

Study of Causes and Effects of Rework in Building Construction Projects

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Abstract

Rework occurs when construction work has to be corrected, removed or repeated because the completed work does not satisfy the approved design, specification, quality requirement or project instruction. It consumes labour, materials and equipment already committed to the project and can disturb subsequent activities. This paper reviews published research on the causes and effects of rework in building construction and develops a practical prevention framework. A structured literature assessment was undertaken using peer-reviewed studies, quality-management research and recent reviews addressing design errors, communication, coordination, workmanship, supervision, change, material problems and rework costs. The evidence shows that rework is multi-causal and that upstream design and information problems can appear later as site defects or repeated work. Indian and international studies identify coordination, communication, errors and omissions, changes, workforce capability, material problems and quality-control deficiencies among recurring causes. The consequences extend beyond direct repair cost to schedule disruption, productivity loss, material waste, disputes and additional management effort. Based on this synthesis, the paper proposes a Cause-to-Control Rework Prevention Chain that places preventive action at the earliest practical point: design verification, information coordination, resource verification, pre-work inspection, execution control and feedback. The framework is intended to be low-cost and suitable for ordinary building projects.

Keywords: Rework, Construction Quality, Design Errors, Coordination, Workmanship, Project Performance

1.INTRODUCTION

Background and Significance

Rework occurs when completed or partly completed construction work has to be corrected, removed or repeated because it does not satisfy the approved design, specification, quality requirement or project instruction. It consumes resources that have already been committed and may interrupt subsequent activities. For this reason, rework is connected with project cost, time, productivity and material use, not only with the immediate quality defect.

Review of Existing Literature

Early quality-cost research demonstrated that design and construction deviations can create substantial direct costs (Burati et al., 1992; Davis et al., 1989). Love and Edwards (1999; 2004) subsequently showed that rework causes are interdependent and that construction rework should be examined as a system rather than as isolated mistakes. More recent studies continue this line of research. Garg and Misra (2021) identified coordination among stakeholders as a critical reason for rework in developing-country building projects, while Hassan et al. (2023) identified coordination and communication, errors and omissions, and project changes among important contributors. Akhil and Jagathyraj (2024) reviewed 45 studies and grouped recurring causes into six categories.

Research Gap

The literature contains extensive classifications of rework causes, but there remains a practical gap between identifying a cause and deciding where prevention should occur. A design omission may later appear as a site defect; an information delay may become an incorrect installation; and weak inspection can allow an error to pass to the next trade. The gap addressed in this paper is therefore a prevention-oriented synthesis that connects recurring causes with early control points, verification records and feedback mechanisms. The framework is designed for practical use and subsequent empirical testing.

Objectives

The objectives are to identify major causes of rework in building construction; examine the effects of rework on cost, time, productivity, materials and coordination effort; compare findings across earlier studies; and propose a simple Cause-to-Control Rework Prevention Chain that can be tested in future project surveys.

2.MATERIAL AND METHODS

Research Design and Literature Assessment

The study adopts a structured literature assessment using peer-reviewed empirical studies, systematic reviews, construction quality research and recognised quality-management standards. The selected literature was organised under six cause domains: design and documentation; coordination and communication; workforce and workmanship; materials and resources; management and inspection; and change and planning. The assessment considered both the point of origin of a cause and the downstream effect of the resulting rework.

Analytical Procedure

The literature was compared to identify recurring causes and common mitigation measures. The comparison then examined where an intervention could be introduced before physical rework occurred. The resulting prevention chain was organised as design verification, information coordination, resource verification, pre-work inspection, execution control, and feedback and learning. Each stage was linked to a simple verification record that can be maintained without specialist software.

Empirical Validation Plan

For future primary research, the framework can be converted into a questionnaire for project managers, engineers, quality personnel, supervisors and contractors. A five-point response scale may be used to rate the importance or frequency of each cause and effect. Descriptive statistics, mean scores, ranking and Cronbach's alpha are suitable for an exploratory study; correlation or regression should be considered only where the final sample and assumptions permit.

Ethical Considerations

The present manuscript is based on published literature and does not claim primary questionnaire findings. Prior work is acknowledged through author-year citations and a numbered reference list. No respondent data, percentages, mean scores or statistical values are invented. For any future respondent study, participation should be voluntary, the academic purpose should be explained, unnecessary personal identifiers should not be collected, and results should be reported in aggregate form.

3.RESULT AND DISCUSSION

Major Rework Cause Domains

Across the literature, rework is repeatedly associated with design and documentation problems, coordination and communication failures, workforce and workmanship issues, material and resource deficiencies, management and inspection weaknesses, and project changes. Garg and Misra (2021) found stakeholder coordination to be a critical cause, while Hassan et al. (2023) highlighted coordination, communication, errors and omissions and changes. Mahamid (2022) further showed that rework is associated with material waste in building construction. The evidence supports a causal-chain interpretation rather than a single-cause explanation.

