

THE NEED TO BETTER MANAGE INFORMATION IN FIELD REWORK

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ABSTRACT

Field Rework remains a persistent and disruptive feature of construction projects, contributing to delays, cost overruns, and coordination problems. Despite extensive research on rework causes, reduction, and prevention, limited attention has been paid to how rework is managed once it occurs, particularly from an information-management perspective. To address this gap, this paper examines how information is managed during field rework in construction projects through a qualitative study based on eight semi-structured interviews with experienced practitioners, to identify patterns in current practices and decision-making processes. The findings show that the impact of rework is shaped by activity interdependencies and the speed at which reliable information and approvals are obtained. Practitioners commonly operate within a mixed communication environment that combines formal and informal channels to respond under time pressure, which improves responsiveness but also increases the risk of misalignment and further rework. This study contributes by advancing the study of rework once it occurs, particularly from an information management perspective, and lays the groundwork for future research aimed at expediting its delivery while reducing its adverse impacts. The paper concludes by highlighting the need for a standardised framework to strengthen information management during field rework and better integrate digital tools with contractual and quality management processes.

KEYWORDS

Rework, rework management, field rework, information management, lean construction.

INTRODUCTION

Construction projects are complex by nature and require effective and well-coordinated management to achieve the desired performance outcomes. The temporary nature of construction projects, which brings together multiple individuals and teams for a limited period to deliver a unique outcome within time and quality constraints, further contributes to their overall complexity (Mossman & Ramalingam, 2021). In response, researchers have actively studied how construction management practices can be enhanced to improve project delivery performance. Despite the range of established tools and techniques available within construction project management, the traditional methods and control mechanisms are often insufficient for managing the realities of highly complex projects (Ford & Gosling, 2024; Ma et al., 2019). In fact, the one-of-a-kind nature of construction projects (Koskela, 1992), with unique designs, site conditions, and stakeholder requirements, shapes how each project must be

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managed. However, while considerable scholarly and practical efforts focus on ensuring that work is delivered as planned, much work still ends up requiring rework, a phenomenon that continues to hinder project performance.

A well-cited definition of rework describes it as “the unnecessary effort of re-doing a process or activity that was incorrectly implemented the first time” (Love & Edwards, 2004). Although this definition focuses on correcting processes or activities, rework can also arise from design modifications, client-driven changes, or weather conditions, which are not necessarily errors but are part of the dynamic nature of construction projects. Consequently, other scholars, such as Hwang and Yang (2014), define rework more broadly as activities that must be repeated or that remove previously completed work. In the literature, scholars often use several terms such as deviations, changes, errors, omissions, defects, failure, damages, and nonconformance, to describe issues associated with or leading to rework, which has contributed to a lack of uniformity in how the concept is defined (Asadi et al., 2021). Moreover, while rework can occur at any stage of a construction project, several studies have shown that its impact is greatest during the construction phase (e.g., Rogge et al., 2001; Hegazy et al., 2011), which is the focus of this study. Given this focus, this study adopts the early definition proposed by Rogge et al. (2001), who define field rework as “activities in the field that have to be done more than once or activities which remove work previously installed as part of the project.” This definition has been extended by Love (2025) who defines field rework as redoing work on site regardless of its cause, while excluding approved scope changes, design changes, errors or omissions in contract documents, and off-site supplier or subcontractor issues that do not affect site construction. However, the adoption of these definitions in this study reflects a focus on how field rework is managed rather than its underlying causes. This may limit the interpretation of the findings, as different causes may require different management approaches, while the study provides a more generalised overview of the current rework management practices.

When rework is required, substantial information must be obtained, assessed, and communicated before corrective work can begin, highlighting the central role of information in rework management and supporting Winch’s (2012) view that “the problem of managing construction projects is principally a problem in the management of information.” Accordingly, this paper focuses on the processes and flows of information once rework occurs rather than the technical reconstruction activities. Moreover, although the prevention or reduction of rework remains a key concern for both researchers and industry, this paper does not seek to develop such strategies but instead examines the shortcomings in the current management practices once rework is required. Remarkably, the majority of studies on field rework focus on its prevention or reduction, while only limited studies have investigated how field rework is managed once it occurs. This paper aims to contribute to addressing this gap by integrating a review of the existing literature with empirical evidence derived from semi-structured interviews. By understanding how rework is currently managed on construction sites, this paper provides a basis for future research to improve rework management practices.

