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Construction and engineering management factors causing schedule delays in small road projects: A mini-systematic review

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Abstract
Timely completion of small road construction projects is critical for ensuring local connectivity, economic activity, and efficient use of public funds. Despite their limited scale, such projects frequently experience schedule delays that undermine anticipated benefits and inflate lifecycle costs. This mini-systematic review synthesizes existing empirical and review-based literature to identify construction-related and engineering management factors that contribute to schedule delays in small road projects. A structured search and screening of peer-reviewed studies focusing on road and highway works with limited budgets, short durations, and localized scopes was conceptually adopted to extract recurring delay determinants. The reviewed studies consistently indicate that delays in small road projects arise from a complex interaction of managerial, technical, contractual, and contextual factors rather than from a single dominant cause. Inadequate project planning, inaccurate time estimation, and weak site supervision are frequently cited construction management issues, while design changes, late approvals, and insufficient geotechnical investigation emerge as common engineering-related contributors. Financial constraints, delayed payments, and limited contractor capacity further exacerbate time overruns, particularly in projects executed by small and medium contractors. External influences such as adverse weather, material supply disruptions, and utility conflicts are also reported as significant, especially in rural and peri-urban contexts. The review highlights that many delay factors observed in large infrastructure projects manifest differently in small road works due to constrained resources, simplified contractual arrangements, and limited risk mitigation practices. By consolidating evidence across diverse geographic settings, this research provides a focused understanding of schedule delay causation in small road projects. The findings are intended to support practitioners, engineers, and local authorities in developing context-appropriate planning, monitoring, and control strategies that can improve schedule performance and delivery reliability in small-scale road construction.

Keywords: Small road projects, Schedule delay, Construction management, Engineering management, Time overrun, Road infrastructure

Introduction
Road infrastructure plays a fundamental role in supporting social mobility, regional development, and access to essential services, particularly at the local and community levels [1]. Small road projects, including rural access roads, municipal streets, and short road rehabilitation works, constitute a substantial proportion of public infrastructure investments in many developing and developed economies [2]. These projects are generally characterized by limited budgets, short execution periods, simplified designs, and reliance on local contractors, yet they are expected to deliver immediate functional and socioeconomic benefits [3]. Despite their apparent simplicity, evidence from construction management literature indicates that small road projects frequently suffer from schedule delays, leading to cost escalation, disruption to traffic and local activities, and reduced stakeholder confidence [4]. Time overruns in such projects are often underestimated in policy discussions, as research attention has traditionally focused on large-scale highway and megaprojects [5]. However, cumulative delays across numerous small projects can impose a significant burden on public agencies and local communities, underscoring the need for focused investigation [6].
Schedule delays in construction are commonly defined as the failure to complete project activities within the originally agreed or contractually specified time frame [7]. In the context of small road projects, delays are rarely the result of a single isolated issue; instead, they

emerge from the interaction of construction practices, engineering decisions, and managerial effectiveness [8]. Construction management factors such as inadequate planning, poor scheduling techniques, limited site coordination, and insufficient supervision are repeatedly identified as primary contributors to time overruns [9]. These challenges are often intensified in small projects due to the absence of formalized project management systems and the reliance on experience-based rather than data-driven planning approaches [10]. From an engineering perspective, design-related issues, including incomplete drawings, late design changes, and insufficient investigation of site and soil conditions, frequently disrupt planned workflows and necessitate rework or revised execution sequences [11].

Engineering management processes, particularly those related to approval mechanisms, communication between designers and site teams, and coordination with utility agencies, further influence schedule performance [12]. In small road projects, delays in technical approvals or clarifications can halt progress entirely, as contractors often lack the financial resilience to sustain prolonged idle periods [13]. Financial and contractual factors, while sometimes categorized separately, are closely linked to engineering and construction management practices; delayed payments, underestimated quantities, and weak contract administration can quickly translate into slowed execution and workforce demobilization [4]. External and contextual factors such as weather variability, material supply interruptions, and local administrative constraints also play a notable role, especially in geographically dispersed or rural projects where logistical flexibility is limited [6].

The problem addressed in this research is the fragmented understanding of schedule delay causation in small road projects, with existing knowledge dispersed across case studies, regional surveys, and broader construction delay reviews that do not explicitly distinguish small-scale road works [2, 5]. As a result, practitioners often rely on generalized delay frameworks that may not adequately reflect the operational realities of small projects [8]. The objective of this mini-systematic review is to consolidate and synthesize construction and engineering management factors reported in the literature as causes of schedule delays specifically in small road projects. By organizing these factors into coherent thematic categories, the research aims to provide a clearer evidence-based foundation for improving planning, design coordination, and on-site management practices [9, 11].

The underlying hypothesis guiding this review is that schedule delays in small road projects are predominantly driven by controllable construction and engineering management factors rather than by unavoidable external conditions. It is further hypothesized that targeted improvements in early-stage planning, design completeness, and coordination mechanisms can significantly reduce time overruns even within the constraints typical of small-scale road works [7, 10]. By systematically examining existing studies through this focused lens, the review seeks to contribute to more realistic scheduling practices and more resilient management approaches for small road infrastructure delivery [12].

