RESEARCH PAPER

Adoption of Agile Methodology in a Complex High-Rise Residential Project: A Case Study

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ABSTRACT

India's residential construction projects generally miss their deadlines due to slow approvals, lack of communication between parties, weak monitoring, high material shortages, low labour productivity, rework, and delayed decision-making. The adoption of Agile methodology as a practical delay-reduction approach in a complex high-rise residential project at Pune is examined in this paper. In which a questionnaire survey of 24 construction professionals is undertaken along with an activity-wise comparison of planned and actual durations for 20 major construction activities. Survey results state that 88% of respondents state that work is affected by approval delay. This follows slow decision-making at 85%, not monitoring it on a daily basis at 83%, poor communication at 79%. The report also states that material shortage is at 75% and rework due to coordination failure at 71%. Also, the delay in drawing revision was at 67% whereas the issue was labour productivity at 63%. The analysis of the actual activity duration shows that selected activities required 224 actual days against 145 planned days, causing 79 delay days with 54.5% overall schedule variance. The highest percentage for delay at 71.4% has been recorded in plumbing work, while external plastering and flooring follow with a delay percentage of 62.5% each. In light of these findings, a hybrid Agile construction management framework is proposed in a form of sprint-based planning, daily stand-ups, approval backlogs, task board, fast escalation, material tracking, quality checklist, sprint review, retrospectives and KPI monitoring. The expected-delay study shows that in selected critical activities, Agile practices have the potential to reduce average delay from 57.7% to 21.5% representing an indicative relative reduction of 62.7%.

Keywords: Agile methodology; residential construction; delay analysis; sprint planning; construction project management; Lean construction;

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1. INTRODUCTION

1.1 Background

In an ever-growing Indian city, a residential high rise is an example of complex construction with dense work packages, multiple trade interfaces and constantly escalating possession and handover pressures. In the case of a building, there is a chain of dependent activities beginning from Survey and Layout, Excavation, Foundation Works, Structural frame, Masonry, MEP work, plastering, flooring, facade work, painting, inspection, snagging, handover. While these activities can find their places on a baseline schedule, the actual productivity of the site depends on a wider production system, that includes drawings, approvals, labour mobilization, material delivery, equipment allocation, safety clearances, quality control, and quick problem resolution. When a single one of these inputs is delayed, the site loses not just one day on one activity; but the continuity on the other work fronts. Residential construction thus makes for a strong context to study the reliability of workflow, instead of seeing delay as just a planning error.

The chosen case is a complex high-rise residential building situated in Pune, Maharashtra, India. The residential growth near Pune is significant and projects in these locations encounter urban logistics anxiety due to limited scope of work and high stakeholder expectations and also have to manage intense trade coordination and schedule pressure from sales. pressure from sales, finance, statutory compliance and customer handover commitments. Even for such projects, formal schedules remain a necessity. Yet, schedule bars alone do not show us why a work front is not yet ready. They also do not show us who owns the blocking issue or when the next decision needs to be made. The identified management dilemma examined throughout the paper is the gap between formal planning and the everyday execution of work activities.

Typical construction management takes place around a master timeframe; weekly progress meetings, written correspondence, requests to inspect, material submission and approval hierarchy. The functions of these controls are contract administration, quality assurance, cost management, statutory compliance, and risk allocation. Nonetheless, conventional systems can slow down when site teams require rapid answers, when drawings are updated, when approval queues lengthen or when trade crews run into unknown constraints. It's not that planning is unimportant; rather, it's too far removed from the daily point of production. A weekly review may reveal that work is behind schedule, however, by the time the delay is apparent, labour may have already been sitting idle, the scaffolding may not have been fully used, a sub-contractor may have moved on workers to another building, or a sequence of finishes may have been disturbed.

1.2 Relevance of Agile methodology

The Agile methodology would be relevant here because of its emphasis on: short planning cycles, visible work, frequent communication, prioritisation of a backlog, fast feedback, and continuous improvement. According to the Agile Alliance (2001) the values prioritizing individuals and interactions, working increments, customer collaboration, and responsiveness to change were articulated in the agile methodology for developing software.

In project management research, Agile has been associated with adaptive planning, iterative delivery, cross-functional collaboration, and frequent reviews that facilitate teams' response to uncertainty (Conforto et al., 2014; Serrador & Pinto, 2015; Stare, 2014). Buildings can't be iterated like a piece of software because built environments are not software. Many tasks related to construction management can still be organized using Agile principles. This can incubator constant worry removal, stand-up meetings (daily meetings), trade co-ordination boards, approval back-logs, material ready to go meetings, defect burn down charts and sprint review.

The main argument of this paper is that Agile should be adopted in residential construction as a management layer rather than as a replacement of the baseline schedule. A master plan outlines the milestones, contractual obligations, statutory requirements, budgets, and overall sequencing logic. The Agile layer will focus on what can we execute soon: what work can start in the next one or two weeks, what constraints should be removed, what approvals are still pending, which resources are not yet ready, which defects are still open and what decisions need to be escalated. This explanation aligns with the emerging trend of hybrid project management wherein Agile approaches are modified to suit regulated, capital-intensive, or physically constrained projects, instead of being ill-adaptively imitated (Lalmi et al., 2021; Leech and Hanslo, 2025; Project Management Institute, 2017).

There is a strong need for hybridization in high-rise residential projects. Structural work has a physical sequence of activity in a workspace and cannot ignore the activity of curing, formwork, reinforcement inspection, concrete supply, vertical transportation, safety systems, floor-cycle constraints. As all of them happen in the same tight spaces, the finishing work is even more coordinated in nature as plastering plumbing, electrical conduits, flooring, doors, windows, painting, cleaning, inspection and handover. Overlapping civil and MEP teams lead to rework, repeated access, damaged finishes, idle crew, and delayed handover. Having everyone focus on the same zones or rooms can be very helpful for agile coordination. A daily stand-up may reveal that tiling the bathroom isn't possible until they obtain the pressure test results for the plumbing, that they cannot start painting until the surfaces defects are closed, that the handover cannot be scheduled until they note all snagging points, etc.

The changing expectations of construction stakeholders has also gotten a lot of attention. Homebuyers and clients want to see proof of progress, guaranteed completion dates, and faster defect rectification. Consultants want drawings and site queries to be tidy and well documented. Predictable work is required in order that labour and equipment are productively used. Developers need to be informed early regarding risks to the schedule and cost. These expectations give rise to a demand for a control system that is document driven, conversation driven, data driven and action driven. The latest studies indicate that there is an increased interest in Agile, Lean, BIM, Takt planning and hybrid systems for improving responsiveness and production reliability, Kineber et al (2024), Moreno et al (2024), Power et al. (2024), Yang and Wang (2025).

Delays during residential construction are often explained in terms of delays related to approvals, drawings, procurement, labour, weather, equipment, rework, and coordination of these delays. Dissections are helpful yet they can mask the dynamism of delay. For instance, an example of a material delay could be the late approval of a sample. Similarly, a labour delay can be caused by uncertainty about the next work front. Rework will happen due to not clear communication between the civil and MEP teams. Finally, an inspection delay can be due to poor readiness not because of the inspector's unavailability. The agile approach provides a more accurate diagnosis by inquiring what hinders the advancement of the next commitment, and what actions must take place today to remove the hindrance. This focuses on the removal of constraints, not the blame

1.3 Problem statement and case context

According to the data presented in this scenario, the assertion suggests that the problem is not limited to just one stage of construction. Among the 20 major construction activities under study all of them were delayed as compared to their planned durations. The planned total duration of these activities is 145 days while the actual duration is 224 days. This will create 79 delay days with overall schedule variance of 54.5%. In questionnaire responses from 24 professionals, it was indicated that approval delays, slow decision making, non-daily monitoring, poor communication, material shortage, re-work due to co-ordination, drawing revision delay, labour productivity were all relevant to site performance. This pattern reveals the need for a control device that links planning, communications, decision-making, resources and readiness.

1.4 Research aim and objectives

The goal of this study is to assess the adoption of Agile to improve the delivery process and reduce delays of a high-rise residential building in Pune. The objectives are to identify major delay factors; quantify schedule variance activity-wise; categorize root causes under approval, communication, monitoring and resource-management heads; suggest activity-level solutions based on Agility; and develop a workable framework with key performance indicators for implementation. Paper does not suggest that Agile is enough to eliminate construction delays. Agile can reduce the time taken to respond to a problem after its identification when it is applied through disciplined routines and backed up by formal project controls.

1.5 Research questions and contribution

The study is guided by the following research questions. What are the major reasons of delay in the selected high rise residential project at Pune Which construction activities experienced the highest schedule variance under the traditional system? Alternatively, which activities are prone to delays? In what ways can Agile practices tackle delays caused by approval, communication, monitoring, and resources? What percentage level of reduction in delays can be expected if the critical activities are done in Agile? We combine the questionnaire results, the planning versus actual delivery length analysis, the root-cause classification, and the Agile solutions on the above-mentioned.

The paper makes both an academic and a practical contribution. It helps to link the literature on Agile project management with Lean construction and delay analysis in a residential scaffolding project. Essentially, it offers site teams a workable framework for implementation without losing existing controls of schedule, quality, safety and contracts. The suggested framework consists of sprint planning, daily stand-up, task prioritization board, approval backlog, fast escalation, material tracking, continuous quality monitoring, sprint review, retrospective and KPI dashboard. Because the construction site needs tools that can be understood by engineers, supervisors, contractors, consultants and trade leaders not a system that only the planning specialists can operate the overall framework is made deliberately simple.

This introduction creates the groundwork for why Agile is important, why it should be adapted, rather than copied, and why Pune case is a useful basis for applied research. The subsequent section will review the literature concerning Agile outside of software, Lean construction, the Last Planner System, visual management BIM-enabled, construction delays, and new studies 2024 to 2026 approved for hybrid Agile-Lean construction management. The methodology section then explains how the case study, survey, and schedule comparison was done. The empirical findings are presented in addition to the agile implementation framework development. The conclusion summarizes findings, recommendations, and future validation needs.