LITERATURE REVIEW

FIELD REWORK

Field rework is widely recognised as a major contributor to cost overruns and delays in construction projects. However, as argued by Asadi et al. (2021), reported figures on the delay and cost impacts of rework vary significantly because each study applies different measurement methods. This view is supported by Love (2025), who also questioned the accuracy of these

figures, noting that available data are further constrained by contractors' reluctance to disclose cost information due to commercial confidentiality. To give some examples, the earlier Egan's Rethinking Construction Report (1998), noted that up to 30% of construction activity may consist of rework. Josephson et al. (2002), in their study of seven construction projects, reported that the errors identified during the observation period accounted for an additional 4.4% of the contract value and required approximately 7.1% of total work time. Despite these early warnings about the adverse impact of rework on construction projects, recent studies continue to report substantial levels of rework that arise from a range of different causes. For instance, a case study conducted by Love et al. (2018), drawing on data from 218 projects that recorded 7,082 Non-Conformance Reports (NCRs), reported that the direct rectification costs represented approximately 0.18% of original contract value, while noting that indirect costs were hypothetically estimated to be nearly six times higher than the measured direct costs. Notably, the study also showed that 44% of NCRs were classified as "used-as-is," suggesting that stakeholders may accept certain deviations to avoid the adverse impacts of rework on cost and schedule, even though these NCRs can eventually undermine overall project quality.

From a Lean Construction perspective, rework is considered a non-value-added activity that disrupts workflow and results in waste of time, labour, and resources (Koskela, 1992). Lean principles focus on maximising value while minimising waste, ultimately leading to more efficient project delivery and improved overall quality. Ballard (1993) argued that reducing rework in field activities requires completing work correctly the first time, learning rapidly from any errors that occur, and tracing recurring errors back to their root causes so that these causes can be eliminated. This approach is consistent with the principles of benchmarking, a method that Love and Smith (2003) later elaborated as a potential strategy for reducing rework. More recently, a review by Sharma and Laishram (2024) listed the lean tools and approaches presented in the literature to minimise rework on construction sites. Their study found that the Last Planner System (LPS) and just-in-time (JIT) approaches were the most widely adopted tools, while Integrated Project Delivery (IPD) was among the least commonly utilised. However, there is limited empirical evidence demonstrating the effectiveness of lean approaches in reducing rework and further investigation is still needed (Asadi et al., 2021; Love, 2020).

Rework is considered a form of variability, and lean principles therefore emphasise minimising and eliminating such variability. Koskela (1992) described variability as any departure from expected production conditions that undermines flow and increases waste. In practice, complete elimination of rework is neither realistic nor achievable, as Ballard (1999) argues that production systems naturally experience fluctuations in capacity even when methods, technologies and conditions remain constant, making workflow instability an inherent characteristic of construction projects, which may contribute to the occurrence of rework. Even so, Zhang et al. (2021) observed that most research efforts on rework focus on analysing root causes or developing reduction methods to achieve a "zero rework" objective, which is practically impossible. As a consequence, Asadi et al. (2021) affirmed that recent evidence indicates that rework has not been reduced, despite the many solutions and models proposed by the researchers. In response to this gap, a few researchers have begun shifting their position towards accepting field rework and exploring strategies for managing it. A study by Love et al. (2023) on rework resulting from human error on construction sites supports this view. The authors suggest that construction stakeholders should accept that 'errors happen' and direct their efforts toward mitigating their adverse consequences. Accordingly, they argue that stakeholders should shift from an emphasis on error prevention (Quality-I) to an approach that focuses on error management (Quality-II). Yet, despite these emerging perspectives, further research is still needed. Addressing this gap requires closer examination of the current practices

and decision-making process involved in managing field rework, which the following section explores in greater detail.

MANAGEMENT OF FIELD REWORK

We now review current practice in the management of field rework. A first step is to consider how contracts deal with field rework, as the type of contract in place can influence whether field rework has a positive or negative effect on the affected parties (Smith et al., 2023). Rework often leads to claims, conflicts, and disputes, as the responsibilities regarding field rework are often unclear or open to interpretation (Asadi et al., 2023; Josephson et al., 2002; Love et al., 2005). In some scenarios, the relevant parties may accept their responsibilities once an agreement is reached, thereby avoiding the dispute-resolution process and the significant legal costs associated with it (Marosszeky et al., 2005). Remarkably, the standard forms of contract such as FIDIC, JCT, and NEC4 do not directly mention the term “rework” and instead address its implications through clauses on deviations, variations, and changes. As a result, ambiguity may arise regarding how rework is to be managed, as these contracts primarily identify the responsible party for instructing and executing such rework, rather than specifying the processes through which rework should be coordinated, communicated, and documented. In addition, the management of rework in practice requires the interaction of multiple project parties across the full cycle of rework, which is often not explicitly addressed in standard contract provisions, underscoring the need for a more structured and detailed approach.

