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Navigating Change Orders in Rail Construction

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Abstract: The construction industry is a vital sector driving economic growth and infrastructure development. However, it faces persistent challenges, particularly in large-scale projects like rail construction, where change orders frequently cause disruptions. In Malaysia, rail projects are critical for modernising transportation networks, but the complexity of managing change orders often leads to significant delays, cost overruns and administrative bottlenecks. This study aims to examine the challenges associated with change order management practices in Malaysian rail construction projects, with the broader intention of providing insights that can inform more effective project delivery. To achieve this aim, the specific objective of the research is to identify and analyse the key challenges in the practice of change order management processes within rail construction projects. A qualitative approach was adopted, involving semi-structured interviews with eight professionals from companies actively contributing to the rail industry, identified through the Malaysian Rail Supporting Industry Roadmap 2030 published by the Malaysia Industry-Government Group for High Technology. The study employed purposive and snowball sampling techniques, recognising the specialised nature of the rail construction community. The findings revealed a total of 15 raw challenges across the 3 phases of the change order management framework, which were subsequently consolidated into 9 overarching themes to capture the recurring issues in change order management implementation within rail projects. The study further underscores the potential of integrating lean construction principles, particularly planning and control practices, as targeted strategies to address these challenges. By providing insights into both the existing issues and opportunities for improvement, this study contributes to strengthening change order management practices and advancing the delivery of rail construction projects in Malaysia.

Keywords: Rail construction, Lean construction, Change order management, Construction project management, Malaysia

INTRODUCTION

The construction industry is the keystone of the national economic development, providing the infrastructure needed to support growth across multiple sectors. Successful infrastructure projects are critical to national development as they enhance mobility, support economic growth and improve quality of life. Within this broader category, rail construction has

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emerged as one of the key contributors, offering significant benefits in terms of connectivity, congestion reduction and sustainable urban development (Sruthilaya, Vilventhan and Gopal, 2024). In Malaysia, rail infrastructure has become increasingly significant, driven by a growing reliance on public transport systems (Ramli et al., 2021). According to Figure 1, data provided from Prasarana Malaysia shows that rail ridership consistently surpasses that of public buses, highlighting the increasing demand for efficient and reliable rail systems (*Prasarana's Ridership*, 2026). This growing demand underscores the urgency of ensuring the successful delivery of rail construction projects.

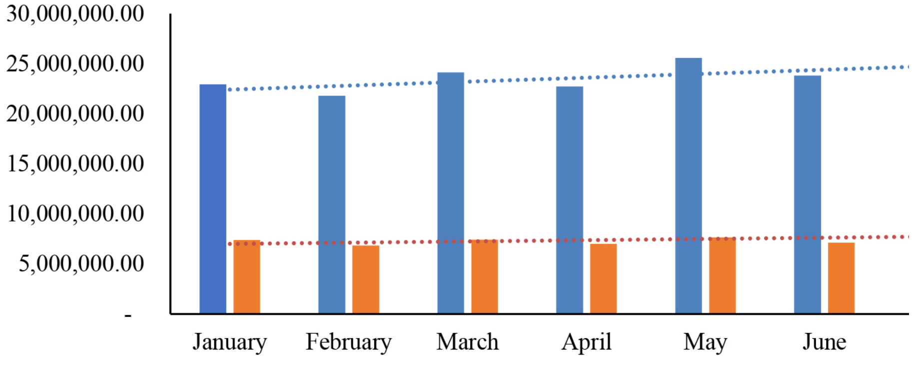

Figure 1. Ridership of rail and bus public transportation (Q2 2024)

However, rail construction projects are inherently complex, requiring extensive coordination among multiple stakeholders, advanced technologies and significant resources. The high degree of complexity is further increased by the dynamic nature of these projects, which often necessitates changes during construction (Palevičius and Kaušylas, 2020). These changes are formalised as change orders, which are an inevitable part of the construction process. Whether driven by unforeseen technical challenges, evolving stakeholder requirements, or external factors, any change orders can have a profound impact on project outcomes (Sruthilaya, Vilventhan and Gopal, 2024).

This study aims to examine the challenges associated with change order management practices in Malaysian rail construction projects, with the broader intention of providing insights that can inform more effective project delivery. To achieve this aim, the specific objective of the research is to identify and analyse the key challenges in the practice of change order management processes within rail construction projects. To establish the significance of effective change order management, Table 1 summarises studies that highlight the impact of change orders on rail projects across different contexts.

Table 1. Change orders in rail projects

No.	Project	Key Factors to Change Orders	Impact on Project	Source
1.	Urban rail projects, Vietnam	i. Inflation ii. Inadequate performance monitoring iii. Insufficient bills of quantities	i. Cost overruns ii. Increased financial risks for stakeholders	Nguyen et al. (2024)
2.	Metro rail projects, India	i. Design changes ii. Land acquisition issues	i. Increased project complexity ii. Delays in execution	Sruthilaya, Vilventhan and Gopal (2024)
3.	Mass Rapid Transit Line 2 (MRT2) Putrajaya Line and Electric Train Service (ETS), Malaysia	i. Design discrepancies ii. Construction changes	i. Cost overruns ii. Project delays	Molarn et al. (2024)
4.	Rail Baltica project	i. Changes in technical requirements ii. Financial constraints	i. Modifications to project parameters ii. Delayed project delivery	Palevičius and Kaušylas (2020)
5.	Urban rail transit projects, China	i. Uncertainties in revenue generation ii. Changes to project agreements	i. Affecting project viability ii. Conflicting stakeholder commitments	Zhang, Jin and Yuan (2023)

Table 1 summarises that poorly managed change orders significantly affect the performance of rail projects. For example, in Vietnam's urban rail projects, inadequate performance monitoring and inflation have led to cost overruns and financial risks (Nguyen et al., 2024), while in India's metro rail projects, land acquisition and design changes resulted in execution delays and increased complexity (Sruthilaya, Vilventhan and Gopal, 2024). Similar challenges were documented in Malaysia's MRT2 and ETS projects, where design discrepancies and construction changes caused both cost overruns and delays (Molarn et al., 2024).

