main contractors manage the project lifecycle and respond to challenges [15]. Main contractors play a vital role in monitoring work and maintaining quality per contracts, aided by their Quality Assurance and Quality Control (QAQC) division, which conducts audits and handles reports to guide decisions [16]. Implementing Construction Industry Standard (CIS 7), better known as QLASSIC by CIDB, ensures adherence to quality required for industry standards [17]. The MRT2 Elevated Project in Klang Valley exemplifies the need for main contractors to use quality management systems and maintain clear communication to make decisions and meet project goals. This study explores how main contractors make quality-related decisions, weighing options to align with project standards and values while addressing issues that arise at different project stages.

2.2. The Present State of Construction Industry in Malaysia

The construction industry is vital for Malaysia's economic growth, playing a key role in wealth creation and improving citizens' quality of life [6]. It includes both public and private sectors focused on building and maintaining structures and systems, like buildings and transport infrastructure [18]. Key projects include residential, non-residential, and engineering work, each needing specific decision-making for quality standards. Major transportation infrastructure, such as MRT1 Sungai Buloh Line and MRT2 Putrajaya Line, and projects like the Pan Borneo highway, follow the National Quality Infrastructure Standards to boost socio-economic benefits [19] [20]. However, challenges related to environmental, social, and governance (ESG) issues require good decision-making and strong stakeholder collaboration [19]. The move toward digital solutions under the Fourth Industrial Revolution (IR 4.0) aims to increase productivity, but slow decision-making can still cause delays and cost overruns in large-scale projects; the construction sector remains crucial in pushing the country towards becoming a developed nation.

2.3. Decision-making and Quality by Definition

In dissecting the decision-making processes of main contractors, several factors come into play, and each exerts its unique influence, as shown in Table 2.

Table 2 Factors Influence Decision-Making in Quality [21]

Factors	Description
Regulatory Compliance	Adherence to regulatory frameworks serves as the bedrock of decision-making, with non-compliance posing existential threats in the form of legal repercussions and reputational damage
Client Expectations	Aligning with client expectations constitutes a central tenet, as exceeding or falling short of these expectations can profoundly impact stakeholder satisfaction and project viability
Resource Optimisation	Balancing quality objectives with resource constraints necessitates a delicate equilibrium, where decisions must strike a harmonious chord between efficacy and efficiency
Risk Management	Anticipating and mitigating risks forms an integral aspect of decision-making, as overlooking potential pitfalls can culminate in project delays and cost overruns
Technological Advancements	Embracing technological innovations empowers main contractors to augment decision-making capabilities, leveraging data analytics and artificial intelligence to enhance quality outcomes

In the construction industry, managing time, cost, and quality is important. The goal is to achieve high-quality results while keeping optimum costs and meeting the project timeline. As noted by [2], a builder's success depends on how well they manage project time, cost, and quality. Making good decisions about quality-related projects is important to ensure standards are met and avoid delays or major issues due to poor quality. Decision-making in quality involves choosing the best option from alternatives and includes defining problems, gathering information, and learning from past experiences [22]. Good decision-making practices focus on balanced actions, consulting with others, transparency, and respect for equality and rights. Table 3 shows the general steps for the decision-making process.

Table 3 Decision-Making Process [22]

Step	Description
1	Identify the Problem
2	Gather Information
3	Identify Options and Alternatives
4	Evaluate and Weigh the Alternatives
5	Select the Best Alternatives
6	Decision Maker Take Action
7	Finalize the Decision Considering the Risk

Meanwhile, quality refers to the degree of excellence and satisfaction of specified attributes or requirements. Low-quality results in inefficiency, wasted time and materials, increased costs, and safety hazards for users [23]. Safety improvements are tied to the quality of materials and equipment, serving as preventive measures against future accidents.

2.4. Decision-making in Construction

Decision-making in construction is a vital process where professionals choose the best options among many alternatives to tackle the issue across all project stages, starting from the planning stage until the post-construction stage [24]. This process is influenced by project constraints, stakeholder needs, regulations, and cost goals. Quality management is essential for effective decision-making, helping teams access alternatives logically and make choices that meet project standards [3]. Construction professionals regularly face complex decisions that impact the project's success and must adapt their choices based on feedback to improve outcomes [5]. Overall, effective decision-making and quality management are key to ensuring project success and achieving competitive excellence in the construction industry.