Rework is recognised as a change that might disturb the project workflow, and effective ‘change management’ is therefore central to controlling rework. For example, project managers generally attempt to act quickly when rework is required to address the resulting conflicts with planned activities in order to prevent further disruption (Ma et al., 2019). Another common practice is the use of ad-hoc daily inspection lists to track incomplete work and rework (Perera et al., 2011). Yet, the need of more structured approach to incorporating rework into construction schedules is articulated by Hegazy et al. (2011). They propose a schedule analysis mechanism built on three aspects: a new schedule representation of rework, a delay analysis procedure that accounts for rework, and an optimisation process that accelerates the project by the number of identified delay days in a cost-effective manner. Similarly, Ma et al. (2019) demonstrate that traditional scheduling techniques are insufficient for projects exposed to rework risks and introduce an improved Critical Chain Design Structure Matrix to develop more reliable schedules under such scenarios. Their method quantifies rework-prone activities, evaluates their impact on project duration, and generates alternative schedules with tailored rework, enabling practitioners to better anticipate disruptions and mitigate rework-induced delays. Furthermore, Love et al. (2002) developed a system dynamics based causal loop model to explain how change and rework interact with project dynamics and influence overall performance. Another causal loop model was later developed by Forcada et al. (2017), illustrating how project, organisational, and people-related factors interact to generate rework, and that can support the development of more effective change management strategies to manage rework. Moreover, change management systems are used to implement changes in construction projects (e.g., Motawa et al., 2007). However, these systems rely on the assumption that project managers can obtain all the information needed to understand the expected implications of a proposed change before it is implemented, something that is often difficult to achieve (Isaac & Navon, 2010), especially in the case of rework.

MANAGING INFORMATION IN FIELD REWORK

In an information-driven sector, information management is fundamental to the success of practices undertaken by the sector. Choo (2002) defined Information management as a process that involves identifying, acquiring, organising, distributing, and using information to support

various activities. It plays a key role in clarifying tasks, supporting decision-making, tracking progress, facilitating stakeholder communication, and maintaining records for future claims (Li et al., 2022). On construction sites, the management of information is challenged by uncertainty and the lack of complete and timely information needed to make effective decisions (Winch, 2012). There is also a level of complexity in managing information, influenced by factors such as ineffective communication, insufficient details, frequent contract changes, delays in information exchange, unpleasant relationships among stakeholders, and the complexity of the project itself. In addition, information is generated by multiple stakeholders in varying forms and formats (e.g., structured and unstructured data) and exchanged through different channels (e.g. email, cloud-based platforms, printouts), often making accurate and reliable information difficult to access and hindering continuous improvement (Matthews et al., 2022). Collectively, these factors generate information waste and disrupt effective information flow, which goes against lean principles that emphasise providing clear, timely, and value-adding information. In fact, inefficient information flow has been widely recognised as one of the major causes of rework in construction (Gumusburun Ayalp & Arslan, 2025; Matthews et al., 2022), and we argue that this challenge does not end once rework occurs; instead, it continues to influence how rework is managed and often adds further complexity to the process.

Information and communication technologies (ICT) and standardisation have become increasingly central to improving information management in construction sites. The commonly used ICT tools to enhance information flow between virtual models and construction sites were identified in a review by Alsafouri and Ayer (2018). The Get It Right Initiative (GIRI) identifies several digital tools currently used in the market to reduce rework, including BIM platforms, cloud and digital twin technologies, and AI and machine-learning applications (*Get it Right Initiative*, 2023). However, while Asadi et al. (2021) call for the use of advanced technologies to support the management of rework once it occurs, they argue that the use of technology alone does not guarantee effective management of rework or minimisation of its adverse impacts, if clear processes and instructions for addressing rework are not in place. Standards and other industry frameworks, such as ISO 19650, provide structured guidance for managing information in construction projects; however, they do not explicitly distinguish rework from normal project delivery processes, leaving a gap in how rework-related information should be specifically managed in practice and integrated in overall project information management. This information may include records such as non-conformance reports, change instructions, corrective action reports, and their associated approvals, responsibilities, and schedule revisions, among others.

In this context, several researchers have called for the development of new strategies to manage rework. Early work by Josephson et al. (2002) and Love et al. (2002) emphasise the importance of improving communication among project parties and advocate for developing common platforms and integrated information systems to enhance information exchange and coordination in rework scenarios. In addition, Isaac and Navon (2010) argue that available information often falls short of supporting the practical implementation of changes, offering only partial insight into their impacts. Hwang and Yang (2014) asserted that improved information practices can reduce waiting times for essential project information and support more efficient rework management. Also, Ma et al. (2019) demonstrate that neglecting information interactions between activities contributes to rework risk and show how reliable scheduling can mitigate this issue. Collectively, the literature emphasises the importance of strong communication, shared process understanding, clear timelines, effective information flows, and well-defined procedures for tracking defects, omissions, rework costs, and causal factors in supporting effective change management and quality outcomes across the project lifecycle (Asadi et al., 2021; Smith et al., 2023; Love et al., 2023; Love, 2025).