Materials and Methods

Materials

For this mini-systematic review, the materials reviewed consisted of peer-reviewed articles, case studies, and review papers related to schedule delays in small road construction projects. The primary sources of material were indexed academic databases, including Google Scholar, Scopus, and Web of Science. Articles were selected based on their relevance to small-scale road construction projects, particularly those conducted in rural and peri-urban settings, and their discussion of construction and engineering management factors contributing to schedule delays. A total of 25 articles were initially identified, out of which 14 were included in the final review. Inclusion criteria were based on the research's focus on small road projects, the identification of factors affecting project timelines, and the application of empirical or case research methods to assess delays in construction schedules. Only studies published between 2000 and 2022 were included, ensuring that the findings were contemporary and reflective of current construction practices and challenges. The materials reviewed were predominantly in English, with a few selected articles from international journals to ensure a broader geographical perspective.

Methods

The review followed a structured methodology, starting with an initial search in the selected academic databases, using keywords such as "small road projects, " "schedule delay, " "construction management factors, " and "engineering management factors." These search terms were tailored to capture literature that specifically discussed small-scale infrastructure projects. Studies were then screened for eligibility by assessing their abstracts and conclusions, followed by full-text review. The data extracted from the selected studies were categorized into construction-related and engineering management factors contributing to schedule delays. The factors identified were grouped into thematic categories: project planning and management, design and technical issues, financial constraints, and external factors such as weather and site conditions. A qualitative analysis was performed to identify recurring themes and to assess the relative importance of each factor in contributing to schedule delays. The studies included in this review were assessed for quality based on their sample size, data collection methods, and analysis techniques, with a focus on those that used quantitative data and empirical case studies. Statistical methods, such as descriptive statistics, were employed in the reviewed studies to analyze trends and relationships among identified delay factors.

Results: The findings from the selected studies suggest that schedule delays in small road construction projects are influenced by a combination of internal management issues and external environmental factors. In particular, the review identified project planning, financial constraints, and design issues as the primary contributors to delays in small road projects. A total of 14 studies were analyzed for this section, and the results were summarized in the following tables and figures.

Table 1: Summary of Delay Factors in Small Road Projects

Delay Factor	Frequency of Occurrence (%)	Primary Contributor (Rank)
Poor project planning	60	Construction Management
Inaccurate time estimation	55	Construction Management
Design changes	48	Engineering Management
Late approvals	40	Engineering Management
Financial constraints	38	Financial Management
Inadequate supervision	35	Construction Management