Across these studies, common consequences such as delays, financial overruns and stakeholder conflicts underscore the critical need for robust change order management practices to evaluate, approve and implement changes systematically.

LITERATURE REVIEW

Practices in Change Order Management

The change order management is a critical process in construction projects, ensuring that modifications are systematically reviewed, approved and implemented without disrupting project objectives (Naji, Gunduz and Naser, 2022). Poorly handled change orders can lead to significant delays, cost overruns and contractual disputes, making a structured change order management framework vital for maintaining project stability (Aslam, Baffoe-Twum and Saleem, 2019). Given the scale and intricacies of rail projects, change order management must not only address technical adjustments but also facilitate clear communication, timely decision-making and risk mitigation strategies.

Rail construction projects often adopt bespoke contractual arrangements, which are tailored to accommodate their unique technical, regulatory and operational complexities (Sukaimi, Prasetijo and Ibrahim, 2024). Despite these customisations, these contracts are still fundamentally based on standard contract forms, such as the Public Works Department and Pertubuhan Arkitek Malaysia standard forms, which outline general provisions for managing change orders in construction projects (Yaman and Ghadas, 2022).

Clause 11 of Pertubuhan Arkitek Malaysia emphasises the architect's authority to issue instructions for variations and outlines mechanisms for their valuation, documentation and approval. Meanwhile, Clause 24 of Public Works Department empowers the superintending officer to instruct and manage variations while ensuring fair valuation and proper execution (Zakaria, Ismail and Yusof, 2022). These clauses underscore the necessity of maintaining clear documentation, conducting thorough evaluations and ensuring structured communication among stakeholders, all of which are integral to successful change order management in rail projects.

As highlighted by Sukaimi, Prasetijo and Ibrahim (2024), while these frameworks establish a centralised approval process, where variations must receive formal approval from the architect under Pertubuhan Arkitek Malaysia or the superintending officer under Public Works Department, this structured hierarchy, although ensuring consistency, often results in procedural delays. The reliance on top-down decision-making can lead to extended approval timelines, which in turn affects project schedules and increases administrative workload (Khahro et al., 2023).

In contrast, international contract frameworks, such as the New Engineering Contract (NEC) and the Fédération Internationale des Ingénieurs-Conseils (FIDIC) contracts, employ more collaborative and time-sensitive change order management strategies (Chammout et al., 2024). These approaches emphasise early notification mechanisms, real-time communication and stakeholder engagement to proactively resolve potential variations before they escalate into major project disruptions (Besaiso et al., 2018). Compared to the traditional centralised process in Public Works Department and Pertubuhan Arkitek Malaysia contracts, these international frameworks promote a more agile and adaptive change order management system.

On top of that, the flexibility of bespoke contracts allows project stakeholders to incorporate additional provisions that specifically address the unique challenges of rail construction projects. These include interdisciplinary coordination, strict safety compliance requirements and the integration of advanced rail technologies (Sukaimi, Prasetijo and Ibrahim, 2024). By combining bespoke contract elements with standardised frameworks like Public Works Department and Pertubuhan Arkitek Malaysia, project owners can balance regulatory consistency with the adaptability needed to manage complex variations effectively.

Despite the presence of standardised contract frameworks, rail projects in Malaysia continue to struggle with inefficiencies in managing change orders. The challenges stem from hierarchical decision-making structures, where approvals must pass through multiple administrative levels, leading to prolonged processing times (Kurwi et al., 2021). Additionally, insufficient technical expertise and inadequate training in change order management methodologies hinder the ability of project teams to respond effectively to contract variations (Pikas et al., 2022). These constraints not only contribute to delays and cost escalations but also create bottlenecks in communication, further complicating project execution. Besides, existing literature often focuses on general construction scenarios, leaving the unique aspects of change order management practices underexplored, particularly in the context of rail construction (Belayutham et al., 2022). Understanding the common practices employed in change order management processes for rail projects is therefore essential for addressing the distinct needs of this sector (Chaka, 2015).

Furthermore, rail construction projects are inherently more complex than other infrastructure developments due to several factors. First, they involve multiple jurisdictional parties, unlike other infrastructure projects such as road projects, which are predominantly overseen by the Public Works Department (Latiff, Jaapar and Isa, 2022). Each rail project in Malaysia is managed by different entities, such as Prasarana, Mass Rapid Transit Corporation, Keretapi Tanah Melayu Berhad or Malaysia Rail Link, each operating under distinct contractual and regulatory frameworks (Molarn et al., 2024). Second, rail projects demand extensive integration with existing infrastructure, requiring precise coordination with operating rail networks, urban planning authorities and transportation agencies (Liu et al., 2023). Additionally, the high safety and technical standards in rail construction introduce stringent compliance measures, often leading to frequent design adjustments and regulatory-driven change orders (Wu et al., 2021).

Although the contractual mechanisms for change orders differ across procurement types, the project manager remains the key figure responsible for managing and approving change orders. As the central coordinator, the project manager ensures compliance with contract provisions, assesses cost and schedule implications and facilitates communication between clients, consultants and contractors (Daniel, Pasquire and Dickens, 2019). However, the efficiency of change order management is often hindered by the bureaucratic and hierarchical nature of decision-making in rail projects.

Process of Change Order Management

The change order management is a multi-stage process that involves the initiation, review, approval and implementation of change orders. Given the intricate nature of rail construction projects, each step requires careful documentation, extensive stakeholder engagement and systematic coordination to ensure that changes are managed effectively and do not disrupt project objectives (Waty and Sulistio, 2022).

Table 1 outlines the key studies highlighting the consequences of poorly managed change orders in rail construction projects, particularly in terms of cost overruns, schedule delays, safety risks and reduced project quality. These studies provide empirical evidence that without a structured change order management process, rail projects are highly vulnerable to inefficiencies and disruptions.

However, the process of change order management is often presented in generic terms, but a review of multiple studies (Motawa et al., 2007; Tam, 2021; Ismaeil and Sobaih, 2024) suggests that it can essentially be understood through 3 major phases comprising 11 interrelated procedures, as shown in Figure 2. These phases reflect how changes move from initiation to full implementation. Such a structured framework provides a systematic basis for understanding how rail projects attempt to handle the complexity of change orders.

