A Comprehensive Analysis of Key Factors Affecting Project Scheduling in Kolhapur City

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Abstract

Efficiency of the scheduling of construction projects is a critical factor that determines timely and cost-effective completion of a project. The paper examines the key issues of scheduling of construction projects in the City of Kolhapur in terms of operation and management. A fuzzy Hierarchical (elimination) approach supported by Relative Importance Index (RII) technique was carried out to discuss survey of engineers and project managers on the prioritization of delay causes on 24 major construction phases. The elements of real-time oversight, skill-based labor distribution and communications were stressed by the engineers whereas the essential aspects of timely decision-making, material supply, and funding transfers were stressed by the project manager. To add to this was five real life case studies, the most common stages that were delay dominated were the following, Footing & Raft Work, Masonry and Finishing activities. Its results indicate that inefficiencies in schedules are inherent, given inappropriate planning of resources, unresponsive surveys, and improper organization. Those delay factors that are high impact, as defined using RII (e.g., RII= 0.817 in terms of inspection frequency and RII= 0.800 in terms of speed of decision making), associate with disruptions on the critical path. To address such setbacks, the research provides a model of strategic measures such as digital tools (BIM, IoT), lean construction, sophisticated procurement systems, as well as the collaborative methods of contracting architecture, and prefab building. These indicators are to change the construction scheduling models of Kolhapur to predictive, sustainable, and efficient execution of projects.

Keywords- Construction Scheduling, Delay Analysis, Lean Construction, Project Management, Relative Importance Index (RII), Risk Mitigation.

1. Introduction

Efficient scheduling in construction projects remains a central factor in ensuring timely delivery, cost optimization, and overall project success(Hajdu, 1997; Hutchings, 2003). As urban regions such as Kolhapur experience accelerated infrastructural development, the challenges associated with scheduling become more pronounced. Delays in construction projects are not just project-specific failures but reflections of broader systemic inefficiencies—including planning inconsistencies, labor shortages, material delays, financial constraints, and inadequate stakeholder coordination(Alzahrani & Emsley, 2013; Assaf & Al-Hejji, 2006a; Sambasivan & Soon, 2007).

Numerous international and regional studies have attempted to classify the critical causes of construction delays(Aftab Memon 1, 2023; Aibinu & Jagboro, 2002; Aibinu & Odeyinka, 2006a; Assaf & Al-Hejji, 2006b; Borse & Khare, 2016; Chan et al., 2004; H. Doloi et al., 2012a; Iyer, K & Jha, K, 2017; Marzouk & El-Rasas, 2014; Pourrostam & Ismail, 2011). Key delay sources have been identified as contractor-related inefficiencies, poor site management, lack of stakeholder communication, financial limitations, weather interruptions, and bureaucratic approvals (H. Doloi et al., 2012b; Enshassi et al., 2009; Frimpong et al., 2003; Fugar & Agyakwah-Baah, 1970; Kaming et al., 1997; Le-Hoai et al., 2008; Sweis et al., 2008). In India, these

challenges are further compounded by rigid public tendering systems and irregular resource mobilization (H. K. Doloi, 2011; Senouci et al., 2016).

Project scheduling tools and techniques have evolved over decades. From traditional approaches like Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) to more advanced frameworks such as Building Information Modeling (BIM) and lean scheduling, the aim has always been to reduce time overruns and enhance predictability (Mohamed Elsherbiny et al., 2024; Porwal & Hewage, 2013)(Bamgbose et al., 2024). Despite such advances, digital adoption in mid-tier Indian cities like Kolhapur remains limited due to technical, financial, and organizational barriers (Mohamed Elsherbiny et al., 2024; Radman et al., 2025).