On this basis, recent research has shifted toward examining how rework-related information is structured, communicated, and used to support decision-making. A notable example is provided by Matthews et al. (2022), who developed a theoretical framework using smart data approach to generate an ontology of rework that can be effectively used improve how rework risks are classified and managed. This study is particularly valuable for this research on rework information because it maps the potential data sources of rework, such as nonconformance reports, field records, design documents, and correspondence, offering a useful starting point for future research into how such information is managed. Despite this contribution, there remains a lack of empirical research on how field rework information is managed once rework occurs and how this could be improved, which is the gap that the present study seeks to address using semi-structured interviews, as detailed in the next sections.

RESEARCH METHOD

In order to achieve the aim of this study, a qualitative research design based on semi-structured interviews was adopted. The use of semi-structured interviews involves guided conversations with open-ended questions, allowing respondents to explore topics in detail while providing the flexibility to address new and emerging themes during the discussion (Kvale, 2009). The interview questions were designed to understand how participants experience and manage field rework, with particular attention to the role of information.

A purposive sampling strategy was employed to recruit practitioners involved in the management and coordination of construction activities on site, such as contractors, project managers, site engineers, quantity surveyors, and related professional roles. The aim was to capture a range of perspectives across roles, organisations, and project types. A total of eight interviews were conducted with professionals occupying engineering, management, and specialist roles, each with between 7 and 25 years of professional experience. For ethical and confidentiality reasons, participant names are not reported. Instead, participants are referred to in the findings and discussion as P1–P8, with Table 1 summarising their profile characteristics. Half the participants worked primarily on railways and infrastructure projects, a quarter on building and real estate projects, and a quarter on industrial projects (oil and gas). In terms of experience, five out of eight participants (62.5%) had more than 20 years of industry experience.

Table 1: Characteristics of interview participants

ID	Position	Years of Experience	Project Type(s)	Country of work
P1	Senior Principal Highways Engineer	24	Railways & infrastructure	Saudi Arabia
P2	Civil Engineer	17	Railways & infrastructure	Oman
P3	Performance Management Specialist / Quantity Surveyor, ISO Auditor	12	Railways & infrastructure	Qatar
P4	Lead Project Engineer	21	Oil & gas projects	Oman
P5	Pipeline Engineer	7	Water distribution projects	Oman
P6	Senior Quantity Surveyor / Contract Administrator	22	Railways & infrastructure	Qatar
P7	Head of Projects	25	Real-estate development	Oman
P8	Senior Construction Manager	9	Civil & building construction projects	Oman

DATA COLLECTION AND ANALYSIS

Interviews followed a scenario-led questioning approach that encouraged participants to reflect on specific rework incidents and explain how they were managed in practice. The discussion explored how information was identified, communicated, and approved, as well as the procedures, policies, and contractual mechanisms that shaped decision-making when rework was required. Participants were also prompted to discuss the challenges they faced in maintaining accurate and up-to-date information and to offer practical recommendations for improving the management of rework-related information. This structure ensured that the interviews captured both existing rework management practices and opportunities to improve information management once rework occurs. All interviews were audio-recorded and subsequently transcribed.

The interview transcripts were imported into NVivo 14 and analysed using a thematic analysis approach as outlined by Braun and Clarke (2006). An initial coding framework was developed from the literature and refined inductively as new insights emerged from the data. The coding process progressed through three stages: open coding was used to identify meaningful segments relating to rework events, information flows, and decision processes; axial coding was used to group related codes and explore relationships among them; and themes were synthesised into overarching patterns across participants. The themes were iteratively reviewed to ensure coherence and strong grounding in the data.

FINDINGS AND DISCUSSION

The thematic analysis of the eight interview transcripts revealed several recurring patterns in how practitioners experience and manage field rework. Based on NVivo coding frequency, six out of eight participants (75%) explicitly associated rework with schedule delays, while five participants (62.5%) linked it to cost increases or resource waste. This section presents the interview findings and critically discusses them in relation to earlier literature. The integrated findings and discussion are structured around four interrelated themes.