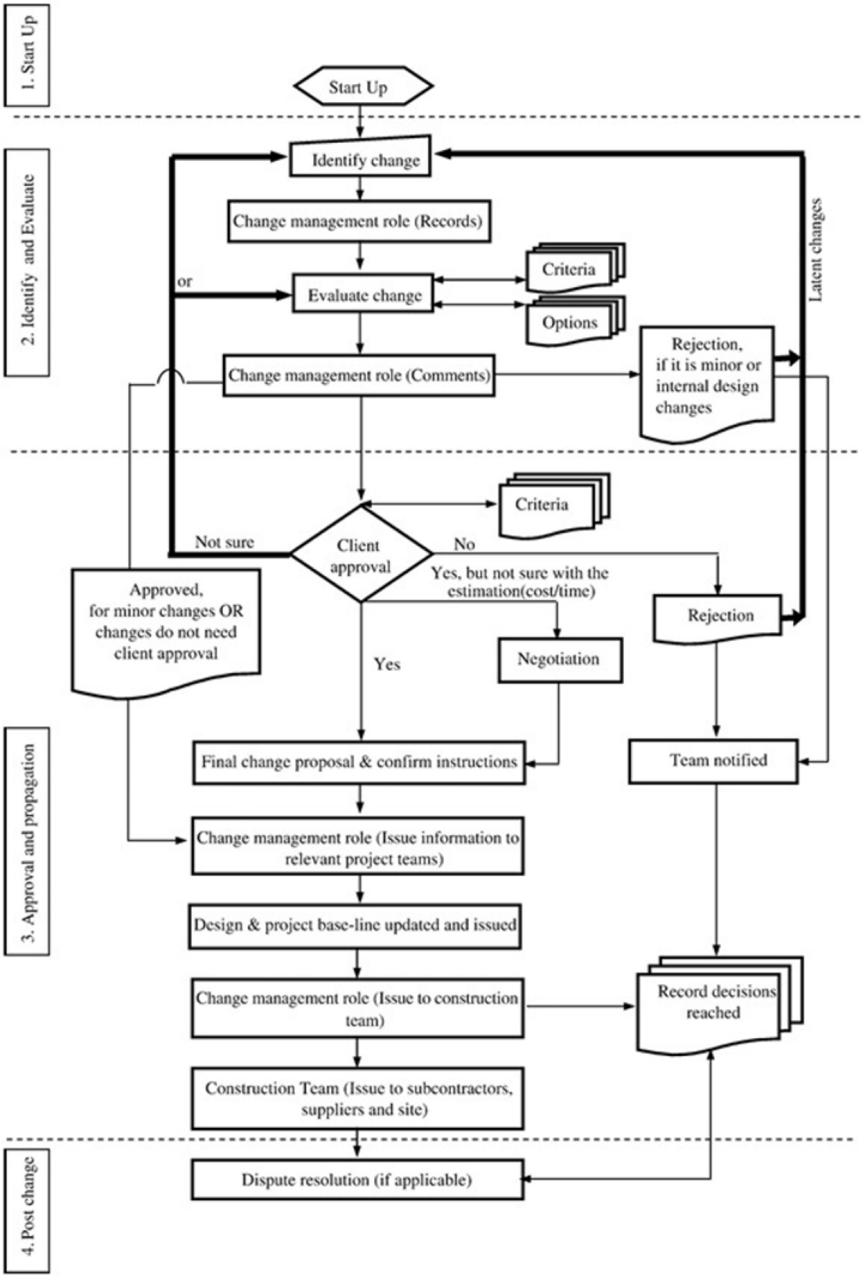

Figure 2. Flowchart of change order management process

Source: Motawa et al. (2007)

Figure 2 illustrates the generic structured process of change order management that applies to all types of construction projects, including rail projects in Malaysia (Motawa et al., 2007). This process ensures effective decision-making and project alignment.

The first phase, Phase A, which comprises Start-Up and Identify and Evaluate, begins when a change is initially recognised, whether arising from regulatory requirements, unforeseen site conditions, or stakeholder demands. At this stage, the change is formally recorded and assessed for its potential impact on cost, time and quality (Naji, Gunduz and Naser, 2022). Preliminary evaluations are then used to determine whether the change should proceed further or be rejected at an early stage to avoid unnecessary delays and complications.

Next, is the Approval and Propagation Phase (Phase B). Once a change is deemed viable, project baselines and design documents are updated accordingly and client approval is sought to validate the necessity of the modification. The approved proposal is then formalised and instructions are communicated across project management, engineering teams and construction crews. Information continues to flow outward to subcontractors, suppliers and site operations, ensuring that every party is aligned with the revised scope (Molarn et al., 2024).

Finally, the Post-Change Phase (Phase C) deals with implementation follow-up and where necessary, dispute resolution. Resolving disputes in a timely and structured manner not only protects project integrity but also provides opportunities for learning and process refinement (Yap, Abdul-Rahman and Chen, 2017). Maintaining a transparent change log throughout the process further supports accountability and provides a historical record that can guide future decisions.

For this study, the 3-phase process, which consists of 11 steps, will serve as the analytical framework for exploring the challenges of change order management in Malaysian rail projects. By engaging with respondents about their experiences at each stage, the research will provide insights into where breakdowns most often occur and why. This approach not only strengthens the empirical investigation but also situates the findings within a well-defined process model, making it possible to connect the identified challenges with broader strategies for improvement.

Lean Construction

As discussed earlier, the change order management is often hindered by delays, bureaucratic decision-making and inefficient coordination among stakeholders. Lean construction, with its core principles of minimising waste, maximising value, improving collaboration and reducing inefficiencies, offers a relevant framework to address these issues (Andújar-Montoya, Galiano-Garrigós and Echarri-Iribarren, 2020). Integrating lean principles into change order management is not merely a theoretical alignment but a practical response to the challenges that typically arise when rail projects change scope, design, or execution (Herrera et al., 2021; Kortenko et al., 2021).