There is a further reason for expanding the introduction, and that is to see Agile adoption in construction as a change in operating rhythm. Numerous project teams already have schedules, checklists, reports or meeting minutes in place but continue to delay action, as these artefacts are not necessarily linked to immediate workface decisions. Through the agile rhythm, the weekly look-ahead plan integrates with daily action. The question asks if each planned task is ready, whether the previous trade has handed over the area, whether drawings and approvals are current, whether materials are physically available, whether labour has been confirmed, and whether quality criteria are understood ahead of execution. This is especially important in high-rise residential work as floors repeat; however, the same repeated activity may fail for different reasons on different floors. The inspection of one floor might get delayed, the procurement of another, the availability of labour for another, and the rework on yet another. The Agile layer proposed thus considers every sprint a commitment to execution and a learning experience. Repeated service blockers are evaluated and utilized to develop correction methods for process failures in the forthcoming cycle.

Table 1 displays the Research Questions & Ins.

Research question	Question focus	Analytical use
RQ1	What are the major causes of delay in the selected high-rise residential project at Pune?	Uses questionnaire results, activity-duration comparison, and root-cause classification.
RQ2	Which construction activities experienced the highest delay under the traditional system?	Compares planned and actual duration data for 20 construction activities.
RQ3	How can Agile methodology address approval, communication, monitoring, and resource delays?	Maps each delay category to Agile practices such as sprint planning, stand-ups, task boards, and escalation.
RQ4	What level of delay reduction is expected after Agile implementation?	Uses expected-delay estimates for selected critical activities and proposes KPIs for future validation.

2. REVIEW OF PREVIOUS WORK

2.1 Agile methodology beyond software

Due to uncertainty, late feedback, and strict planning, Agile methodology started to evolve over the last years. The Agile Manifesto highlights the significance of people, working outputs, collaboration and responsiveness for change. Further studies on project management showed that Agile could benefit projects outside software. For instance, if requirements are uncertain or there is frequent interaction with stakeholders, iterative planning, cross-functional teams, transparent task boards, and frequent feedback can boost performance. (Conforto et al., 2014; Serrador & Pinto, 2015; Stare, 2014). Nonetheless, the literature warns against a universal solution that is Agile. Agile practices should fit into the culture, governance and maturity of teams and projects especially when related to contracts, compliance, safety, physical production (Papadakis & Tsironis, 2018; Project Management Institute, 2017).

Traditionally, construction has employed a range or set of planning techniques, including critical path schedules, bar charts, cost baselines, formal submittals, inspection procedures, and change management. The methods are important because a construction project involves a large area of capital investment. Further, it involves legal obligations. Moreover, it involves safety responsibilities. Finally, it involves physical work that can’t be undone. Due to professional negligence and unreasonable behaviour, a bad concrete pour, a wrongly placed sleeve, or a late inspection cannot be resolved as easily as the next software bug. Consequently, we need to be selective about transferring Agile to construction. The right question is not whether a construction project should become fully Agile, but which Agile practices can make daily coordination more robust while retaining the formal controls needed for scope, quality, safety, statutory approvals, and cost control.

2.2 Lean construction and the Last Planner System

There is the strongest theoretical connection between Agile and construction in lean construction. According to Koskela (1992), construction is seen as not only transformation of inputs into outputs, but also flow and value generation. This perspective of flow and transformation value is essential when a lot of delay takes place not during the value-adding task itself but when waiting for information, materials, access, inspection, equipment, or decision.

Lean construction has been developed to reduce waste, stabilize workflow, improve reliability and align production with customer value. Ballard (2000) formalizes these ideas through Last Planner System focusing on look-ahead planning, removal of constraints, reliable weekly commitments and measurement of percent plan complete. These ideas closely relate to the sprint planning and daily review in Agile.

The innovative system devised by the Last Planner specifically addresses the gap between planned work and executable work as relevant to Pune case. A job may appear on the schedule but it may not be executable if drawings are not issued, materials are not approved, labour not available, access is blocked or previous trade has not executed its job. Ballard and Howell wanted to shield production from uncertainty and make short-term commitments more reliable. This principle is augmented through visible backlogs along with stand-up meetings, sprint goals and retrospectives.

A look-ahead plan in residential buildings could become a sprint backlog with the floor-wise work packages, constraints, approvals, inspection requests, resources, and quality acceptance criteria.

Hybridization has been examined in recent literature. According to Lalmi et al. (2021), a combination of traditional project management methodology and adaptive project management methodology could be used at different phases of a construction project. Leech and Hanslo (2025) also identify hybrid project management in response to the issues that stem from pure Agile for large or controlled environments. One gets the same logic for construction: the traditional methods provide governance and baseline control, and Agile methods improve communication and short term. The significance of this hybrid logic is due to the fact that one cannot run a residential job off daily improvisation and the baseline must be disciplined. However, these cannot be delivered efficiently if decisions, resources and inspections are handled only through a controlling cycle that takes place weekly or monthly.

2.3 Recent Agile, Lean, BIM, and hybrid construction studies

From 2024 to 2026 empirical construction research supports the relevance of Agile and Lean integration. Moreno et al. (2024) explored the Agile project management in pre-construction stage and resulted in benefits such as adaptability, accountability, transparency and teamwork. A study by Kineber et al. (2024) of critical success factors of Agile project management for sustainable residential construction highlighted dynamic project optimisation and Agile project foundations as important implementation dimensions. According to Power et al. (2024), the Last Planner System, or LPS, Takt and Scrum are comparable. With development and iterations Scrum can enhance production planning or PPC, with more reliable commitments. Yang and Wang (2025) proposed a hybrid Lean-Agile model that integrates Scrum, Last Planner System, BIM collaboration and prioritization mechanisms and knowledge management. Based on the Agile literature and studies this paper argues that Agile has value in construction in view of the physical production reality.

Tools like BIM and digital collaborative applications are already part of the Agile debate. BIM can boost visualization, detect clashes, coordinate designs, extract quantities, plan 4D, and facilitate communication between project participants (Azhar, 2011; Eastman et al., 2018; Succar, 2009). According to Sacks, Koskela, Dave, and Owen (2010), Lean and BIM possess important synergies since BIM improves information reliability while Lean improves production flow. BIM utilizes 4D construction planning, design review, and construction analysis to mitigate delay factors in residential building projects. Combined with Lean tools such as collaborative meetings a positive impact can be seen. Tools to avoid overruns before they occur. In an Agile construction approach, project coordination on a daily basis can be enabled through BIM giving visibility to clash, work front readiness, and sequencing.

Digitalization is not replacement for management discipline. A dashboard listing hundreds of open items is not Agile unless teams have a mechanism to prioritize, assign ownership, close constraints and learn on repeated blockers. According to Agrawal et al. (2024), there is an increasing interest in digital support for Lean construction as described in the Last Planner System planning and control. In residential building, the practical lesson is that digital boards and RFI trackers, inspection logs, material dashboards and defect apps should make routines. Daily stand-ups should use data to determine what must get done today, what must get escalated, and what constraints threaten the next sprint. Without this routine, technology is just another thing to report on.

The 2026 Lean Construction Journal issue further substantiates that production planning relies on collaboration networks, Takt, daily rhythms, and human-centered leadership. Eivazi Ziaei et al. (2026) proposed a health-check framework for Last Planner System implementation through social network analysis, in which communication between stakeholders is to be part of LPS effectiveness. In their 2026 case report of a residential construction project on daily Takt implementation, Munkvold, Laedre and Drevland focused on Takt and Agile similarities. Both rely on rhythmic planning and short feedback cycles. Researchers Ben Moummad, Lamdouar and Abdelhamid (2026) connected crew dynamics to Lean construction principles whereas Pourrahimian, Salhab and Hamzeh (2026) continued the analysis of balanced human-AI collaboration in construction project management. The changing role of planners and controllers in the evolution of production scheduling is discussed in detail in these studies.

2.4 Construction delays in residential projects

Delays are multi-causal, according to a recurring theme in the delay literature. Williams (2005) criticized the mainstream project management discourse for failing to consider the complexity behind overruns. In residential projects, reasons for delays are bottlenecks in approval, changes in drawings, slowed down decisions, delays in procurement, lack of labour, interference in equipment, weather, rework, weak monitoring and management, poor communication, and incomplete closure of handover. There are often related to each other. A drawing revision may lead to material changes; material changes may cause procurement issues; procurement delays may idle labour; idle labour may disrupt the next floor cycle; disrupted sequencing may cause rework. Delay management should focus on systems and interactions, not just symptoms.

Schedule slippage in construction projects is often due to material availability, design changes, poor coordination and slow decisions. The case in Pune follows this pattern. Out of the total responses received thus far, 88 % of the respondents reported delays in approval, followed by slow decision making at 85 %, daily monitoring at 83 %, poor communication at 79 %, material shortage at 75 %, coordination failure rework at 71 %, drawing revision delays at 67 % and labour productivity issue at 63 %. The results of these studies are consistent with construction delay literature that views the delay as a coordination and information-flow problem just as much as a resource problem. This is why it is relevant to have daily visibility and swift escalation on Agile.

In high-rise residential constructions, finishing as well as MEP activities are prone to delay. For MEP work to commence there should be suitable civil readiness. MEP work has to be coordinated with the stipulated slab opening, sleeves, shaft access, wall chasing, pressure testing, electrical conduits, waterproofing, tiling and final fittings. The quality readiness and completion of defects of finishing activities such as plastering, flooring, painting, door and window handover. A delay of one trade can mean multiple visits from other trades. The work packaging in an agile style can mitigate this issue by defining floor acceptance criteria, assigning trade owners, and managing pending work through room-level or zone-level sprint boards.