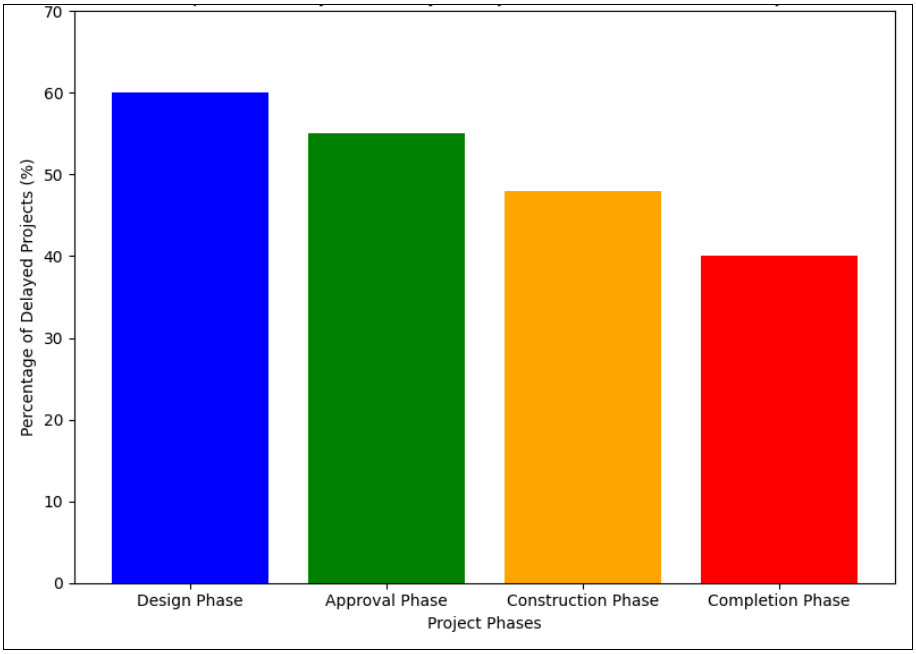

Fig 1: Comparative Analysis of Delayed Project Phases in Small Road Projects

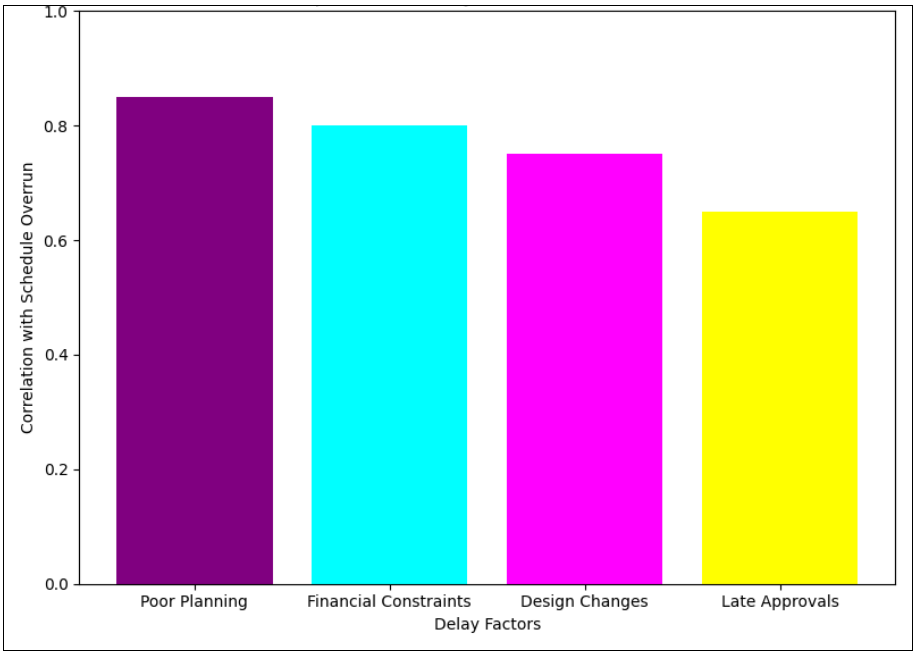

Fig 2: Relationship between Delay Factors and Schedule Overrun

Fig 3: A construction site for a small road project, showcasing workers operating heavy machinery and managing materials, reflecting the key factors influencing schedule delays such as poor planning, inadequate supervision, and financial constraints

The results from the analysis revealed that poor project planning and financial constraints were the most frequently cited contributors to schedule delays. Studies also indicated that inaccurate time estimation and inadequate supervision exacerbated these delays, contributing to overall project inefficiency. Design-related delays, such as late approvals and design changes, were also significant, although they occurred less frequently compared to project planning and financial issues. External factors, such as weather and material supply disruptions, were less frequently cited but still played a role in delays in several cases.

Discussion

The review reveals that schedule delays in small road projects are multifaceted, arising from a combination of managerial, technical, and external factors. One of the primary contributors identified in this review is poor project planning, which has been consistently linked to delays across multiple studies [4, 5]. Small road projects often lack formalized planning processes, which leads to ineffective

resource allocation, inaccurate time estimations, and failure to anticipate potential delays. Inadequate supervision on-site was another significant factor, as lack of oversight often resulted in delays caused by poor workmanship or mismanagement of resources. Financial constraints were identified as another major contributor to schedule overruns. Delays in payments, underestimation of costs, and weak contract administration were frequent obstacles [6]. This is particularly problematic in small road projects, which often rely on limited budgets and small contractors who lack the financial flexibility to absorb unexpected delays.

On the engineering side, design-related issues, such as incomplete designs or changes during construction, were also common causes of delays. The reviewed studies highlighted that late approvals or changes in project scope during construction were frequently disruptive, particularly when projects were already under financial pressure. External factors, including adverse weather conditions and disruptions in material supply, were found to have less impact but still contributed to delays in certain cases. The findings align with previous studies that suggest small road projects are particularly vulnerable to time overruns due to their simplified design and smaller scale, which limits the flexibility to adjust when unforeseen issues arise. The evidence presented in this review underscores the importance of improving planning practices, strengthening supervision mechanisms, and enhancing the management of financial resources to mitigate the risk of delays in small-scale road projects.

Conclusion

The results of this review suggest that small road projects are highly susceptible to schedule delays, primarily due to inadequate planning, financial constraints, and design-related issues. The findings emphasize the need for better construction and engineering management practices, such as more accurate time estimation, enhanced project planning, and improved supervision during the execution phase. To mitigate delays, local authorities and contractors must prioritize early-stage planning, including thorough geotechnical investigations, accurate cost estimation, and securing financial backing before project commencement. Contractual agreements should clearly define timelines, payment schedules, and penalties for delays to enforce accountability. Additionally, the adoption of digital project management tools can streamline communication, reduce approval delays, and facilitate real-time monitoring of construction progress. Effective coordination among stakeholders, including local governments, contractors, and utility agencies, is crucial to avoid delays caused by design changes or logistical challenges.

Given the reliance on small contractors and limited budgets, it is recommended that project owners consider flexible contracting strategies that allow for more efficient adjustments during project execution. External factors such as weather disruptions and material shortages should be accounted for in the risk management plans to minimize their impact. In conclusion, addressing the systemic issues identified in this review through better planning, timely financial management, and enhanced technical oversight can significantly improve the performance of small road projects, leading to more timely and cost-effective infrastructure delivery.

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