The fundamental rationale for linking lean construction with change order management is rooted in their shared objectives. Both emphasise structured processes that ensure project alignment, resource optimisation and timely delivery. Change orders, if poorly managed, can undermine project performance through cost overruns, schedule delays and compromised quality. The lean construction was explicitly designed to tackle such inefficiencies by promoting value generation, eliminating non-value-adding activities and fostering proactive collaboration. Hence, when construction teams face challenges in managing change orders, lean construction offers tested methodologies that can directly strengthen change order management practices, making them more predictable and responsive.

The relevance of lean construction to change order management in this study is situated within the category of planning and control practices. As identified by Babalola, Ibem and Ezema (2019), planning and control practices target inefficiencies in managing timelines, resources and costs, which are precisely the areas most affected by change orders. By emphasising structured planning and continuous improvement, planning and control practices provide a framework for making change order management workflows more resilient and adaptive. Table 2 in this study outlines nine planning and control practice methodologies, each designed to address a distinct source of inefficiency within project management.

Several of these practices demonstrate direct applicability to change order management in rail projects. For example, the LPS enhances workflow reliability by ensuring that planned tasks are realistic, well-sequenced and achievable within the allocated timeframes (Lappalainen et al., 2022). This reduces the likelihood of cascading delays when changes occur. Similarly, work structuring and scheduling helps optimise task allocation, minimising bottlenecks that often arise when change orders disrupt original schedules (Andersen, Belay and Seim, 2012). LBMS further supports change order management by improving the deployment of resources according to site-specific demands, thereby maintaining efficiency even when modifications are introduced (Mouflard and Seppänen, 2012).

Table 2. Planning and control practices methodologies

No.	Type of Planning and Control Practices	Key Focus	Source
1.	Last Planner System (LPS)	Collaborative planning	Lappalainen et al. (2022)
2.	Work structuring and scheduling	i. Breaking down tasks ii. Better clarity and sequencing	Andersen, Belay and Seim (2012)
3.	Location-Based Management System (LBMS)	Managing work based on physical locations	Mouflard and Seppänen (2012)
4.	Benchmarking	Comparing against industry standards/best practices	Huang et al. (2023)
5.	Six Sigma	i. Process improvement ii. Defect reduction	Siddiqui et al. (2016)
6.	Value-based management	Aligning decisions with value creation	Björnfot et al. (2011)
7.	Daily cluster/huddle meetings	Focused team meetings to plan daily tasks	Belayutham et al. (2022)
8.	Pull scheduling/planning	Scheduling tasks based on downstream needs	Basahel (2019)
9.	Error-proofing	Designing processes to prevent mistakes	Basahel (2019)

Other planning and control practices also reinforce different aspects of change order management. Benchmarking enables project teams to measure performance against industry best practices, providing a clearer basis for evaluating the impact of change orders (Huang et al., 2023). Six Sigma reduces process variability, increasing consistency in managing modifications (Siddiqui et al., 2016), while practices such as value-based management and value stream mapping ensure that only value-adding activities are retained in the workflow, aligning with the principle of avoiding unnecessary rework in change order management (Björnfot et al., 2011). Meanwhile, daily cluster or huddle meetings create opportunities for real-time coordination, ensuring that change orders are communicated quickly and acted upon decisively (Belayutham et al., 2022). Pull scheduling grounds project timelines in actual site progress, preventing rigid adherence to outdated schedules when changes occur. Lastly, error-proofing (Poka-Yoke) strengthens quality assurance by reducing rework, a frequent consequence of poorly managed change orders (Basahel, 2019).

While each practice targets different inefficiencies, the collective advantage of these planning and control practices shares the common goal of improving predictability and reducing waste, which is directly tied to the challenges of managing change orders. However, despite the availability of nine distinct planning and control practice approaches, challenges in change order management practices continue to occur in rail projects due to their own underlying causes. This makes it important not only to recognise the theoretical strengths of each planning and control practice but also to examine which specific challenges are most effectively addressed by which practices.

Therefore, lean construction is not treated as an additional objective of this study but as a conceptual framework to situate the analysis of change order management challenges. By mapping the identified challenges in Malaysian rail projects against the relevant planning and control practices, the study positions lean construction as a lens through which these obstacles can be better understood. For rail projects where efficiency, safety and coordination are paramount, lean practices provide both the theoretical grounding and the practical tools to enhance the way change orders are processed.

METHODOLOGY

A research gap exists in understanding the practical challenges of change order management in rail construction projects. Therefore, this study adopts a qualitative research approach, using the established change order management framework of 3 phases, inclusive of 11 procedures, as the basis for inquiry. By asking respondents to reflect on their experiences across each step of the change order management framework, the study captures first-hand insights into the challenges practitioners face.

Qualitative methods are employed in this study to enable an in-depth exploration of industry practices, thereby uncovering issues that are often overlooked in the broader literature (Dursun, 2023). Furthermore, this study also adopts a deductive approach, as it is grounded in the existing change order management framework, rather than aiming to generate a new theory (Pearse, 2019). The deductive logic directly supports the research objective of identifying and analysing challenges across each phase and procedure of the change order management process. The sampling frame for participants in this study was derived from the Malaysian Rail Supporting Industry Roadmap 2030, developed by the Malaysia Industry-Government Group for High Technology (MIGHT [Malaysia Industry-Government Group for High Technology], 2014), which identifies organisations that remain active and strategic to the national rail sector. These organisations include rail operators and asset owners, design manufacturing and assembly firms, maintenance, repair and overhaul companies and support services providers. Within these organisations, individuals were purposively selected based on two main criteria: (1) professional experience in rail project management and (2) direct involvement in the handling of change order processes. This study also employed snowball sampling to complement the purposive selection process. Given the specialised nature of rail project management, initial respondents were asked to refer additional experts who met the selection criteria.

Figure 3 presents an overview of how the study was operationalised. The interviews continued until data saturation was achieved, ensuring that responses were comprehensive and that no new significant themes emerged (Saunders et al., 2018). All audio recordings were transcribed verbatim to ensure accuracy and preserve the richness of participants' responses. The data were then analysed using thematic analysis with NVivo15 (Lumivero, Denver, CO, US) software, through an iterative cycle of coding, constant comparison and refinement of emerging categories. Initial codes were generated from the interview transcripts and progressively grouped into sub-themes and broader themes based on conceptual similarity and relevance to the research objectives.