2.5 The Influence of Culture and Performance Measurement on Implementation

Literature Agile construction also mentions culture. If representatives are attending without decision rights, problems are being hidden to avoid blame, subcontractors are excluded from planning, senior managers do not respond to escalated blockers this agile routine will not work. According to the Project Management Institute 2025, business acumen and organizational navigation are both important to project outcomes, and so it follows for construction Agile adoption. Sprint planning involves commitments among people who control labour, materials, access, drawings, inspections, and decisions. It is not a scheduling exercise. Arranging an environment in which issues are raised at an early stage and resolved quickly.

There is another stream which deals with performance measurement. Conventional metrics concentrate on the percentage of completion and milestone status, but Agile-Lean calls for leading indicators. Percent plan complete, constraint closure rate, approval cycle time, RFI response time, decision latency, resource readiness, defect burn-down, and rework index are more actionable because they indicate whether future work is ready. Ballard (2000) employs percent plan complete as a measure of planning reliability. Furthermore, lean and agile studies continue to emphasize short-cycle measurement Power et al. (2024); Eivazi Ziaei et al. (2026). We need KPIs of this kind for the Pune case because weekly percentage progress will not explain why plumbing, flooring, painting and handover are delayed.

The literature additionally notes that Agile needs to be safeguarded from two risks. First, ceremonial Agile where the team has daily meetings but decisions still take the same time as before. The second is uncontrolled change in which a responsive project rationale is used to justify scope creep or repeat design revisions. Consequently, the Construction Agile must include rules for escalation, design freeze date, impact analysis, formal change control and clear acceptance criteria. The proposed framework in this paper keeps the baseline schedule, quality plan, safety requirements, statutory processes and contract administration as is while adding Agile routines for the four key objectives of coordination, monitoring and learning.

2.6 Research gap and conceptual proposition

This paper addresses the need for a practical, activity-level Agile framework to reduce delays in residential construction in the context of Indian high-rises. According to the existing literature, Agile, Lean, BIM, Takt, hybrid methods, among others, can prove to be effective. However, the substantial majority of the papers remain conceptual, design/pre-construction only, broader industry surveys, etc.

Most promising papers. A case-based framework developed using questionnaire data and planned-vs-actual duration data of residential building in Pune is presented. It connects each type of delay to Agile recommendations and suggests the expected delay reduction of critical activities. The framework does not claim to be the final proof of post-implementation performance. It is a structured pilot model that can be validated through future before-after measurement.

To conclude, the literature supports five conclusions, which guide the rest of the paper. First, the values of Agile can enhance responsiveness, collaboration, and learning; however, these must be adapted to the constraints of the construction industry. The Last Planner System and lean construction provide an excellent production-control basis for adopting Agile. BIM and technological instruments are effective enablers when linked to routine and decisions. Furthermore, residential delays are multi-causal and need integrated management of approvals, communication, monitoring and resources. Implementation with hybrid model, not pure Agile lastly, construction which require formal baseline control and short cycle execution control. The interpretations and methodology of the Pune case study have been shaped.

3. RESEARCH METHODOLOGY

3.1 Research design

The research design used in this particular research is an applied case study. Research on delay causes took place in a real project environment; hence the case study approach is appropriate where the interaction in context between organizational routines, approvals, communication patterns, resource readiness and activity durations takes place (Yin, 2018). The research uses mixed methods because it examines quantitative evidence from the percentages on the questionnaires and the duration of activities while providing (Creswell & Creswell, 2018) qualitative interpretation of the root cause and Agile responses. The objective is twofold in nature: diagnostic and prescriptive. The first refers to the identification and quantification of delay patterns under the traditional system. The second relates to the development of an Agile-based framework suitable for piloting as an improvement model.

3.2 Case study profile

The case unit refers to a high-rise residential building at

Pune, Maharashtra, India. The case building was chosen as it typifies a classic multi-stakeholder residential construction setting with civil, structural, MEP, finishing, quality, planning, consultant, contractor, and site-management interfaces. Using Agile framework in such project gives an opportunity to study Agile as such projects require formal controls and daily coordination.

3.3 Gathering of primary data

There were two important data streams. A questionnaire survey of 24 professionals associated with case building was the first. The site engineers, project managers, planning engineers, supervisors, contractors, and QA/QC engineers were the respondents. To gather the perception of various delay factors like those related to approvals, communication, daily progress meetings, material shortage, work monitoring, drawing revision, labour shortage, contractor-consultant coordination, rework, the multiple level approval, etc. The second data stream received was activity-duration data for 20 major construction activities. The calculations done for all activities included planned duration, actual duration, delay days, and percentage delay.

3.4 Design of the Questionnaire

The survey used yes/no options and poor/average/good answers mostly. This straightforward format was chosen because the objective was to acquire unambiguous diagnostic information from professionals who work under pressure on the site. The goal of the questions was not to measure abstract attitudes but to see whether any constraints were affecting day-to-day work. For instance, the respondents were asked whether the approval delay affects site progress; are daily progress meetings regularly conducted; is the work monitored on a daily basis, etc. like whether the drawing revisions are quickly informed and whether the shortage of material or labour prevents the progress at the site. The responses were transformed into percentages to reveal the maximum perceived delays and factors.

3.5 Data analysis procedure

We compare the planned duration and actual duration of 20 construction activities for activity-duration analysis. The formula applied was: percentage delay = (actual duration – planned duration)/planned duration * 100 that gives a direct measure of schedule variance at activity level. The next step calculates the total planned duration, total actual duration, total delay days, overall schedule variance and average activity-level delay. The results of this activity level activity were used to identify the activities with the highest delays and to map each activity to likely root causes and Agile based corrective actions.

The causes of delay were classified into four groups namely, approval delays, communication delays, monitoring and tracking delays, and resource-management delays. This classification was chosen because it directly connects to manageable Agile interventions. Approval backlogs, due dates, escalation thresholds and look ahead inspection planning can manage approval delays. Teams can hold daily stand-up meetings and use a shared task board to mitigate communication delays. Cross-functional trades can further help this. Daily tracking, sprint review, and KPI dashboards can deal with monitoring delays. Delays of Resource can be remedied by material tracking, work escalation sprints and resource readiness.

3.6 Reliability, ethics, and limitations

The analysis of the anticipated decline in delays was designed as a forecast model and not as an actual, post-implementation measure. The expected post-Agile delays (percentage) were assigned to selected critical activities on the logic that with speedy approvals, daily collaboration, early removal of constraints and readiness of resources etc. can reduce construction delay but cannot eliminate it. These expected values should be seen as targets for piloting and not as evidence of an actual achieved result. The authors suggest a future validation by means of an 8 week to 12-week pilot comparing an agile managed work front with a conventionally managed work front on identical KPIs.

The use of two different streams of evidence strengthened reliability, namely, the perception-based questionnaire results and the objective planned-vs-actual duration data. Using only the survey would have permitted the findings to reflect opinion without schedule evidence. Had duration data only been used, the analysis would have shown where the delay occurred but not why it happened. By merging the two, we can better identify root causes and suggest Agile solutions. Notwithstanding, the study is constrained by its single-case design, small number of respondents, and improvement estimates based on forecast. Consequently, the framework should be viewed as a management proposal, which is to be empirically tested before generic application.

Table 2. Case study profile.

Parameter	Details
Case identifier	Anonymized high-rise residential case
Selected study unit	A Building
Project type	Residential high-rise building project
Location	Pune, Maharashtra, India
Construction status during study	Work in progress
Main study focus	Delay analysis under traditional management and development of Agile-based improvements

Table 3 shows the respondent profile.

Designation	Number of respondents	Share of total (%)
Site Engineers	8	33.3%
Project Managers	2	8.3%
Planning Engineers	3	12.5%
Supervisors	5	20.8%
Contractors	4	16.7%
QA/QC Engineers	2	8.3%
Total	24	100.0%

Table 4. Questionnaire format used for construction professionals.

Sr. No.	Question	Response type
1	Does approval delay affect site progress?	Yes/No
2	Is communication between departments effective?	Poor/Average/Good
3	Are daily progress meetings conducted regularly?	Yes/No
4	Does material shortage affect productivity?	Yes/No
5	Is work monitored daily?	Yes/No
6	Are drawing revisions communicated quickly?	Yes/No
7	Does labour shortage create delays?	Yes/No
8	Is coordination between contractor and consultant effective?	Poor/Average/Good
9	Does rework frequently occur on site?	Yes/No
10	Do multiple approval levels delay execution?	Yes/No

4. RESULTS AND DISCUSSION

4.1 Findings of the questionnaire survey

The findings of the questionnaire survey indicating that managerial and coordination-related constraints are more serious than technical ones. According to 88% of respondents, approval delays were rated highest amongst all delaying factors. A further 85% reported slow decision-making and 83% reported a lack of daily follow-up. According to reports, communication between different teams was ineffective as mentioned by 79% of the respondents. Lack of material shortage was reported by 75%. Furthermore, Rework and Delay was due to changed drawing and coordination failure. This happened by 71% and 67% and there were issues related to labour productivity by 63%. The results indicate that delays are not limited to labour availability or site productivity. They are closely connected to how information, approvals, decisions, and constraints flow through the project organization.

The determination of delay factors' ranking is important because it indicates the type of managerial intervention required. If labour shortage was the only and dominant issue than the solution would have been only concentrated on workforce mobilization. If the only force was material shortage, then the only solution will be procurement planning. Nonetheless, in this case, the score of approval delays, decision latency, monitoring weakness and gap of communication all scored above 79%. The trend suggests that a system for coordination is needed in this project to shorten the time between opening and closing issues. The relevance of Agile practices is that they create daily routines to surface blockers, assign owners, and escalate unresolved decisions.

Table 5. Questionnaire response analysis.