2.5. Factors Influencing Quality-Related Decision-making

In construction project decision-making, timely access to information is crucial [25]. This process typically involves sorting through options to select the most viable ones for further consideration [19]. Decision-making techniques include managing uncertainties, complying with requirements, evaluating alternatives during conceptual design, and selecting materials and manufacturers [26]. Quality decision-making impacts three major elements:

a) Economic factors, as decisions affect the cost-effectiveness of large infrastructure projects, to ensure optimal cost optimisation for both public and private construction ventures [6].
b) Environmental considerations, where choosing environmentally friendly processes is crucial for urban construction, impacting safety, social lifestyle, and population welfare [27]
c) Technical aspects, such as decision-making, guide the implementation of construction methods in large infrastructure projects, providing valuable insights for operational systems [19].

Effective decision-making also depends on the project's nature, design team collaboration, decision-makers' abilities and personalities, and client input [22]. Five major factors influencing decision-making in quality include effective communication and coordination within the project team, quality assurance and control measures, tracking and monitoring, clear roles and responsibilities, feedback mechanisms, and adherence to procedures and guidelines [6]. However, project failures and decision-making among main contractors may result from lack of experience, slow decision-making, non-compliance with quality requirements, design changes, information coordination issues, unrealistic scheduling, and inaccurate evaluation of quality issues. Attention to these factors is essential to avoid project impacts like rejection, double work, stop-work orders, delays, and cost overruns. According to [6], successful completion of large infrastructure projects requires efficient decision-making processes involving all participants, not just main contractors. Table 4 shows factors that contribute to decision-making in the construction industry, according to various authors.

Table 4 Factors Contribute to Decision-Making in Construction

Author	Factors
[11]	Like many railway projects, it is complex and requires careful decision-making. Which can make it challenging for decision-makers to find quick solutions
[11]	Scenario planning and situational assessments are important for dealing with emergencies effectively. These strategies help decision-makers predict possible problems, plan backup solutions, and maintain quality in changing conditions.

Table 4 Factors Contribute to Decision-Making in Construction (cont')

Author	Factors
[2]	Balancing time, cost, and quality is essential for project success. Time, cost, and quality are seen as key factors in planning and controlling construction projects. Success is often defined by minimising project duration and total cost while maximising quality.
[2]	Contracts now place more emphasis on quality performance in addition to time and cost.
[22]	Poor quality could lead to health and safety issues
[28]	Megaprojects and large-scale public engineering works hold significant strategic importance, greatly influencing a nation's economy, politics, and environment. Plus, optimize cost and high-quality play an important role in guiding construction companies' strategic decision-making for such projects
[23]	Occupational safety and health (OSH) in rail construction can be improved by focusing on three (3) safety practices: providing clear manuals, maintaining construction material and equipment properly, and conducting a risk assessment.
[18]	The two MRT lines in Greater Kuala Lumpur could help reduce CO^2 emissions from private motor vehicles by 6%, bringing significant health benefits to the population

2.6. Overview of the MRT2 Elevated Project in the Klang Valley

The MRT Elevated Project in Klang Valley demonstrates the importance of quality-related decision-making in construction. By prioritising careful planning, proactive risk management, and commitment to high standards, main contractors address complex challenges in construction. As Malaysia grows economically, transportation infrastructure like the MRT system reflects this progress. The MRT project, consisting of three (3) lines (MRT1, MRT2, and the upcoming MRT3), is vital for providing affordable and efficient public transport while reducing traffic congestion in urban areas. The project involves several stakeholders: Suruhanjaya Pengangkutan Awam Darat (SPAD) as the Supervising Agency, Mass Rapid Transit Corporation Sdn Bhd (MRTC) as the Project Owner, and MMC-Gamuda Joint Venture Sdn Bhd as the original Project Delivery Partner. Figure 1 shows the Integrated Line in Klang Valley.