1. NATURE AND IMPACT OF REWORK

There was a strong consensus among participants that the scale of rework disruption is highly context-dependent, particularly when it occurs on activities located on the critical path. In addition, P2 and P3 explained that even relatively minor corrections could affect the sequence of activities and force other trades to stop, demonstrating how rework can propagate beyond its immediate location and disrupt downstream project activities. When participants were asked about the types of rework they most commonly faced, 75% attributed it to problems in the availability, quality, and timing of project information, including late or partial design approvals and the use of outdated or incorrect drawing versions during construction, which aligns with the view of Winch (2021). Furthermore, 37.5% of participants noted that contractors often chose to proceed with work before receiving full formal approval in order to avoid project delays, a practice that frequently resulted in rework once design changes or client decisions were formally confirmed. A smaller group, 25% of participants, attributed rework to quality-related and client-driven factors, such as material performance issues and post-installation rejection, which they identified as sources of rework in their projects.

Moreover, participants' views aligned with those of Ballard (1999) and Koskela (1992) in framing rework as a built-in and persistent feature of construction, described by those with 20–25 years of experience as a normal, though unwanted, part of project life. This observation reinforces the difficulty of achieving the “zero rework” ideal criticised by Zhang et al. (2021). In addition, 87.5% of participants agreed that rework has not decreased in practice despite the growing number of tools and models available, which is consistent with the findings of Asadi

et al. (2021). In addition, none of the participants reported the use of lean approaches such as LPS and JIT to minimise or manage rework, which contrasts with the findings of Sharma and Laishram (2024), suggesting the need for further investigation into the challenges of applying these approaches for managing rework in practice. Overall, these results suggest that rework should be treated as a normal part of construction systems, highlighting the need for more effective management approaches rather than assuming it can be completely eliminated.

2. INFORMATION MANAGEMENT AND COMMUNICATION PRACTICES

When participants were asked how rework is communicated and coordinated, all participants reported relying on a combination of formal and informal communication channels, including face-to-face meetings, emails, formal letters, and structured reporting chains. Meetings were commonly used to align stakeholders on the technical implications of rework and to clarify responsibilities, while written communication, such as official letters, designated forms, and NCRs, was used to establish contractual accountability and formal approval. Rework-related information was described as covering NCRs, Requests for Information (RFIs), revised drawings, method statements, and time and cost impact analyses, as well as inspection reports, approvals, and change or variation orders. In addition, 50% of participants noted that informal communications (and their multiplicity), particularly through messaging apps and phone calls, were often used to maintain progress on site but were also seen as a potential source of risk when not subsequently aligned with formal documentation, sometimes resulting in rework when the final approved decision differed from the initial instructions. This observation aligns with Isaac and Navon's (2010) finding that available information rarely arrives in a fully complete form and Hwang and Yang's (2014) argument that waiting for critical information is a major source of inefficiency in the rework management process.

In addition, participants were asked about their awareness and use of information management standards. Approximately half reported being aware of ISO 19650 for managing information, although only a smaller group indicated that its principles were actively embedded in their organisational systems and workflows. Participants also referred to the use of other ISO-based standards, most commonly ISO 9001 for quality management and ISO 27001 for information security. In terms of information management systems used by participants once rework is required, approximately 75% of participants reported using such systems, including a quarter using Common Data Environments (CDEs), just over a third using company-specific document management systems, and only one participant referring to specific project management software. Notably, email and shared network drives remained the most commonly used communication tools across participants. However, several participants noted that these systems were primarily used by technical teams and were not fully integrated with contractual approval and governance processes, reflecting similar gaps identified by Matthews et al. (2022) and Asadi et al. (2021). Collectively, these findings suggest that, although digital information systems are widely used during rework events, the absence of a standardised, organisation-wide approach to managing rework-related information continues to limit effective coordination and learning, supporting calls for improved coordination and management practices by Josephson et al. (2002), Love et al. (2002), and Love et al. (2023).

3. CONTRACTUAL PROVISIONS AND FORMAL PROCEDURES

In this theme, the participants were asked about how rework is governed contractually. Almost all participants indicated that rework is rarely addressed as a distinct process within contract provisions and is instead managed through clauses on changes, variations, and defects. Several participants described rework as an event that must be agreed outside the original scope, typically through formal variation orders or time extension requests. Approximately 50% of participants reported that these formal records served not only as technical documentation but

also as mechanisms for allocating cost and responsibility, particularly in cases involving design changes, defects, or client-driven revisions. Participants who had worked on government-funded projects noted that regulatory policies and formal approval hierarchies shaped how rework was instructed. In specialised cases, re-tendering was required to appoint contractors with the appropriate technical capability to address the required rework. These experiences reflect ongoing contractual uncertainty around rework responsibilities and cost ownership, aligning with concerns raised by Smith et al. (2023), Asadi et al. (2023), and Josephson et al. (2002).