Delay factor	Positive responses (%)	Interpretation
Approval delays affect work	88%	Highest-rated delay factor; indicates that slow approval chains directly stop work fronts.
Slow decision-making process	85%	Shows that delayed decisions are a critical management bottleneck.
Lack of daily monitoring	83%	Indicates that weekly or delayed tracking allows problems to grow before correction.
Poor communication between teams	79%	Confirms weak information flow between departments and site teams.
Material shortage issues	75%	Shows that procurement and availability constraints interrupt activity flow.
Rework due to coordination failure	71%	Links poor coordination with additional work and productivity loss.
Delay due to drawing changes	67%	Shows that design changes and late revisions affect execution.
Labour productivity issues	63%	Indicates resource-efficiency problems, though less severe than approval and monitoring issues.

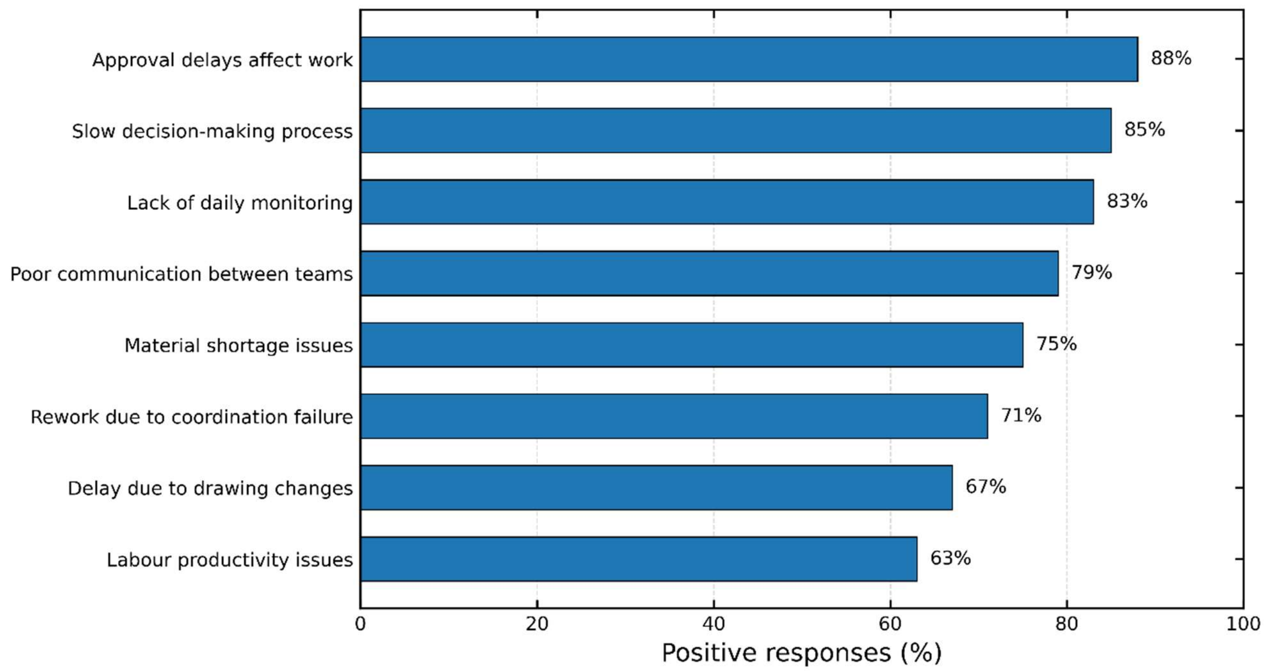

Figure 1. Questionnaire survey results for major delay factors (N = 24).

4.2 Planned versus actual duration analysis

Analysis of planned duration versus actual duration corroborates the survey finding. The planned duration of the 20 activities was 145 days and actual duration was 224 days. This led to a delay of 79 days and a schedule variance of 54.5%. The average activity-level percentage delay was about 54.2%. The intended duration to complete no studied activity. The participatory analysis doesn't imply equal influence of every activity on the project completion date as critical path logic and overlapping work fronts require individual analysis. Nevertheless, it has shown a systematic reliability problem in executing in the near term.

The construction activity that recorded the maximum percentage of delay was plumbing work at 71.4%. This was followed by external plastering and flooring, which both recorded a percentage delay of 62.5% each. There was a delay of 60% in footing concreting, first-floor slab, painting work and handover of project. The work of electrical conduit and final finishing recorded 57.1% delay. These activities require excellent coordination, inspections, material readiness, civil-MEP interface management, quality readiness, and speed of decision-making. The high plumbing delay is quite noticeable as it depends on civil readiness, sleeve locations, shaft access, material availability, pressure testing, waterproofing coordination, tiling sequence, and inspection closure. Thus, a plumbing delay can affect flooring, painting, other finishes, and handover.

This suggests that Agile interventions should not be generic but targeted. Foundation and structure activities will be optimally targeted by the construction team with inspection readiness, material supply, labour planning, equipment allocation and daily progress monitoring. Finishing and MEP activities need more detailed floor-wise room-wise coordination. Handover activity will have defect burn-down and approval closure as documentation readiness and customer-facing quality check. It is improbable that a weekly meeting will manage these dependencies. One approach is to use one- or two-week sprints tied to the floor zones or trade packages complemented with 10-minute daily stand-ups and a visible task board.

Table 6. Planned duration, actual duration and delay by activity.

Construction activity	Planned duration (days)	Actual duration (days)	Delay (days)	Delay (%)
Site Clearing and Layout	5	7	2	40.00%
Excavation Work	8	12	4	50.00%

PCC Work	4	6	2	50.00%
Footing Reinforcement	6	9	3	50.00%
Footing Concreting	5	8	3	60.00%
Column Casting	7	10	3	42.86%
Plinth Beam Work	6	9	3	50.00%
Backfilling Work	4	6	2	50.00%
Ground Floor Slab	10	15	5	50.00%
First Floor Slab	10	16	6	60.00%
Brickwork	12	18	6	50.00%
Internal Plastering	10	15	5	50.00%
External Plastering	8	13	5	62.50%
Electrical Conduit Work	7	11	4	57.14%
Plumbing Work	7	12	5	71.43%
Flooring Work	8	13	5	62.50%
Door and Window Fixing	6	9	3	50.00%
Painting Work	10	16	6	60.00%
Final Finishing	7	11	4	57.14%
Project Handover	5	8	3	60.00%

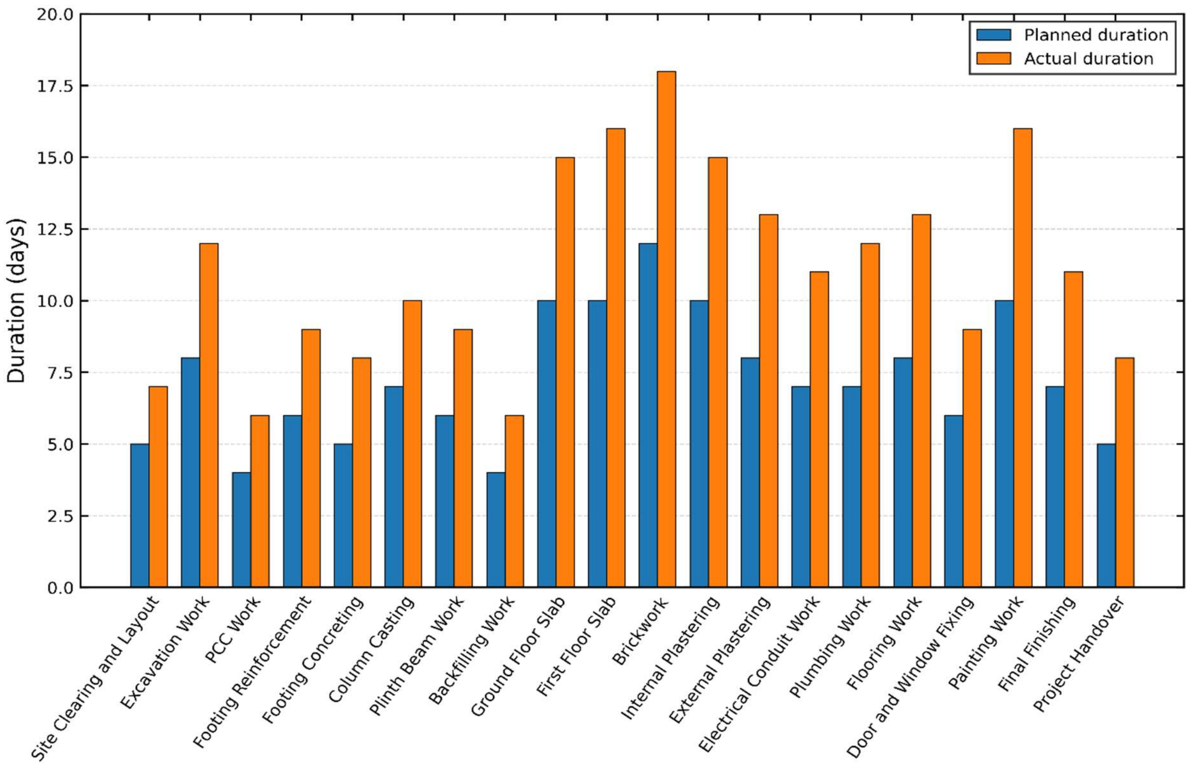

Figure 2. Duration planned versus duration actual per construction activity.