Table 1: Major Rework Cause Domains Identified in the Literature

Cause domain	Common causes	Practical meaning
Design and documentation	Errors, omissions, incomplete details and late revisions (Burati et al., 1992; Love et al., 2000).	Detect errors before information reaches site.
Coordination and communication	Poor information flow, discipline conflicts and delayed decisions (Garg and Misra, 2021; Hassan et al., 2023).	Coordinate interfaces and close critical information issues.
Workforce and workmanship	Skill limitations, incorrect execution and inadequate supervision (Garg and Misra, 2021; Mahamid, 2022).	Strengthen competence and first-line checking.
Materials and resources	Wrong, defective or unavailable materials and storage problems (Hassan et al., 2023; Mahamid, 2022).	Verify materials before work begins.
Management and inspection	Weak supervision, late inspection and ineffective quality control (Josephson and Hammarlund, 1999).	Introduce timely hold points and inspections.
Change and planning	Scope changes, client changes, late instructions and poor sequence planning (Hwang et al., 2014; Love, 2002).	Control changes and assess downstream effects before implementation.

Effects of Rework

The literature shows that rework has effects beyond direct repair cost. Love (2002; 2005) examined rework in relation to project type, procurement and total cost. Forcada et al. (2017) analysed 788 incidents from 40 Spanish building projects and developed a rework-cost prediction model based on original project conditions. Mahamid (2022) found a relationship between rework and material waste, showing that quality failures may also create resource losses. These findings indicate that a rework register should track cost, time, labour and material consequences rather than only the defect itself.

Table 2: Main Effects of Rework and Suggested Indicators

Effect	Typical mechanism	Suggested indicator
Cost	Additional labour, materials, plant and subcontractor effort.	Recorded rework cost relative to affected work value.
Time	Correction interrupts planned sequence and access.	Hours or days of programme disruption.
Productivity	Workers repeat activities while downstream trades wait.	Lost work-hours attributed to rework.

Effect	Typical mechanism	Suggested indicator
Material use	Removed or rejected material may be replaced or discarded.	Quantity or value of material replaced or wasted.
Coordination	Additional approvals, inspections, meetings and information requests.	Number of rework-related coordination cycles.
Relationships	Repeated correction can produce dissatisfaction or disputes.	Unresolved quality issues, notices or claims.

Proposed Cause-to-Control Rework Prevention Chain

The principal contribution of this paper is a prevention chain that moves the intervention upstream. Instead of waiting for a visible defect, the project team checks the information and conditions that make the defect possible. Design verification is followed by controlled information coordination, resource confirmation, pre-work inspection, execution control and structured feedback. The chain does not claim that one control eliminates rework; it provides a repeatable method for reducing avoidable recurrence.

Table 3: Proposed Cause-to-Control Rework Prevention Chain

Stage	Control action	Simple verification
1. Design verification	Review drawings, specifications and constructability before release.	Approved design-check record.
2. Information coordination	Control revisions and close critical information issues.	Current drawing register and closed issue log.
3. Resource verification	Confirm correct material, equipment and workforce readiness.	Pre-start resource checklist.
4. Pre-work inspection	Verify setting-out, levels, dimensions and interfaces before irreversible work.	Inspection request or hold-point record.
5. Execution control	Use competent supervision and task-specific checks.	Daily quality checklist.
6. Feedback and learning	Record immediate and underlying causes and the preventive action taken.	Rework register with cause code and action.

Comparison With Previous Research

The proposed chain is consistent with the causal logic reported in earlier studies but places stronger emphasis on prevention and learning. Burati et al. (1992) demonstrated the cost significance of design deviations, while Love et al. (1999; 2016) showed that rework causes are interdependent. Garg and Misra (2021) emphasised coordination in developing-country construction, and Hwang et al. (2019) showed the potential of building information modelling to reduce rework when it is used for coordination. The proposed chain therefore combines established quality-control practices with structured information and coordination controls.

Low-Cost Implementation

A small contractor does not need a sophisticated digital quality platform to begin. A controlled drawing register, pre-start checklist, inspection request, non-conformance record and simple rework register can provide the basic information needed to identify repeated problems. The same records can later be digitised or linked to building information modelling when project size and complexity justify the investment. This makes the framework suitable for ordinary building projects as well as postgraduate field studies.

4.CONCLUSION

Conclusion

Rework in building construction is a multi-causal quality and project-management problem. The literature demonstrates recurring links with design information, coordination, communication, workforce capability, materials, supervision, inspection and project change. Its consequences extend to cost, programme disruption, labour productivity, material use and project relationships. The contribution of this study is a Cause-to-Control Rework Prevention Chain that moves from early design verification to controlled information, resource confirmation, pre-work inspection, execution control and feedback. The framework is intentionally simple and can be applied without laboratory testing or expensive software. Its main limitation is that the present paper is a literature-based synthesis rather than an empirical survey. The next research stage should collect genuine project responses, establish the relative importance of the identified causes and test the reliability and explanatory value of the proposed framework. Such validation would improve its value to construction practitioners, students and future researchers seeking practical methods for reducing avoidable rework.

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