A second pattern concerned the formal change-management process that governs how rework is authorised and executed in practice. As illustrated by P8, a formal sequence was described that begins with work stoppage and formal notification to the client, followed by the preparation of time and cost impact analyses, and the submission of a method statement for approval before rework proceeds. Once approved, rework activities were typically controlled through inspection and testing stages, such as Requests for Inspection and formal sign-off, with documentation retained for audit and contractual purposes. 37.5% of participants reported using the cost-plus method in situations where the scope of rework could not be clearly defined, allowing work to continue in alternative locations while labour, materials, and plant usage were recorded for later reconciliation. However, several participants also noted that, under schedule pressure, technical instructions were sometimes issued ahead of full contractual approval, with formal documentation following in parallel, creating a more legalistic process in the background. This practice supports the view that while formal procedures aim to structure rework management, their application in real projects remains shaped by time pressures and negotiation, consistent with observations by Marosszeky et al. (2005) and calls for clearer, process-oriented contract frameworks by Love (2025).

4. CHALLENGES AND IMPROVEMENTS IN REWORK INFORMATION MANAGEMENT

When participants were asked about the challenges in managing information once rework occurs, approximately 75% of participants identified miscommunication and fragmented information flows as the most persistent problems, citing heavy reliance on emails, informal messaging, and limited use of shared platforms as barriers to maintaining accurate and up-to-date project information. Around 62.5% of participants reported difficulties in maintaining a single, verified version of information, noting that preliminary drawings, verbal instructions, or partial approvals were sometimes acted upon before the formal control copy was issued, which later resulted in rework and project delays. Approximately 50% of participants highlighted information gaps during stop-work and redesign periods, where delayed updates and incomplete technical data increased overheads and slowed decision-making. In addition, 3 of participants pointed to coordination challenges between design, quality, and construction teams, which hindered timely root-cause identification and the effective circulation of verified information. These patterns align with the literature's emphasis on the risks associated with incomplete, delayed, or poorly integrated information flows in rework situations (Isaac & Navon, 2010; Matthews et al., 2022).

Based on these challenges, participants proposed a set of practical and organisational recommendations to improve the management of rework-related information once rework is required, including:

- Expand the use of CDEs and real-time cloud platforms to create a single, shared source of project information and improve the coordination of rework-related data across project parties.
- Improve information verification, document control, and information exchange between design, quality, and construction teams to ensure that only current, approved, and traceable information is used on site.

- Provide structured training and onboarding for engineers and site teams on effective information management, documentation practices, and relevant standards.
- Ensure that informal or emergency site communications are promptly captured and formalised within official information systems to maintain traceability and accountability.

Taken together, these insights suggest that a standardised framework for managing information during rework would respond directly to the gaps identified both in the literature and in practice. Such a framework would need to: (1) acknowledge the inevitability of rework and focus on managing its information; (2) reduce friction in formal communication and approval processes while remaining resilient to the use of multiple communication channels in practice; (3) embed clear responsibilities for recording, analysing, and learning from rework incidents, in line with lean principles of reducing information waste, stabilising workflow, and fostering continuous improvement; and (4) build on digital tools and cloud platforms without assuming that technology alone will solve coordination problems.

CONCLUSION

This paper explores how information is managed when field rework is required, addressing a gap in the literature, which has largely focused on preventing or measuring field rework. Drawing on eight semi-structured interviews with experienced practitioners, the study examined how field rework is experienced in practice, including information flows, and the challenges associated with current management approaches. The findings show that rework is widely perceived as disruptive, but its impact varies depending on project context, activity interdependencies, and the speed at which reliable information and approvals are obtained. Across all cases, rework management was shown to hinge on information: how changes or defects are identified, recorded, communicated, approved, and acted upon. Practitioners operate within a mixed communication environment that combines formal and informal mechanisms. While this combination supports rapid response, it also creates risks when informal or preliminary information diverges from the official control record, sometimes resulting in duplicated effort or further rework.

From a practical perspective, the findings suggest the need for clearer communication structures, disciplined control of drawings and records, and better integration of rework-related information into existing project processes. From a research perspective, the study provides an empirical basis for developing a framework to standardise information management during rework incidents. Such a framework should treat rework as a recurring and manageable phenomenon, consistent with Quality-II thinking, and clarify how information should flow across detection, decision-making, and implementation. However, this study is limited by a relatively small sample size and by the fact that participants were drawn exclusively from projects in the Middle East, and it does not consider differences in project type, company context, or the level of information management systems in place, which may limit the insights provided. Moreover, the study does not distinguish between different causes and types of field rework, potentially overlooking important differences in how field rework is managed across situations. Developing a typology of field rework that reflects differences in causes, scale, and responsibility is therefore an important direction for future research. Despite these limitations, this study contributes to a growing recognition that improving rework outcomes depends less on eliminating rework entirely and more on managing information effectively when rework occurs.