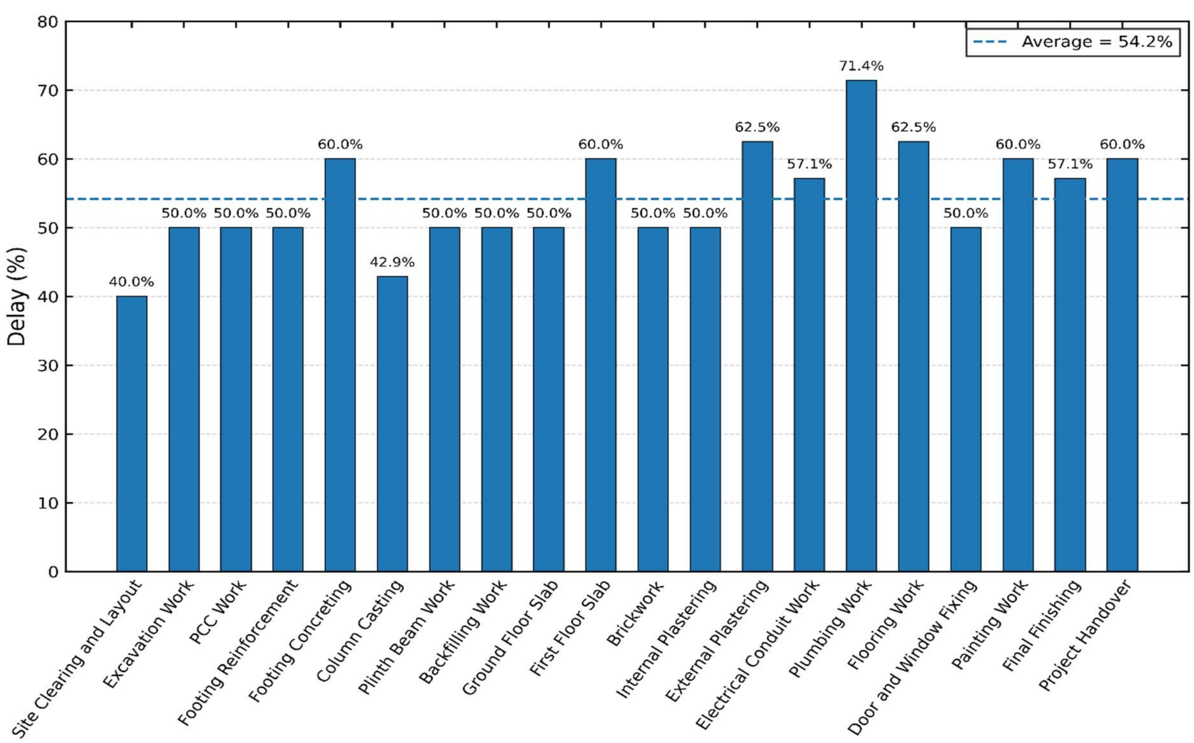

Figure 3. Percentage delay by construction activity.

4.3 Delay classification and root-cause synthesis

Delays due to approval were decomposed into drawing approval delay, inspection delay, material approval delay and billing approval delay. Delays in approval-based drawing contributed 40%, inspection 30%, material approval 20% and billing approval 10% of all delay. It is clear from this distribution that the problem almost entirely technical and production-oriented, and not just commercial. The approval of drawings and inspections impacts the start, continuation or close of work. So, the Agile approval backlog should separate technical approvals critical to the site from commercial workflows that are less critical. Each approval item must have an owner responsible for the item, submission date, target decision date, ageing status, and escalation threshold.

Delays in communication causing rework stem from communication gaps, improper coordination, slow decision-making, and delays in informing activities. At 35%, the largest share of the communication impact that stems from communication gaps was rework. These results correlate with the delays in activity found in MEP and finishing work. When teams don't get timely updates, they may work off outdated drawings, miss a dependency, use the wrong dimensions, or complete their work before the previous trade is ready. Daily stand-ups can mitigate this risk by compelling each trade to declare what was finished yesterday, what will be done today, and what blockers will require assistance.

Monitoring and tracking delays were mainly caused by a lack of daily tracking, accounting for 38%. Twenty-seven per cent for late detection of delay, twenty per cent for weak accountability and fifteen per cent for poor monitoring of productivity. The results indicate that the detection of delay was late. A weekly review can identify that a particular activity has slipped, but it cannot recover the daily decisions that were missed. Agile monitoring alters the pace of control. Instead of waiting for their next team meeting, teams review their commitments daily and close their blockers before they build up. You may wonder whether stand-ups require long meetings. Stand-ups are meant to be short and simple. A well-run stand-up should be time-boxed, action-oriented and link back to the task-board.

In total, 40% of the delay in resource management (material shortage), 30% is due to labour shortage, 20% is due to unavailability of equipment, and 10% is due to improper allocation of resources. The results underscore the necessity of resource sprint planning. Do not approve a sprint unless the readiness of labour, material, equipment, access, drawings, and inspections is sufficient. This process resembles the make-ready system in the deal planner. The purpose helps to prevent work being released to site which cannot be relied upon for completion. In reality, the sprint board should have a resource readiness check for each top-priority activity.

Four interacting delay loops are shown by the root-cause synthesis. The pipeline being delayed must stop drawing and inspection as they will “not” leave any pending. The second communication loop is that ambiguous instructions can lead to wrong sequencing or rework of subsequent activities or, at the very least, make each activity take longer in terms of labour. The third one is the monitoring loop: issues are detected too late, corrective action is delayed, and the next weekly review shows an increase in the variance. The fourth cause of construction project delays is the resource loop where material, labour, or equipment is not available. This leads to stopping of work fronts which in turn reduces productivity of the construction project. Agile practices promote targeted loops through greater visibility, faster feedback and enhanced responsibility.

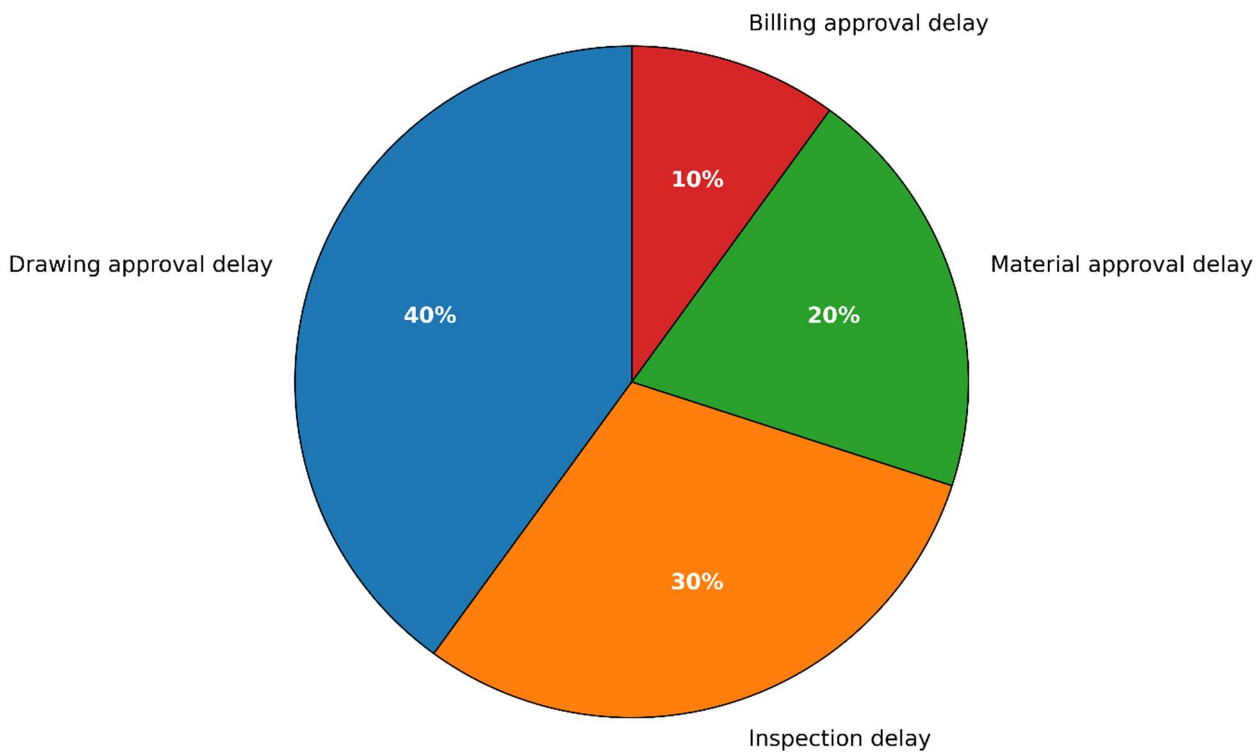

Figure 4 shows the contribution of delays related to approval.

Table 7. Approval delay distribution and Agile response.

Approval delay type	Contribution (%)	Agile response
Drawing approval delay	40%	Maintain a drawing approval backlog with due dates, owners, and escalation thresholds.
Inspection delay	30%	Use daily inspection scheduling and 24–48-hour look-ahead clearance planning.
Material approval delay	20%	Track samples and material approvals in procurement sprints.
Billing approval delay	10%	Separate commercial approval workflow from site-critical technical approvals where possible.