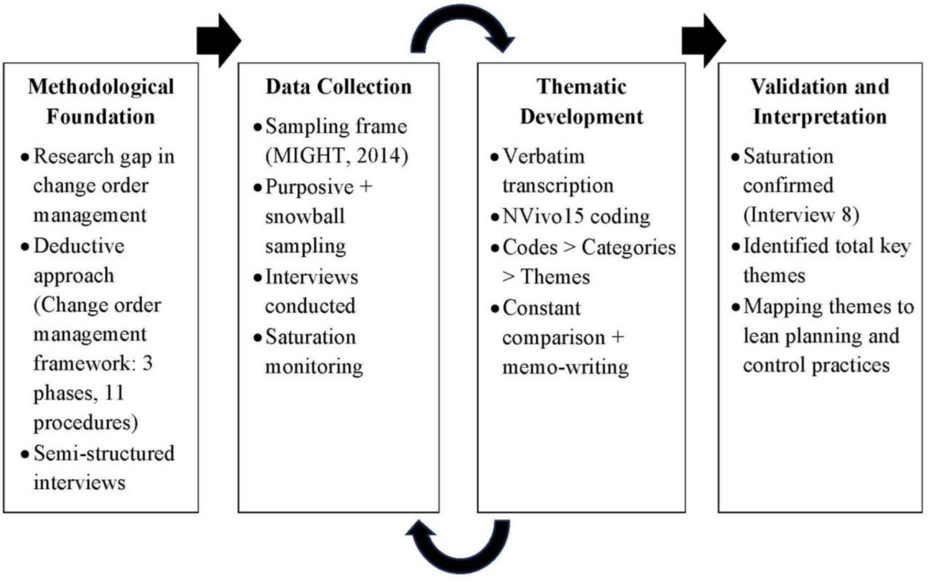

Figure 3. Overview of qualitative analysis workflow

As illustrated in Figure 4, 66.7% of themes were already identified by Interview 2, showing that most themes emerged early. Theme saturation was achieved by Interview 6, with no new themes appearing in Interviews 7 and 8, indicating strong stability. Data collection and analysis were conducted concurrently, where codes and categories were developed directly from the interview responses. A constant comparison method was applied throughout the process, supported by ongoing memo-writing to document analytical decisions and refine theme boundaries. This iterative cycle continued until Interview 8, at which point no further insights emerged and analytical saturation was confirmed.

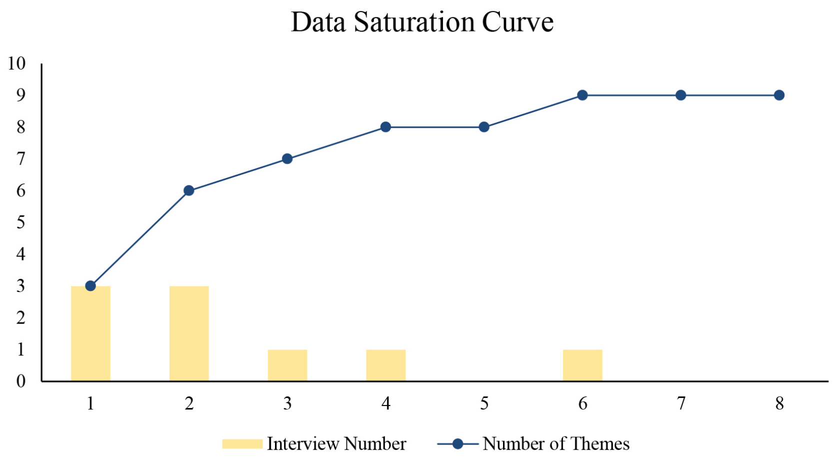

Figure 4. Data saturation curve

To strengthen the analysis, the challenges reported by respondents were not only coded into overarching themes but also systematically mapped to relevant planning and control practices within lean construction. This step ensured that the findings moved beyond a descriptive account of challenges and instead highlighted their alignment with established improvement practices. In doing so, each challenge identified across Phases A, B and C was reviewed in relation to which of the nine planning and control practices could most appropriately address it. This analytic structure allowed the study to connect the observed challenges in change order management practices with potential lean-based solutions, thereby enhancing both the practical and theoretical contributions of the research.

RESULTS

The interview was structured based on the established change order management framework, which comprises 3 phases and 11 procedures. Using this framework as a guide, respondents were asked to reflect on the challenges encountered in managing change orders within each phase. From the 8 professionals interviewed, as shown in Table 3, a total of 15 raw challenges were initially identified across the framework. These raw challenges were then consolidated and refined into broader categories to capture recurring patterns.

Table 3. Research respondents

Respondent	Position	Experience (Years)
R1	Senior project manager	12
R2	Quantity surveyor	5
R3	Director of project management	12
R4	Quantity surveyor	9
R5	Quantity surveyor	2
R6	Quantity surveyor	4
R7	Junior project manager	1
R8	Quality assurance and quality control engineer	3

The coding process resulted in the identification of nine overarching themes that capture the issues within change order practices:

1. Limited collaboration.
2. Inadequate clarity and sequencing.
3. Gaps in location-based management.
4. Absence of benchmarking against best practices.
5. Inefficient processes and persistent defects.
6. Misalignment between decisions and value creation.
7. Ineffective team meetings.
8. Poor consideration of downstream needs.
9. Weak mistake-proofing mechanisms.

Table 4 presents the 9 overarching themes of challenges in change order management implementation, derived from the 15 raw challenges reported by respondents. Several raw challenges were coded under more than one theme, reflecting their relevance across multiple aspects of the change order management framework. These themes are subsequently elaborated in the following paragraphs according to the phases of the change order management framework.