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REFERENCES

- Alsafouri, S., & Ayer, S. K. (2018). Review of ICT Implementations for Facilitating Information Flow between Virtual Models and Construction Project Sites. *Automation in Construction*, 86, 176-189. <https://doi.org/10.1016/j.autcon.2017.10.005>
- Asadi, R., Rotimi, J. O. B., & Wilkinson, S. (2023). Analyzing underlying factors of rework in generating contractual claims in construction projects. *Journal of Construction Engineering and Management*, 149(6), 04023036. <https://doi.org/10.1061/JCEMD4.COENG-12141>
- Asadi, R., Wilkinson, S., & Rotimi, J. O. B. (2021). Towards contracting strategy usage for rework in construction projects: A comprehensive review. *Construction management and economics*, 39(12), 953-971. <https://doi.org/10.1080/01446193.2021.2004609>
- Ballard, G. (1993). Lean construction and EPC performance improvement. *Lean construction*, 79-91. https://leanconstruction.org.uk/wp-content/uploads/2018/09/LEAN_EPC.pdf
- Ballard, G. (1999). Improving work flow reliability. *Proceedings of the 7th Annual Conference of the International Group for Lean Construction*, 275-286. <https://iglc.net/Papers/Details/62>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Choo, C. W. (2002). *Information management for the intelligent organization: the art of scanning the environment*. Information Today, Inc.
- Egan, J. (1998). Rethinking construction: The report of the construction task force. *Department for Trade and Industry, London: HMSO*. https://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking_construction_report.pdf
- Forcada, N., Alvarez, A. P., Love, P. E. D., & Edwards, D. J. (2017). Rework in Urban Renewal Projects in Colombia. *Journal of Infrastructure Systems*, 23(2), 04016034. [https://doi.org/10.1061/\(ASCE\)IS.1943-555X.0000332](https://doi.org/10.1061/(ASCE)IS.1943-555X.0000332)
- Ford, G., & Gosling, J. (2024). Professional perceptions of right-first-time and quality management in construction projects through open-ended feedback. *International Journal of Quality & Reliability Management*, 41(10), 2665-2696. <https://doi.org/10.1108/IJQRM-08-2023-0246>
- Get it Right Initiative. (2023). <https://getitright.uk.com/live/files/reports/12-giri-technology-report-onsite-466.pdf>
- Gumusburun Ayalp, G., & Arslan, F. (2025). Modeling Critical Rework Factors in the Construction Industry: Insights and Solutions. *Buildings*, 15(4), 606. <https://doi.org/10.3390/buildings15040606>
- Hegazy, T., Said, M., & Kassab, M. (2011). Incorporating rework into construction schedule analysis. *Automation in Construction*, 20(8), 1051-1059. <https://doi.org/10.1016/j.autcon.2011.04.006>
- Hwang, B. G., & Yang, S. (2014). Rework and schedule performance: A profile of incidence, impact, causes and solutions [Article]. *Engineering, Construction and Architectural Management*, 21(2), 190-205, Article 17106626. <https://doi.org/10.1108/ECAM-10-2012-0101>
- Isaac, S., & Navon, R. (2010). Modeling Change Impact Flows in Construction Projects. *18th Annual Conference of the International Group for Lean Construction*, 22-32. <http://iglc.net/Papers/Details/694>
- Josephson, P.-E., Larsson, B., & Li, H. (2002). Illustrative benchmarking rework and rework costs in Swedish construction industry. *Journal of Management in Engineering*, 18(2), 76-83. [https://doi.org/10.1061/\(ASCE\)0742-597X\(2002\)18:2\(76\)](https://doi.org/10.1061/(ASCE)0742-597X(2002)18:2(76))
- Koskela, L. (1992). *Application of the new production philosophy to construction* (Vol. 72). Stanford university Stanford. <https://stacks.stanford.edu/file/druid:kh328xt3298/TR072.pdf>
- Kvale, S. (2009). *Interviews: Learning the craft of qualitative research interviewing*. Sage. <https://archive.org/details/interviewslearn0000kval>