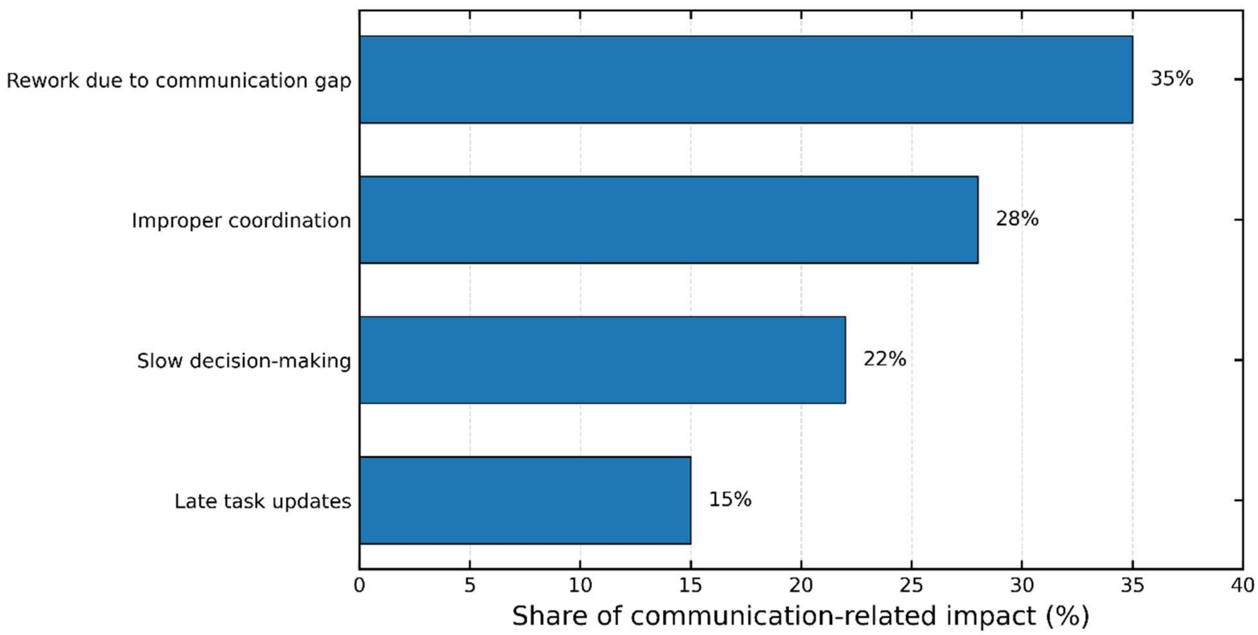

Figure 5. Communication delay impact.

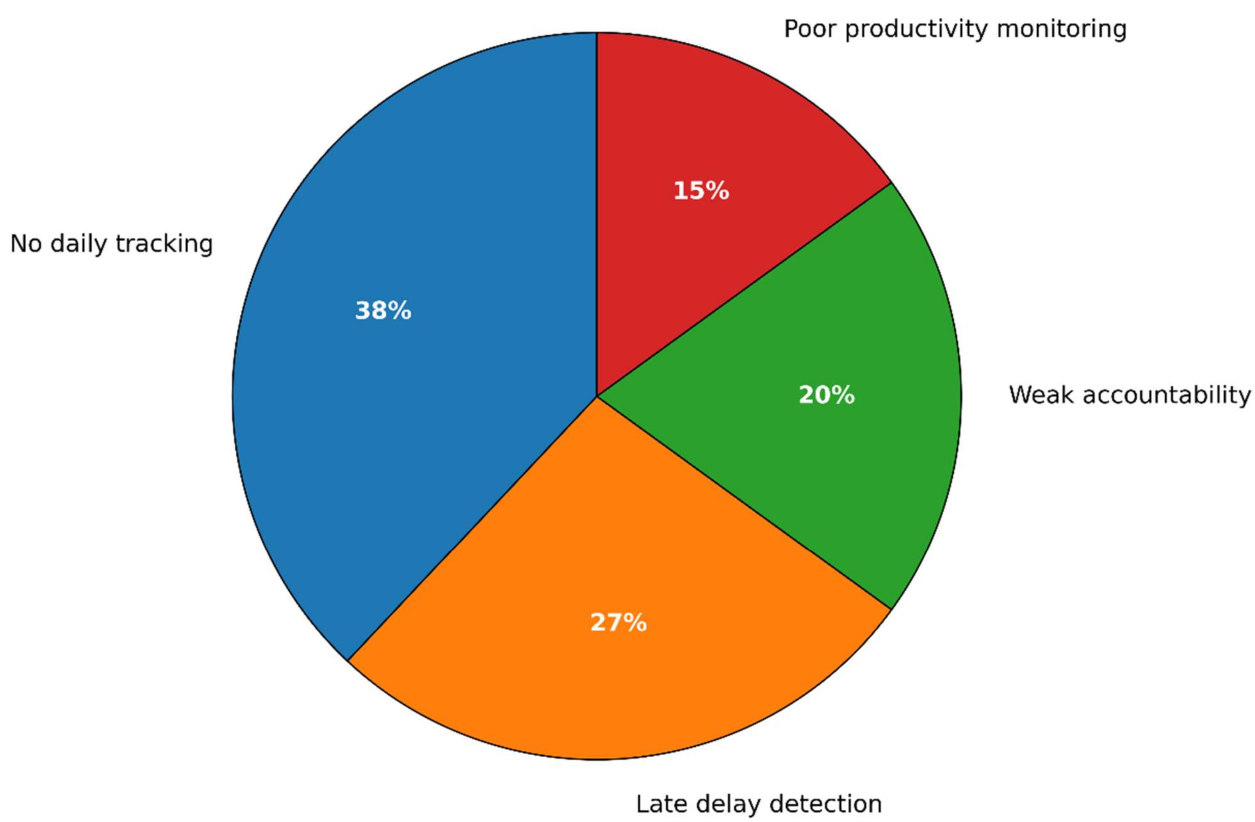

Figure 6. Monitoring failure distribution.

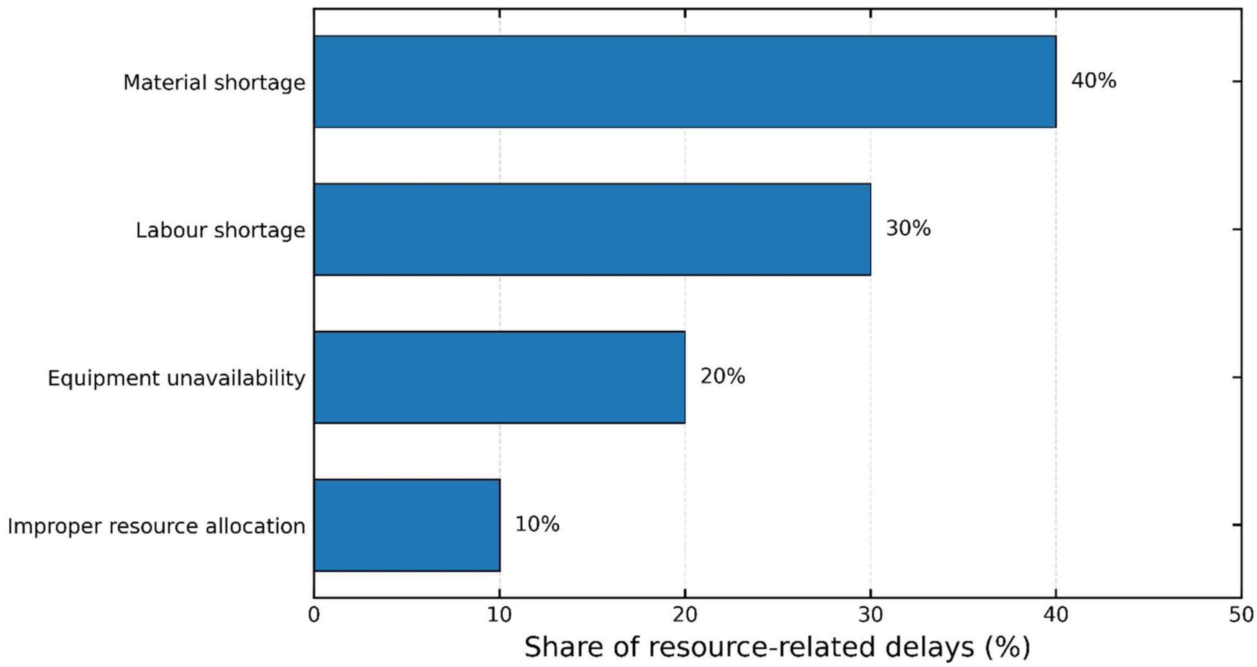

Figure 7. Resource delay analysis.

Table 8. Root-cause synthesis and Agile-based corrections.

Root cause category	Typical manifestation in the case	Effect on project performance	Agile-based correction
Approval delays	Delayed drawings, inspections, material approvals, and billing approvals.	Work stoppage, idle labour, delayed milestones, and increased duration.	Fast escalation system, approval backlog, daily approval tracking, and sprint-wise approval planning.
Communication delays	Slow instruction flow, poor team updates, civil-MEP gaps, and unresolved site issues.	Rework, confusion, improper sequencing, and productivity loss.	Daily stand-up meetings, shared task board, collaborative sprint planning, and real-time communication channels.
Monitoring delays	No daily progress tracking, late issue identification, and weak accountability.	Schedule overrun, resource wastage, and delayed corrective action.	Daily progress meetings, sprint reviews, KPI dashboard, and continuous monitoring cycle.
Resource delays	Material shortage, labour shortage, equipment unavailability, and improper allocation.	Interrupted work fronts, idle time, and longer execution duration.	Resource sprint planning, material tracking system, daily resource review, and task prioritization.

4.4 Proposed Agile framework for delay reduction

The case project's proposed agile framework includes seven elements. Sprint-based planning breaks down short-term activities into one- or two-week cycles for execution based on the master schedule and overall look-ahead plan. The daily stand-up meetings will create a shorter communication loop between site engineers, site supervisors, contractors, planning people, QA/QC person, and critical trade leaders. The third tool is task prioritization board which identifies whether work is high priority, medium priority or low priority. Fourthly, fast escalation system has time limits for approvals, inspections, decisions, and material shortages. Fifth, a material board tracks samples and purchase orders delivery shortages alternatives. Quality checklist monitoring reduces rework and enhances closure at finishing stage. Sprint reviews and retrospectives turn recurring blockers into process improvements.

The framework ought to be executed at the work front level before being expanded throughout the project. A practical pilot could start with one building zone, or one floor cycle, or one finishing package A weekly sprint planning meeting should be held by the pilot team to define commitments; a daily stand-up to manage blockers; a mid-sprint constraint review for critical approvals and materials; and an end-of-sprint review to measure percent plan complete and unresolved constraints. A simple physical board or digital dashboard with four columns – Planned, Ready, In Progress, done to be used by the pilot. You can add lanes for Blocked, Awaiting Approval, Material Pending, Inspection Pending, and Rework.