Table 4. Themes of challenges in change order management implementation

Change Order Management Framework	**Nodes (Challenges)**	**Key Themes**	
Phase A: Start-Up and Identify and Evaluate	Late identification of changes	CS	Inadequate clarity and sequencing
	Incomplete or unclear documentation	PM	Weak mistake-proofing mechanisms
	No clear criteria for cost/time/scope evaluation	CS	Inadequate clarity and sequencing
	Limited collaboration across teams	CB	Limited collaboration
	Unclear roles in managing changes	CS	Inadequate clarity and sequencing
Phase B: Approval and Propagation	Slow client approval	DVC	Misalignment between decisions and value creation
	Design and baseline updates not aligned	DW	Poor consideration of downstream needs
		BM	Absence of benchmarking against best practices
	Poor communication of approved changes	CB	Limited collaboration
	Info not reaching subcontractors/ suppliers on time	CB	Limited collaboration
		LBM	Gaps in location-based management
	Weak coordination between consultants, contractors and site	TM	Ineffective team meetings
	Last-minute instructions outside formal process	TM	Ineffective team meetings
Phase C: Post-Change	Disputes over scope or cost responsibility	DVC	Misalignment between decisions and value creation
	Excessive paperwork in dispute resolution	PM	Weak mistake-proofing mechanisms
	Delayed resolution affecting progress	PM	Weak mistake-proofing mechanisms
		PD	Inefficient processes and persistent defects
	Lack of lessons learned for future projects	BM	Absence of benchmarking against best practices

Phase A: Start-Up and Identify and Evaluate

Phase A of the change order management framework, which encompasses the early procedures of identifying, recording, evaluating and commenting on proposed changes, was found to be particularly challenging for respondents. Across the eight professionals interviewed, five recurring issues were emphasised, reflecting the difficulties of initiating change orders systematically.

First, respondents highlighted the late identification of changes, where potential changes were often identified only after they had already begun the construction process. This challenge reflects the theme of inadequate clarity and sequencing, as the absence of structured and transparent steps made it difficult to detect potential changes early.

In this context, clarity refers to having well-defined procedures, responsibilities and timelines that guide how changes are identified and recorded. Without such clarity and proper sequencing, changes remain unnoticed until they escalate into disruptions. This mirrors findings by Aslam, Baffoe-Twum and Saleem (2019), who observed that insufficient clarity in early processes often leads to reactive rather than proactive change handling.

Second, the issue of incomplete or unclear documentation emerged as another obstacle. Several respondents described how some change requests lacked the necessary detail to support informed decision-making. This was categorised under weak mistake-proofing mechanisms, as missing or fragmented records can affect the systematic verification and create room for errors. Similar concerns were reported by Khoso et al. (2019) who emphasised that incomplete documentation undermines accountability and increases the risk of rework.

The next challenge was the absence of clear criteria for evaluating cost, time or scope implications. Respondents expressed uncertainty about which benchmarks or standards should guide the assessment of changes, leading to inconsistent judgments. This also falls under inadequate clarity and sequencing, underscoring the lack of standardised reference points to ensure consistent evaluation. This echoes the argument of Mittal and Paul (2018), who highlighted the absence of common criteria as a critical weakness in construction change management.

Fourth, limited collaboration across teams was repeatedly noted. Respondents shared that decisions in this phase were often made within silos, with minimal input from other stakeholders, resulting in delays and misalignments downstream. This reflects the theme of limited collaboration, highlighting the importance of cross-functional integration in the early change order management stages. The importance of early stakeholder involvement is similarly stressed in Kurwi et al. (2021), who linked poor collaboration with downstream inefficiencies.

Lastly, respondents identified unclear roles in managing changes, where ambiguity over who held the authority to evaluate, approve or reject proposals frequently caused confusion. This again reflects inadequate clarity and sequencing, since unclear responsibilities not only slowed down decisions but also disconnected them from broader project priorities. This finding resonates with Khahro et al. (2023), who argued that role ambiguity often results in delayed approvals and weakens alignment with project objectives.

Phase B: Approval and Propagation

Phase B of the change order management framework, which includes the approval of changes and their propagation across design, project baselines and construction teams, presented six major challenges as highlighted by respondents. Unlike Phase A, where the issues centred on initiating and clarifying changes, Phase B was characterised by coordination breakdowns and procedural inefficiencies that disrupted the smooth flow of approvals and information.

One of the challenges was the slow approval process from clients and this was linked to the misalignment between decisions and value creation theme. Prolonged client decision-making often held up critical project activities, forcing teams either to wait or proceed informally, both of which compromised efficiency and alignment with project priorities. This resonates with Khahro et al. (2023), who highlighted that delayed approvals from clients are a common driver of schedule overruns and reactive workarounds in construction projects.

Another challenge was the misalignment between design updates and project baselines. Respondents explained that revised drawings and scope changes were not consistently reflected in updated schedules, creating discrepancies between planning and actual execution. This reflected poor consideration of downstream needs because teams did not properly consider how design changes would affect later stages of the project. It also indicated the absence of benchmarking against best practices, since there were no standardised reference points for reconciling updates systematically. Similar gaps were reported by Mahamid (2017), who noted that inconsistent alignment between design and baseline updates often leads to rework and resource inefficiencies.

Inconsistent communication of approved changes to parties was also highlighted as a major challenge. Respondents explained that information was sometimes shared only with certain groups, such as consultants or main contractors, while others, like subcontractors or site teams, were left out.

This created gaps in collaboration, as uninformed teams could not coordinate their work properly. Even when the information was passed on, it often came in different formats or through unconnected channels, resulting in inconsistent instructions.

In addition, delays in reaching subcontractors and suppliers, particularly those located away from the main project offices, also further reinforced this communication gap. These problems were also categorised under limited collaboration and gaps in location-based management, as the widespread of stakeholders and weak coordination systems often caused information breakdowns. Similar concerns were highlighted by Yap, Abdul-Rahman and Chen (2017) who noted that fragmented and delayed communication in construction projects often leads to misunderstandings, inefficiencies and slow change implementation.

Furthermore, weak coordination between consultants, contractors and site teams further compounded these issues. This was categorised under ineffective team meetings, as discussions were either not held regularly or lacked structure, preventing stakeholders from reaching common decisions. Daniel, Pasquire and Dickens (2019) similarly emphasised that poorly managed meetings limit early identification of coordination gaps, leading to delays and misalignment.