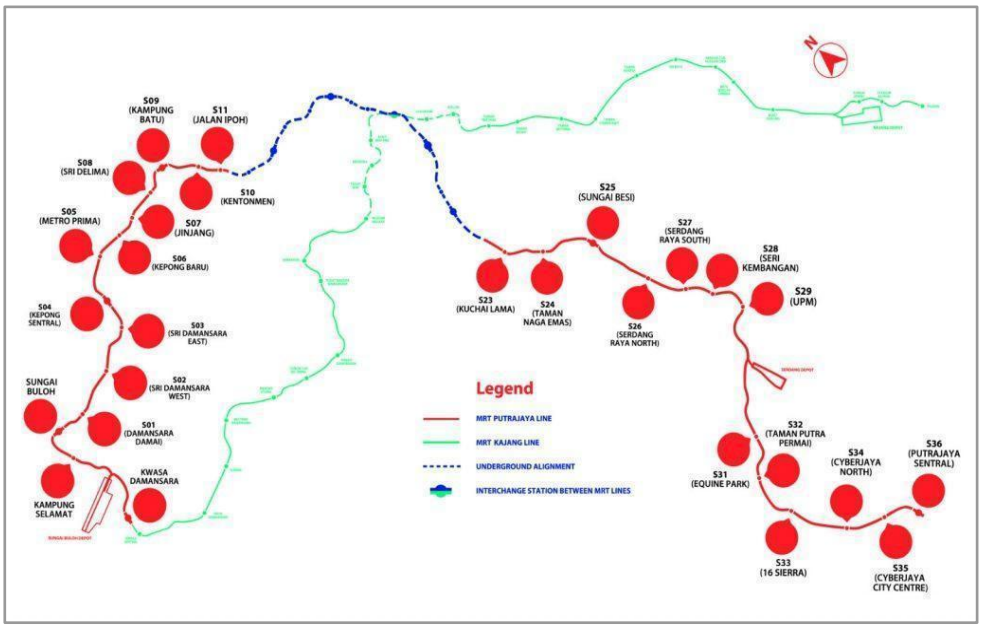


Figure 1 The Integrated Line

The MRT project highlights the urgent need to enhance public transportation to alleviate traffic congestion in areas like Greater Kuala Lumpur, also known as Klang Valley. Built with elevated viaducts, stations, and tunnel works, the MRT system aims to serve thousands of passengers daily, linking urban areas and promoting sustainable urban development. The quality policy of the project emphasises safety, convenience, and reliability, meeting stakeholder expectations and supporting continuous improvement. By handling issues like utility relocation and traffic diversion effectively, the project contributes not only to better transportation but also to environmental sustainability and urban growth in Malaysia's metropolitan regions. The MRT2 Elevated project has been awarded to ten (10) main contractors responsible for constructing infrastructure elements like viaducts, stations, depots, multi-storey car parks, and other ancillary buildings. These contractors are leading construction companies in Malaysia, known for their strong track records on past projects.

3.0 METHODOLOGY

3.1. This study adopts a quantitative approach to analyse factors influencing decision-making in quality in the construction industry, specifically targeting professionals in railway construction, particularly those who are involved in Mass Rapid Transit (MRT) Projects. A 5-point Likert scale questionnaire is distributed to 50 respondents, prioritising engineers or executives with a minimum of five years of relevant experience [29]. The collected data utilises the Relative Importance Index (RII) method to identify key factors impacting quality decision-making among the main contractors in the MRT2 Elevated Project in Klang Valley. The survey phase gathers stakeholders' perceptions of the importance of various factors, including project management practices, quality control, and regulatory compliance. Figure 2 shows the research methodology process for the case study of the MRT2 Elevated Project in Klang Valley.

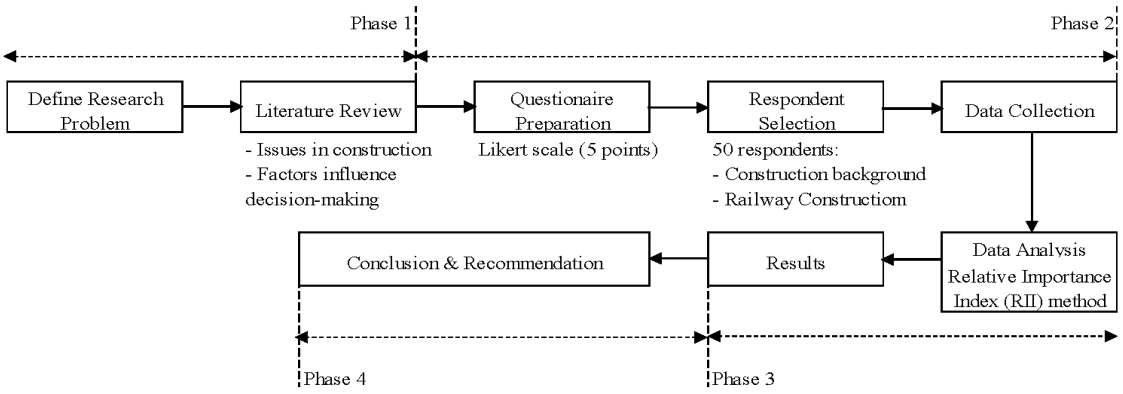


Figure 2 Research Methodology Process

The RII method helps researchers understand the priorities of main contractors in quality-related decisions for the MRT2 Elevated Project in Klang Valley. The findings can guide project management strategies, quality assurance, and stakeholder engagement to improve construction outcomes in Klang Valley and future MRT projects. Below is Equation 1 to derive the RII value for the data collection:

$$RII = \Sigma W / (A \times N) \quad (1)$$

Where:
W = weighting that is given to each potential factor to the case study by the respondents
A = highest weight
N = total number of respondents

The RII value ranges from 0 to 1, with 0 not inclusive. As the value of RII increases, more potential factors influence decision-making in quality, such as standards and regulations, client requirements, quality control protocols,

material selection, decision-maker competency, managerial dynamics, continuous improvement initiatives, health and safety requirements, and documentation related to the MRT2 Elevated Project in Klang Valley. Table 5 below displays the respondents' ratings of the potential factor, their corresponding rankings, and their importance level.

Table 5 Importance Level from RII

Importance Level	RII
High, H	0.8<RII<1.0
High-Medium, H-M	0.6<RII<0.8
Medium, M	0.4<RII<0.6
Medium-Low, M-L	0.2<RII<0.4
Low, L	0.00<RII<0.2

4.0 RESULTS

4.1. Findings and Results for Quantitative Research

4.1.1. Section 1: Demographic Information of Respondent

In the quantitative research findings for Part A's closed-ended question, which focuses on gathering demographic information, 50 respondents participated to assess quality-driven decision-making by the main contractors for the MRT2 Elevated Project in Klang Valley. Based on the data collected, this study successfully met the criteria for the majority of target respondents. Table 6 shows the descriptive statistics for the demographic profile.

Table 6 Descriptive Statistic for Demographic Profile

Description	n=50
Gender	
Male	29 (58.0%)
Female	21 (42.0%)
Age	
23 – 30	5 (10.0%)
31 – 40	36 (72.0%)
41 – 50	7 (14.0%)
51 and above	2 (4.0%)
Years of Experience	
Within 5	4 (8.0%)
6 – 10	15 (30.0%)
11 – 15	20 (40.0%)
16 - 20	3 (6.0%)
20 and above	8 (16.0%)

Table 6 Descriptive Statistic for Demographic Profile (cont')

Description	n=50
Academic Qualification	
Doctorate	1 (2.0%)
Masters	16 (32.0%)
Bachelor's Degree	31 (62.0%)
Diploma	2 (4.0%)
Job Sector	
Client	2 (4.0%)
Contractor	33 (66.0%)
Consultant	10 (20.0%)
Developer	5 (10.0%)
Job Designation	
Director	2 (4.0%)
Manager	15 (30.0%)
Engineer	23 (46.0%)
Architect/Designer	2 (4.0%)
Site Personnel	1 (2.0%)
Surveyor	2 (4.0%)
Contract/Commercial/Finance/Legal	3 (6.0%)
Others	2 (4.0%)

4.1.2. Section 2: Key Factors Influencing Quality-Driven Decision-Making by Main Contractors for the MRT2 Elevated Project

The findings from the data collection for Section 2 focused on identifying critical factors contributing to decision-making in quality among the main contractors involved in the MRT2 Elevated Project in the Klang Valley. Fifteen critical factors from the previous study were listed in the closed-ended question and known as "Potential Factors" numbers 1-15 for analysis. The results from the calculation using the Relative Importance Index (RII) method/formula for each potential factor for the case study of the MRT2 Elevated Project in the Klang Valley. The ranking is determined based on the importance level and all fifteen potential factors, resulting in a high, H ranking with a value between $0.8<RII<1.0$. The results are shown in Table 7, and from the table, there are three (3) potential factors with the highest RII:

Table 7 Results and Importance Level using the RII formula

Potential Factors	RII = ΣW/ A x N	Rank	RII Value
Capability of the decision-maker	0.904	1	High, H
Time, Cost, Quality Benchmark	0.900	2	High, H
Safety and Health Requirement	0.884	3	High, H
Structure of organization and level of strategy in attaining organizational efficiency and effectiveness	0.880	4	High, H
Strategic Management Process of Planning and Scheduling	0.880	5	High, H
Procurement Process	0.876	6	High, H
Compliance to the required standard	0.876	7	High, H
Quality Assurance and Quality Control Management	0.876	8	High, H
Project scope, changes in contract, policies and regulations	0.872	9	High, H
Cost Savings Exercise	0.864	10	High, H
Risk Management	0.864	11	High, H
Design Issues/Design Changes	0.864	12	High, H
Lack of communication within the organisation	0.852	13	High, H
Shortage of materials	0.832	14	High, H
Political Scenario and Stakeholder Engagement	0.816	15	High, H

4.2. Discussion – Top Five (5) Factors Influencing Quality-Driven Decision-Making by Main Contractors for the MRT2 Elevated Project

4.2.1. Capability of the Decision-Maker

Capability of the Decision-Maker (RII = 0904): This factor highlights the decision-maker's ability to make well-informed choices that affect various project areas, including knowledge, skills, problem-solving, risk management, and communication. With experience handling frequent emergencies, decision-makers can use scenario planning to respond effectively to urgent issues [11, 22].

4.2.2. Time, Cost, and Quality Benchmark

Time, Cost, and Quality Benchmark (RII = 0900): Balancing time, cost, and quality is crucial for main contractors aiming for high-quality decision-making. According to [2], this balance helps reduce project duration and cost while maximising quality, which is essential for the MRT2 Elevated Project in Klang Valley.

4.2.3. Safety and Health Requirements

Safety and Health Requirements (RII = 0884): In large rail construction projects, decision-making must prioritise safety and health requirements, alongside advanced materials and equipment to meet the quality [23]. Safety and health aspects are important to protect both workers and the surrounding community.

Main contractors shall ensure they are complying with these standards, which often requires using material or advanced equipment, which helps main contractors meet stringent quality and safety benchmarks [18]. Compliance with the quality standards not only aligns with safety and health requirements but also enhances the overall quality, durability, and reliability of the infrastructure, and it is essential for the project's long-term success and public trust.

4.2.4. Structure of organization and level of strategy in attaining organizational efficiency and effectiveness

Structure of organisation and level of strategy in attaining organisational efficiency and effectiveness (RII = 0.880): The structure of an organisation and its level of strategic planning are crucial for achieving efficiency and effectiveness. The structure reflects detailing how roles such as decision-maker and tasks are managed within the company. With rapid urbanisation, more construction companies are emerging to handle large infrastructure projects, driven by the increased demand for infrastructure. In developing countries, focusing on quality can significantly enhance the efficiency and effectiveness of these projects. An organisation comes to life when people work together and perform key functions that support the achievement of shared goals [20].

4.2.5. Strategic Management Process of Planning and Scheduling

Strategic Management Process of Planning and Scheduling (RII = 0.880): The construction of large infrastructure projects significantly affects regional environments, and using ideal strategic management of planning and scheduling can help reduce these impacts. To achieve project goals, the main contractor must balance constraints like quality, safety, cost, and timelines within plan resources. Current approaches to strategic management of planning and scheduling cover the entire project life cycle, involving complex decision-making across multiple stakeholders [28].

5.0 CONCLUSION

Construction experts involved in MRT projects within the Klang Valley emphasise the critical importance of quality-related decision-making for major contractors. Poor decisions in this area can result in subpar workmanship, compromised safety and environmental standards, and led to time inefficiencies and cost overruns. In conclusion, quality-driven decision-making by main contractors for the MRT2 Elevated Project is influenced by five (5) key factors that contribute to project success. The capability of the decision-maker stands out, emphasising the importance of skills, experience, and scenario planning to handle project challenges effectively. Equally important is the balance of "triple constraints", which are time, cost, and quality benchmarks, allowing contractors to optimise project duration and quality without cost overruns. Safety and health requirements play a critical role in guiding decisions for large-scale rail projects, ensuring safe and efficient execution.

Additionally, a well-defined organisational structure and strategic planning enable efficiency by assigning clear roles and responsibilities, which is essential for the growing number of infrastructure projects in urbanised regions. Finally, a strategic management process for planning and scheduling supports decision-making across the project life cycle, helping contractors manage resources effectively and coordinate with multiple stakeholders to achieve project goals while minimising environmental impacts. Therefore, these factors create a robust framework for quality-focused decision-making on large infrastructure projects by main contractors in future similar projects.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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