Activity-wise solution mapping illustrates how to apply Agile to specific construction activities. Site instructions for clearing and layout should be quick and daily. Need equipment assignment in the sprint plan for excavation work The tracking of material is crucial in PCC work Approval escalation is required for footing reinforcement drawing. The schedule needs inspection for Footing concreting. Planning of manpower resource needed for column casting. Plinth beam work involves communication reviews to avoid rework. The shuttering, reinforcement, inspection and concrete supply of the slab work should be planned together. Brickwork needs better coordination among civil, MEP, and planning teams. Quality checklists and defect burn-down are required for plastering, flooring, painting, and finishing. Handover of project needs quick decision-making and closure.

The examination of traditional versus Agile systems cannot simply be characterized as a comparison of bad versus good. The traditional system offers essential control, while the Agile system refers to execution responsiveness. The conventional system is more effective in terms of formal planning, contractual milestones, quality documentation, statutory approvals and safety. Communication can happen every day, delays can be detected early, tasks can be prioritized, and issues can be resolved with the Agile system. A hybrid solution is therefore recommended. Even if the agile practices support daily production management, controls on the baseline schedule, budget, safety, quality and contracts will remain in place.

Table 9. Delay analysis based on activities and agile solutions

Construction activity	Major reason for delay	Impact on project	Agile-based solution
Site Clearing and Layout	Delayed site instructions	Work initiation delayed	Daily coordination meetings
Excavation Work	Equipment unavailability	Idle labour and machine time	Sprint planning for equipment allocation
PCC Work	Material procurement delay	Foundation activity delay	Material tracking board
Footing Reinforcement	Drawing approval delay	Reinforcement work stoppage	Fast escalation system
Footing Concreting	Inspection delay	Concreting postponed	Daily inspection scheduling
Column Casting	Labour shortage	Structural delay	Workforce planning sprint
Plinth Beam Work	Rework due to communication gap	Additional execution time	Daily review meetings
Backfilling Work	Improper sequencing	Delay in next activity	Task prioritization board

Ground Floor Slab	Delayed shuttering work	Slab completion delay	Collaborative planning system
First Floor Slab	Material shortage	Work interruption	Real-time material monitoring
Brickwork	Poor coordination between teams	Slow progress	Cross-functional team meetings
Internal Plastering	Rework due to uneven surface	Increased labour hours	Continuous quality monitoring
External Plastering	Weather and planning issues	Delay in finishing work	Weekly sprint planning
Electrical Conduit Work	Drawing revision delay	Rework generation	Rapid issue escalation
Plumbing Work	Dependency on civil work	Workflow interruption	Integrated task scheduling
Flooring Work	Delayed material delivery	Finishing work delay	Procurement sprint tracking
Door and Window Fixing	Measurement mismatch	Rework and fitting delay	Daily coordination reviews
Painting Work	Surface correction and rework	Project completion delay	Quality checklist monitoring
Final Finishing	Multiple pending activities	Delay in handover	Priority-based task management
Project Handover	Slow approval and inspection	Client dissatisfaction	Fast decision-making workflow

Table 10. Core components of the proposed Agile framework.

Agile component	Construction adaptation	Expected benefit
Sprint-based planning	Divide near-term work into one- or two-week execution cycles linked to the look-ahead plan.	Better tracking, improved preparation, and reduced waiting time.
Daily stand-up meeting	Short meeting among site engineers, supervisors, contractors, planning personnel, QA/QC staff, and critical trade leads.	Real-time communication, faster decisions, and immediate problem solving.
Task prioritization board	Classify tasks into high, medium, and low priority based on criticality and dependency.	Better workflow management and focus on critical constraints.
Fast escalation system	Escalate drawings, inspections, approvals, material shortages, and access issues according to thresholds.	Reduced stoppages and faster issue closure.
Material tracking	Track pending samples, purchase orders, delivery status, shortages, and substitute	Improved procurement readiness

board	options.	and fewer site interruptions.
Quality checklist monitoring	Use floor-wise and room-wise acceptance criteria for finishing, MEP, and handover.	Reduced rework and faster defect closure.
Sprint review and retrospective	Review completed commitments, incomplete work, root causes, and process improvements.	Continuous learning and accountability.

Table 11. Comparison of traditional and Agile project-management systems.

Parameter	Traditional system	Agile system
Planning method	Fixed schedule with limited short-term adaptation.	Sprint-based planning linked to look-ahead constraints.
Communication	Hierarchical and delayed.	Continuous, collaborative, and issue-focused.
Monitoring	Weekly or monthly review.	Daily tracking with sprint review.
Problem resolution	Slow and escalation-dependent.	Immediate issue identification and fast escalation.
Team coordination	Limited cross-functional interaction.	Collaborative teams including site, planning, consultants, contractors, and trade supervisors.
Delay detection	Late detection after slippage occurs.	Early detection through daily progress and backlog tracking.
Resource management	Reactive allocation after shortage occurs.	Proactive resource sprint planning and material tracking.
Flexibility	Low; difficult to adjust priorities.	High within formal scope, safety, quality, and approval controls.
Delivery efficiency	Lower because blockers remain hidden longer.	Higher because blockers are made visible and closed faster.

4.5 Expected delay reduction and KPI framework

The anticipated delay mitigation was assessed for 10 chosen significant activities. The expected delay after the Agile implementation was estimated to be 21.5%, while the average delay currently existing in these activities is 57.7%. The approximate fall indicated here is 36.2 percentage points while that of the relative is 62.7%. As per the estimates we received from our research, project handover was to see a maximum jump. If approval closure, defect burn-down, and decision-making become Agile, the delay will see a reduction from 60% to 15%. The plumbing delay of the project can come down from 71% to 28%. This can happen if the dependencies of civil-MEP, material readiness, pressure testing and inspection planning are uploaded on the sprint board.

Approach these estimates with caution. The post-implementation outcomes are not measured; they are targets for the pilot implementation. The level of improvement that is actually achieved will depend on support from leadership, involvement of subcontractors, authority to make decisions, discipline on planning, quality of data and teams being willing to raise problems early. If agile tools are considered to be new paperwork rather than a decision-making system, they can fail. As such, the pilot should measure the actual before-after changes using percent plan complete, approval cycle time, constraint closure rate, decision latency, rework index, defect burn-down and resource readiness.

The implementation of KPI Framework is a critical part. The reliability of your weekly commitments is assessed by percent plan complete. The constraint closure rate assesses whether blockers are solved before the planned activity start. Approval cycle time is the measuring time for drawing, material, and inspection approvals. Cycle time for RFI or drawing revision measures design-response speed. The availability of labour, material, equipment, access and drawings before starting work is termed as resource readiness index. Rework index assesses coordination and quality leakages. Defect burn-down assesses the discipline of finishing and handover closure. Governance responsiveness is measured by decision latency. With these KPIs combined, Agile transforms from a meeting ritual to a production control system.

Table 12. Delay reduction anticipated through Agile implementation.

Construction activity	Existing delay (%)	Expected delay after Agile (%)	Expected reduction (percentage points)
Excavation Work	50%	20%	30%
Footing Reinforcement	50%	18%	32%
Slab Work	60%	25%	35%
Brickwork	50%	22%	28%
Electrical Work	57%	24%	33%
Plumbing Work	71%	28%	43%
Flooring Work	62%	25%	37%
Painting Work	60%	20%	40%
Final Finishing	57%	18%	39%
Project Handover	60%	15%	45%