Finally, the issue of last-minute instructions given outside the formal approval process further highlighted weaknesses in team meetings. In several cases, stakeholders bypassed the official approval channels, such as written consent from consultants or clients. And instead issued direct instructions on-site. For example, contractors were sometimes told verbally to change the sequence of work or to use alternative materials without proper documentation. While these ad-hoc decisions were intended to keep progress moving, respondents noted that they often created disruptions later, as the changes were not formally recorded or aligned with contractual requirements. This aligns with Zakaria, Ismail and Yusof (2022), who observed that informal instructions increase the likelihood of disputes and weaken accountability.

Phase C: Post-Change

The final stage of the change order management framework, Phase C (Post-Change), focuses on dispute resolution. Although it contains only one procedure, respondents emphasised it as the most contentious and administratively demanding stage. Four main challenges were identified, reflecting both procedural inefficiencies and missed opportunities for organisational learning.

A recurring challenge was disputes over scope or cost responsibility, where contractors, consultants and clients disagreed on who should bear financial or time-related consequences. This was linked to misalignment between decisions and value creation, as stakeholders often prioritised protecting their contractual interests over preserving overall project value, prolonging conflicts and straining relationships. Similar issues were reported by Daniel, Pasquire and Dickens (2019), who noted that unresolved contractual disputes often delay project progress and affect stakeholder collaboration.

Excessive paperwork in the dispute resolution process was also highlighted. Respondents described it as bureaucratic and repetitive, introducing delays and errors. This challenge aligns with weak mistake-proofing mechanisms, reflecting how reliance on manual documentation reduces process reliability. Sbiti et al. (2021) also emphasised that documentation that is complicated or hard to manage increases the risk of mistakes and slows down change management.

Delayed resolution of disputes further impacted on-site progress, as unresolved issues created bottlenecks for subsequent activities. This challenge relates to both weak mistake-proofing mechanisms and inefficient processes and persistent defects, highlighting how unresolved issues disrupt project flow and can cause repeated errors. Similar observations were made by Attia and Uddin (2024), who found that delayed dispute resolution often propagates inefficiencies downstream in construction projects.

Finally, respondents highlighted a lack of lessons learned for future projects. Despite frequent disputes, there were few structured mechanisms to analyse root causes or transfer insights to subsequent projects. This was linked to the absence of benchmarking against best practice, indicating how missed learning opportunities hinder continuous improvement in change order management processes. This aligns with Chen et al. (2015), who stressed that systematic benchmarking and knowledge transfer are critical for improving change management practices.

DISCUSSION

Building on the literature review, each of the nine key challenges identified across phases of the change order management framework can be addressed through targeted planning and control practices drawn from lean construction. Table 5 presents the potential planning and control practices for each change order management phase, linking the challenges identified from respondents to practical, phase-specific solutions. The planning and control practices have been mapped to the change order management phases in which they are most relevant, highlighting their potential to mitigate specific challenges at each stage.

Table 5. Potential planning and control practices for each change order management phase

Change Order Management Framework	Key Challenges		Potential Planning and Control Practice Solutions for Related Challenges	
Phase A: Start-Up and Identify and Evaluate	CS	Inadequate clarity and sequencing	Work structuring and scheduling	Breaking down tasks Better clarity and sequencing
	PM	Weak mistake-proofing mechanisms	Error-proofing	Designing processes to prevent mistakes
	CB	Limited collaboration	LPS	Collaborative planning
Phase B: Approval and Propagation	DVC	Misalignment between decisions and value creation	VBM	Aligning decisions with value creation
	DW	Poor consideration of downstream needs	Pull scheduling/ planning	Scheduling tasks based on downstream needs
	BM	Absence of benchmarking against best practices	Benchmarking	Comparing against industry standards/ best practices
	CB	Limited collaboration	LPS	Collaborative planning
	LBM	Gaps in location-based management	LBMS	Managing work based on physical locations
	TM	Ineffective team meetings	Daily cluster/ huddle meetings	Focused team meetings to plan daily tasks
Phase C: Post-Change	DVC	Misalignment between decisions and value creation	VBM	Aligning decisions with value creation
	PM	Weak mistake-proofing mechanisms	Error-proofing	Designing processes to prevent mistakes
	PD	Inefficient processes and persistent defects	Six Sigma	Process improvement Defect reduction
	BM	Absence of benchmarking against best practices	Benchmarking	Comparing against industry standards/ best practices

Potential Planning and Control Practices for Phase A Challenges

Phase A of the change order management framework focuses on initiating, identifying and evaluating proposed changes. Respondents highlighted three key challenges in this phase. First, inadequate clarity and sequencing were reported, where unclear task responsibilities and poorly structured procedures hinder early detection and recording of change orders. This lack of clarity not only delays tasks but also increases the likelihood of errors and complicates collaboration (Nolan-McSweeney, Ryan and Cobb, 2023). Applying work structuring and scheduling as a planning and control practice addresses this by breaking down tasks into manageable components, establishing logical sequences and clarifying responsibilities, thereby reducing uncertainty and improving early-phase efficiency (Andersen, Belay and Seim, 2012).

The second challenge is weak mistake-proofing mechanisms. Incomplete or inconsistent documentation was perceived as a critical factor leading to errors during change order activities. Integrating error-proofing planning and control practices can proactively safeguard processes by preventing common mistakes, reducing rework and reinforcing the reliability of early-phase procedures. This approach also complements clarity and sequencing efforts, as well-defined tasks make error-proofing more effective (Basahel, 2019).

Finally, limited collaboration was noted, with stakeholders often working in silos, resulting in miscommunication and delayed alignment on proposed changes. The LPS introduces a structured collaborative planning approach that engages relevant parties in joint discussions and commitments (Belayutham et al., 2022; Lappalainen et al., 2022). By fostering shared understanding and coordinated action, LPS not only mitigates collaboration challenges but also reinforces the effectiveness of sequencing and error-proofing interventions in Phase A.

Potential Planning and Control Practices for Phase B Challenges

Phase B of the change order management framework focuses on formal approval and propagation of proposed changes. Respondents highlighted five interrelated challenges at this stage, which collectively influence the quality, alignment and flow of decision-making.