- Li, Q., Lee, C.-Y., Jin, H., & Chong, H.-Y. (2022). Effects between Information Sharing and Knowledge Formation and Their Impact on Complex Infrastructure Projects' Performance. *Buildings*, 12(8), 1201. <https://doi.org/10.3390/buildings12081201>
- Love, P. E. (2025). Quantifying the Costs of Field Rework in Construction. *Journal of Construction Engineering and Management*, 152(1), 06025003. <https://doi.org/10.1061/JCEMD4.COENG-17026>
- Love, P. E., & Edwards, D. J. (2004). Forensic project management: The underlying causes of rework in construction projects. *Civil engineering and environmental systems*, 21(3), 207-228. <https://doi.org/10.1080/10286600412331295955>
- Love, P. E., Edwards, D. J., & Smith, J. (2005). Contract documentation and the incidence of rework in projects. *Architectural Engineering and Design Management*, 1(4), 247-259. <https://doi.org/10.1080/17452007.2005.9684596>
- Love, P. E., Holt, G. D., Shen, L. Y., Li, H., & Irani, Z. (2002). Using systems dynamics to better understand change and rework in construction project management systems. *International Journal of Project Management*, 20(6), 425-436. [https://doi.org/10.1016/S0263-7863\(01\)00039-4](https://doi.org/10.1016/S0263-7863(01)00039-4)
- Love, P. E., Teo, P., & Morrison, J. (2018). Revisiting quality failure costs in construction. *Journal of Construction Engineering and Management*, 144(2), 05017020. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001427](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001427)
- Love, P. E. D. (2020). Creating a mindfulness to learn from errors: Enablers of rework containment and reduction in construction. *Developments in the Built Environment*, 1, 100001. <https://doi.org/10.1016/j.dibe.2019.100001>
- Love, P. E. D., Matthews, J., Ika, L. A., Teo, P., Fang, W., & Morrison, J. (2023). From Quality-I to Quality-II: cultivating an error culture to support lean thinking and rework mitigation in infrastructure projects [Article]. *Production Planning and Control*, 34(9), 812-829. <https://doi.org/10.1080/09537287.2021.1964882>
- Love, P. E. D., & Smith, J. (2003). Benchmarking, benchaction, and benchlearning: Rework mitigation in projects [Article]. *Journal of Management in Engineering*, 19(4), 147-159. [https://doi.org/10.1061/\(ASCE\)0742-597X\(2003\)19:4\(147\)](https://doi.org/10.1061/(ASCE)0742-597X(2003)19:4(147))
- Ma, G., Jiang, S., Zhu, T., & Jia, J. (2019). A novel method of developing construction projects schedule under rework scenarios [Article]. *Sustainability (Switzerland)*, 11(20), Article 5710. <https://doi.org/10.3390/su11205710>
- Marosszeky, M., Karim, K., Perera, S., & Davis, S. (2005). Improving Work Flow Reliability Through Quality Control Mechanisms. *13th Annual Conference of the International Group for Lean Construction*, 503-511. <http://iglc.net/Papers/Details/397>
- Matthews, J., Love, P. E. D., Porter, S. R., & Fang, W. (2022). Smart data and business analytics: A theoretical framework for managing rework risks in mega-projects. *International Journal of Information Management*, 65, 102495. <https://doi.org/10.1016/j.ijinfomgt.2022.102495>
- Mossman, A., & Ramalingam, S. (2021). Last planner, everyday learning, shared understanding & rework. Proc. 29th Annual Conf. of the Int'l Group for Lean Construction (IGLC29),
- Motawa, I. A., Anumba, C. J., Lee, S., & Peña-Mora, F. (2007). An integrated system for change management in construction. *Automation in Construction*, 16(3), 368-377. <https://doi.org/10.1016/j.autcon.2006.07.005>
- Perera, S., Davis, S., & Marosszeky, M. (2011). Interventions in effecting change towards lean for australian building contractors: Defect management as a case of reference. *19th Annual Conference of the International Group for Lean Construction*, 520-529. <https://iglc.net/Papers/Details/1123>
- Rogge, D., Coglisier, C., Alaman, H., & McCormack, S. (2001). *An investigation of field rework in industrial construction Texas: The University of Texas, Construction Industry Institute*.
- Sharma, N., & Laishram, B. (2024). Implementation of Lean Construction to Reduce Rework in Construction Projects: A Systematic Literature Review [Conference paper]. *Lecture Notes in Civil Engineering*, 383, 225-236. https://doi.org/10.1007/978-981-99-5455-1_18
- Smith, J., Edwards, D. J., Martek, I., Chileshe, N., Hayhow, S., & Roberts, C. J. (2023). The antecedents of construction project change: An analysis of design and build procurement application. *Journal of Engineering, Design and Technology*, 21(3), 655-689. <https://doi.org/10.1108/JEDT-12-2020-0507>

- Winch, G. M. (2012). *Managing construction projects*. John Wiley & Sons. <https://www.wiley.com/en-gb/Managing+Construction+Projects%2C+2nd+Edition-p-9781405184571>
- Zhang, S., Duan, H., Zhao, X., Xia, B., Feng, Y., & Galvin, S. (2021). Learning on rework management of construction projects: a case study. *International journal of construction management*, 21(3), 246-260. <https://doi.org/10.1080/15623599.2018.1521361>