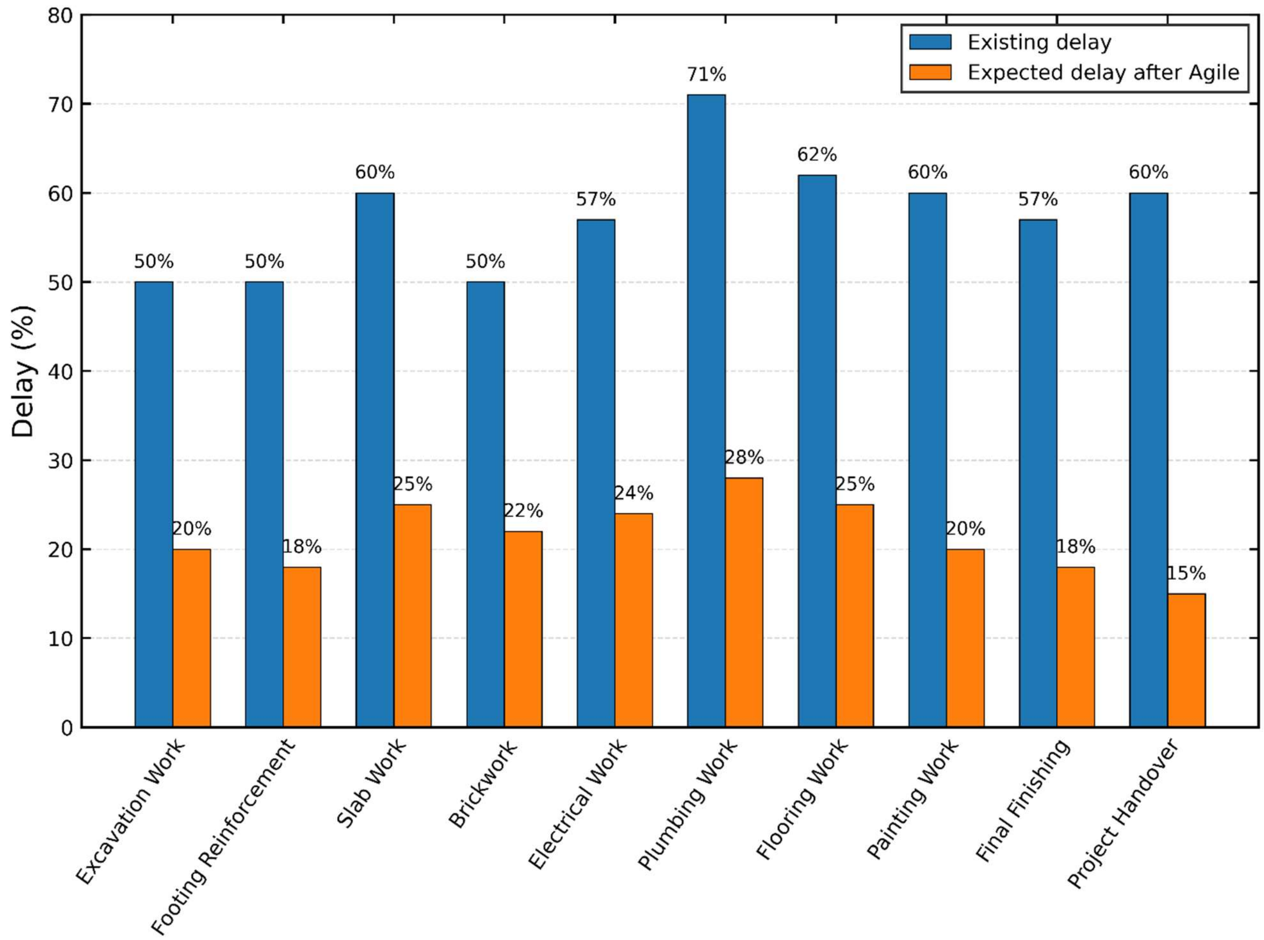

Figure 8. Expected delay reduction using Agile methodology.

Table 13. KPI framework for Agile implementation in residential construction.

KPI	Definition	Frequency	Purpose
Percent plan complete (PPC)	Completed weekly commitments divided by planned commitments.	Weekly	Measures reliability of short-term planning.
Constraint closure rate	Constraints closed before planned activity start divided by total constraints due.	Weekly	Measures make-ready effectiveness.
Approval cycle time	Average days from submission to approval for drawings, materials, and inspections.	Weekly/monthly	Measures speed of approval process.
RFI/drawing revision cycle time	Average days from issue identification to accepted response.	Weekly/monthly	Measures design-response speed.
Resource readiness index	Share of planned activities with labour, material, equipment, access, and drawings ready before start.	Weekly	Prevents work stoppage due to resource gaps.

Rework index	Rework events or rework hours per floor or package.	Monthly	Tracks coordination failure and quality leakage.
Defect burn-down	Open defects closed per sprint against new defects raised.	Weekly	Measures finishing and handover closure discipline.
Decision latency	Average days for decisions above agreed time or cost impact threshold.	Weekly/monthly	Measures governance responsiveness.

4.6 Managerial implications and risk controls

The managerial implication is to treat the reduction of delays as a workflow reliability problem. While a schedule indicates what "should" happen, a "workflow" system ensures that work is ready to happen. Managers must therefore question five times daily, whether the next work front is ready? Which sanction hampers advancement? Which material or labour resource is not accessible? What trade dependency creates rework? Which decision must be escalated today? These are easy questions but rarely answered in a systematic way in weekly reviews. Agile helps organization increase visibility and repeatability.

For consultants and design coordinators there will be a framework to prioritize by site impact drawing revisions and RFIs. Some questions are different than the rest in importance. A quicker escalation of a query relating to blocking concrete or MEP shaft work is preferable to query affecting later-stage non-critical item. Contractors and subcontractors must frame commitments that are realistic and capable of being measured. A subcontractor shall not start to commit to a flooring on a floor unless the substrate is ready, available materials, and closed preceding MEP checks. The framework means that QA/QC teams must plan inspections in advance rather than requesting them when incomplete work is discovered.

There is need for risk controls. Ceremonial Agile can produce additional meetings without coming to a faster decision. Involvement was restricted to stand-ups, decision rights, and escalation risk. By timing. Allowing uncontrolled changes, including poor practices that create scope creep or cause rework, can expose the project to claims. If subcontractor participation is weak, sprint commitments become unrealistic; trade supervisors are involved in sprint planning and PPC review to mitigate this. When one implements the tool before defining the process, making the digital boards reporting heavy. This can be avoided when the process, taxonomy, owner, and acceptance criteria are defined before selecting the software. The use of KPIs for punishment creates a blame culture; however, this issue is addressed by using KPIs for learning and constraint removal.

The findings also indicate that varying phases need different Agile emphases. Look-ahead planning, inspection scheduling and resource readying are the most important routines during the foundation and structural work. During masonry and MEP rough-in, the civil-MEP coordination, clarity of drawing and sequencing of access is given focus. During the finishing phase, the focus is on quality checklists, material tracking, defect burn-down and room task boards. When you handover, documentation, final approvals, customer-facing quality, and closure of all open issues definitely get attention. A single agile template should therefore be customized by project stage.

Table 14. Risks and mitigation measures for Agile adoption.

Risk	Potential effect	Mitigation
Ceremonial Agile	More meetings without faster decisions.	Create decision rights, escalation rules, and time-boxed agendas.
Uncontrolled changes	Scope creep, rework, cost impact, and schedule disruption.	Use design freeze dates, impact analysis, and formal change control.
Weak subcontractor participation	Commitments not owned by executing teams.	Include trade supervisors in sprint planning, daily huddles, and PPC review.

Tool-first implementation	Digital board becomes a reporting burden.	Define process, taxonomy, owners, and acceptance criteria before selecting software.
Conflict with contracts	Ambiguous obligations and claim risk.	Use Agile for coordination and learning; retain formal contract administration.
KPI misuse	Blame culture and distorted reporting.	Use KPIs for learning, constraint removal, and continuous improvement.

The larger conversation is that Agile construction isn't about informality. It is all about being disciplined in your response. It is often thought that one must constantly change plans. Within the context of construction, agile should mean shielding the plan by being amongst the first to identify constraints, being quick to respond but also learning from the same blockers that keep recurring. This interpretation works well with Lean construction, BIM collaboration, Takt planning, and project governance. The Pune case shows that the biggest delay factors are exactly those that can gain from disciplined responsiveness approvals, decision making, monitoring, communication, material readiness and rework closure.

The research verifies the importance of Agile in Lean construction. Lean recognizes waste and emphasizes reliability in workflows. Agile proposes routines for short-cycle adaptation. BIM and digital tools ensure visibility. Traditional management ensures control of contracts and compliance. The combination of these elements leads to a hybrid production-management system. The anticipated benefit is not just a decrease in the number of delay days. Other benefits include better accountability, enhanced team communication, earlier identification of issues, less rework and more reliable handover. The Integrated Interpretation conclusion and recommendations are presented in the following section.

5. CONCLUSION

5.1 Conclusion

The study was conducted to ensure delay reduction in a high-rise residential construction project located at Pune by adopting Agile. The research consisted of a questionnaire survey of 24 construction professionals and analysis on 20 major construction activities. The results showed that the delay was systematic and not an isolated incident. All 20 activities crossed the planned completion time and caused 79 delay days against the planned 145 delay days with an overall schedule variance of 54.5%.

Findings from the questionnaire showed that the major causes of delay included approval and decision-making delays, no daily monitoring, poor communication/communication gap, shortage of material, rework due to non-coordination, delay in drawing revision and labour productivity. According to the activity-duration analysis, plumbing work suffered the maximum percentage delay and it was followed by external plastering, flooring, footing concreting, first-floor slab, painting, final finishing, and project handover. The key activities rely heavily on cross-trade coordination, material readiness, closure of inspections, quality readiness and timely decision making. The results therefore support the argument that residential delay reduction requires a management system that enhances daily visibility and quick closure of constraints.

The proposed framework modifies Agile practices for construction. It covers sprint plans, daily stand-ups, task prioritization boards, approval backlogs, quick escalation, material tracking, ongoing quality checks, sprint reviews, retrospectives, and KPI dashboards. The framework will not substitute the master schedule, budget, safety plan, quality plan, statutory approvals and contract administration. Rather, it acts as a coordination and control layer that improves the reliability of short-term execution. A hybrid method is more appropriate than a pure Agile approach because construction is physically sequenced, safety-critical, contractually-bound, and reliant on inspections and statutory controls.

Analysis of expected delay implies that practices based on Agile can decrease average delay in selected critical activities from 57.7 percent to 21.5 percent, indicating a relative average reduction of about 62.7 percent. This figure should be viewed as a target during the piloting or implementation stage and not a measured post-implementation result. A future pilot examining an Agile-managed work front vis-à-vis a conventionally managed work front should be conducted for a period of eight to twelve weeks. The pilot must monitor various parameters like percent plan complete, closure rate, approval cycle time, RFI cycle time, resource readiness, and more of the plan development.

5.2 Recommendations

Below are the practical recommendations. You should try out Agile first on one building zone, one floor cycle or one finishing package. In the sprint planning and daily stand-up meetings, site engineers, planning engineers, supervisors, contractors, QA/QC, and trade leaders are included. Third, create a backlog of drawings, inspections, materials, and critical decisions requiring owner's approval with due dates. Additionally, use material readiness boards to prevent work front stoppage. Use floor-wise quality checklists and defect burn-down charts in finishing and hand over Sixth, preserve formal controls for managing the work scope, cost, safety, quality, legal, and contract administrator. Utilise KPIs for learning and improvement, not to identify blame.

The overall conclusion is that the Agile method can improve the performance of residential construction if it is fitted to the construction's physical and contractual realities. The value of the work management process is that it makes work visible, facilitates communication, shortens cycle time of decision-making, prioritizes based on constraints, and builds a disciplined learning loop. The piece of work in Pune reveals that Agile has good potential as a practical delay-reduction approach in complex residential construction when used in combination with Lean construction, BIM-enabled visibility and existing baseline governance.

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