The first challenge is misalignment between decisions and value creation. Respondents indicated that decisions made during approval often did not reflect project priorities or client-defined value, leading to approvals that satisfied procedural requirements but failed to optimise project outcomes. This misalignment suggests a gap in how value is interpreted and operationalised across stakeholders (Andrić et al., 2019). Implementing value-based management as a planning and control practice can help in ensuring that the approval decisions are systematically evaluated against value drivers, enabling teams to prioritise options that maximise benefits and reduce unnecessary cost or scope implications (Björnfot et al., 2011).

The second challenge involves poor consideration of downstream needs. Participants reported that decisions made in Phase B frequently overlooked the impact on subsequent activities such as site execution, procurement or coordination with other work packages. This upstream-downstream disconnect can trigger rework, delays and unanticipated resource conflicts once changes are propagated. Pull scheduling offers a suitable planning and control practice to address this issue by planning approvals based on downstream requirements, ensuring that each decision supports and does not disrupt the subsequent workflows (Basahel, 2019).

The third challenge in this phase is the absence of benchmarking against best practices (BM). Respondents noted that approval decisions were often made in isolation from industry norms or past project performance, reducing opportunities for learning and improvement. Without referencing evidence-based benchmarks, decisions risk becoming subjective and inconsistent. Introducing a benchmarking planning and control practice encourages teams to compare proposed changes with established standards or historical data, promoting more informed and defensible approval outcomes (Huang et al., 2023). Benchmarking also complements value-based management by providing objective reference points for evaluating value.

Limited collaboration also emerged as a recurring challenge in Phase B. Stakeholders involved in approvals often worked independently, resulting in fragmented perspectives and delayed consensus. This siloed approach weakens value alignment and increases the likelihood of overlooking downstream implications. The LPS provides a structured collaborative environment where decision-makers engage in joint discussions and enable transparent evaluation of impacts (Belayutham et al., 2022; Lappalainen et al., 2022). In this context, LPS not only enhances collaboration but also reinforces the effectiveness of value-based management and pull scheduling by ensuring collective reasoning.

Finally, respondents highlighted gaps in location-based management. Despite approvals being granted, there was often poor visibility of how approved changes affected specific physical locations on-site. This lack of spatial awareness complicates coordination, increases congestion risks and affects resource allocation (Mohamad, Nekooie and Al-Harthy, 2012). Applying a LBMS helps teams assess change impacts by mapping work packages to actual site locations, enabling more precise propagation of instructions (Mouflard and Seppänen, 2012). This planning and control practice also interrelates with downstream planning, as spatial clarity reduces conflicts that pull scheduling aims to prevent.

Potential Planning and Control Practices for Phase C Challenges

The final phase in the change order management framework (Phase C) focuses on monitoring, evaluating and consolidating the outcomes of implemented changes. In this stage, respondents highlighted four key challenges that influence the effectiveness of post-change performance and learning.

The first challenge is misalignment between decisions and value creation. Respondents noted that even after changes were implemented, project teams often struggled to ensure that the outcomes delivered the intended value. This suggests that value considerations were either not fully embedded during implementation or were not systematically tracked afterwards (Andrić et al., 2019). Applying value-based management in this phase ensures that post-change evaluations can assess whether the results align with defined value objectives. By creating feedback loops that connect outcomes to value drivers, value-based management strengthens organisational learning and helps refine future decision-making (Björnfot et al., 2011).

Weak mistake-proofing mechanisms emerged as the second challenge. Respondents reported that recurring errors or inconsistencies may appear during post-change activities, indicating that preventive controls were insufficient or not integrated into the revised processes. This reveals that change implementation may resolve surface-level issues but leave underlying process vulnerabilities unaddressed. Therefore, integrating error-proofing planning and control practices provides structured safeguards that prevent common mistakes from reoccurring, helping teams stabilise the improved process and reduce variability (Basahel, 2019). This practice also complements value-based management, as fewer errors support more predictable value delivery.

The third challenge involves inefficient processes and persistent defects. Participants observed that, even after changes were executed, some processes remained unstable or continued to produce defects, suggesting gaps in root-cause analysis or continuous improvement capability (Huang et al., 2023). Applying Six Sigma as a planning and control practice is particularly relevant in this phase, as its structured methodologies (e.g., define, measure, analyse, improve and control) allow teams to identify defect sources, reduce variability and enhance process performance (Siddiqui et al., 2016). Six Sigma not only addresses the symptoms of inefficiency but also promotes data-driven evaluation, which strengthens the value alignment initiated through value-based management and improves the reliability of error-proofing measures.

A final challenge identified was the absence of benchmarking against best practices. Respondents noted that post-change evaluations rarely compared performance improvements against industry standards or prior project benchmarks, limiting the organisation's ability to assess whether the implemented changes truly represented an improvement. Incorporating benchmarking as a planning and control practice enables teams to evaluate post-change outcomes in relation to external references or historical baselines (Huang et al., 2023). This comparison provides a clearer picture of performance gaps, validates the effectiveness of the change and informs further refinement. Benchmarking also reinforces Six Sigma efforts by offering objective metrics to gauge progress.

CONCLUSION

This study identified nine interrelated challenges across the three phases of change order management in Malaysian rail construction projects, revealing that inefficiencies are systemic rather than phase-specific. By mapping these challenges to relevant planning and control practices from lean construction, the study demonstrates that each change order management phase has clear opportunities for targeted interventions.

These findings matter because they highlight where change orders break down and show how value misalignment, process inefficiencies, weak error prevention and limited collaboration accumulate across phases to affect overall project performance. Integrating planning and control practices provides a structured, value-driven approach to improving decision-making and strengthening the efficiency of change order management activities in rail projects.

Theoretically, this study contributes a novel, phase-specific mapping framework that links qualitative insights on change order management challenges directly to actionable lean strategies. This bridges a gap in existing literature where change order management and planning and control practices have typically been examined separately, offering a more integrated way to conceptualise change management in complex infrastructure contexts.

Practically, the study offers project teams and contractors a set of phase-by-phase planning and control practice options that can serve as a preliminary guideline for enhancing coordination, reducing delays and improving the quality of change order decisions. While this research provides the initial mapping, practitioners can further explore, customise and implement these practices to suit project needs. For policymakers, the findings highlight the importance of promoting consistent, transparent change order management standards and encouraging the implementation of lean-based practices to elevate industry performance.

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