The Relative Importance Index (RII) has emerged as a robust statistical tool for prioritizing delay factors based on stakeholder inputs. Studies across Nigeria, Saudi Arabia, Malaysia, and India have used RII to rank factors such as design errors, skilled labor shortage, material lead time, and equipment failure (Abd El-Razek et al., 2008; Aibinu & Odeyinka, 2006b; Ali & Rahmat, 2010; H. Doloi et al., 2012b; Haseeb et al., 2012; Sambasivan & Soon, 2007).This study uses RII to analyze 24 stages of scheduling through surveys with engineers and project managers across Kolhapur construction projects

Another dimension gaining attention is the role of stakeholder communication and collaboration in improving schedule performance. Fragmented decision-making and unclear project goals often lead to rework, inspection delays, and coordination gaps (Al-Khalil & Al-Ghafly, 1999; Love et al., 1999; Toor & Ofori, 2008).Studies suggest that early stakeholder engagement, along with Integrated Project Delivery (IPD) models, can lead to improved alignment of resources and project timelines (Elawi et al., 2016; Porwal & Hewage, 2013; Vilutiene et al., 2019).

In response to global sustainability goals, time and cost efficiency are now being considered not only from a financial but also an environmental perspective. Off-site construction, modularization, and automation are being deployed to enhance both speed and sustainability in project execution(Memon et al., 2012; Pan et al., 2012)

Despite the abundance of international literature, localized case-specific insights are scarce. Kolhapur, as a growing urban center, presents a unique opportunity to analyze these issues. By combining empirical data and survey analysis, this study aims to bridge the gap between global scheduling strategies and local ground realities.

2. Research Methodology

The methodology adopted for this study integrates both qualitative and quantitative approaches to comprehensively examine the critical factors affecting construction project scheduling efficiency in Kolhapur City. Primary data was gathered through structured surveys and interviews with engineers, project managers, in the construction industry, while secondary data was obtained from relevant literature and case studies. Quantitative analysis was carried out using the Relative Importance Index (RII) method, which transformed qualitative survey responses into numerical rankings to prioritize the impact of various scheduling factors. 24 stages of construction enabled the classification of high, medium, and low-impact issues across dimensions such as labor, material availability, financial constraints, and managerial practices. Expert consultations and case evaluations further contextualized the findings, and the study concluded by proposing strategic recommendations tailored to the region, incorporating modern project management tools, improved resource planning, and localized mitigation strategies to enhance scheduling efficiency and reduce project delays.

3. Role of Engineer and Project Managers

Two stakeholders who have a massive effect in a construction project particularly in scheduling and proper running of a project on time are the engineers and the project managers. They are supposed to satisfy

operational and strategic aspects in the delivery of projects. The engineers would be in charge of day to day operations of the site as far as ensuring the adequate use of resources, control of quality, and adhering to the technical specification, on the other hand, the project managers would be in charge of the planning, financial control, procurement, and the decision-making processes. These are the professionals with varying perceptions which are significant in assisting in getting real problems which impact projects within their schedules. The two groups combined in this study would ensure that all the issues that exist with regard to schedules are known thus enabling them to come up with some viable and practical ways of improving the performance of construction projects.

In this study, the most important contributions of the engineers and the project managers were used to have in-depth understanding about the scheduling situations encountered during the construction projects in the Kolhapur City. Realizing that their roles were different and complementary, engineers being in charge of on-site processes and implementation of resources and project managers in charge of planning, procurement, and decision-making, the research engaged them by carrying out survey-based studies. Individually structured questionnaires were developed to reflect the perception of the two groups on 18 (engineers) and 24 (project managers) important issues that define the project timelines. The responses were further studied based on the use of Relative Importance Index (RII) technique that allowed developing the quantitative ranking based on the qualitative answers. The answers collected with the assistance of this survey were further analyzed in terms of (RII) method, which helped to translate the subjective data to the scale that consists of 0 through 1. The increased values of RII imply more importance in influencing the project schedules. The engulfment by both perspectives to the technical and managerial delay causes provided a full picture of the issue and the results of the RII were utilized to prioritize high-impact areas to be the subject of specific intervention measures to enhance scheduling efficiency and the performance of the whole project. Below figure shows the details of their responses.

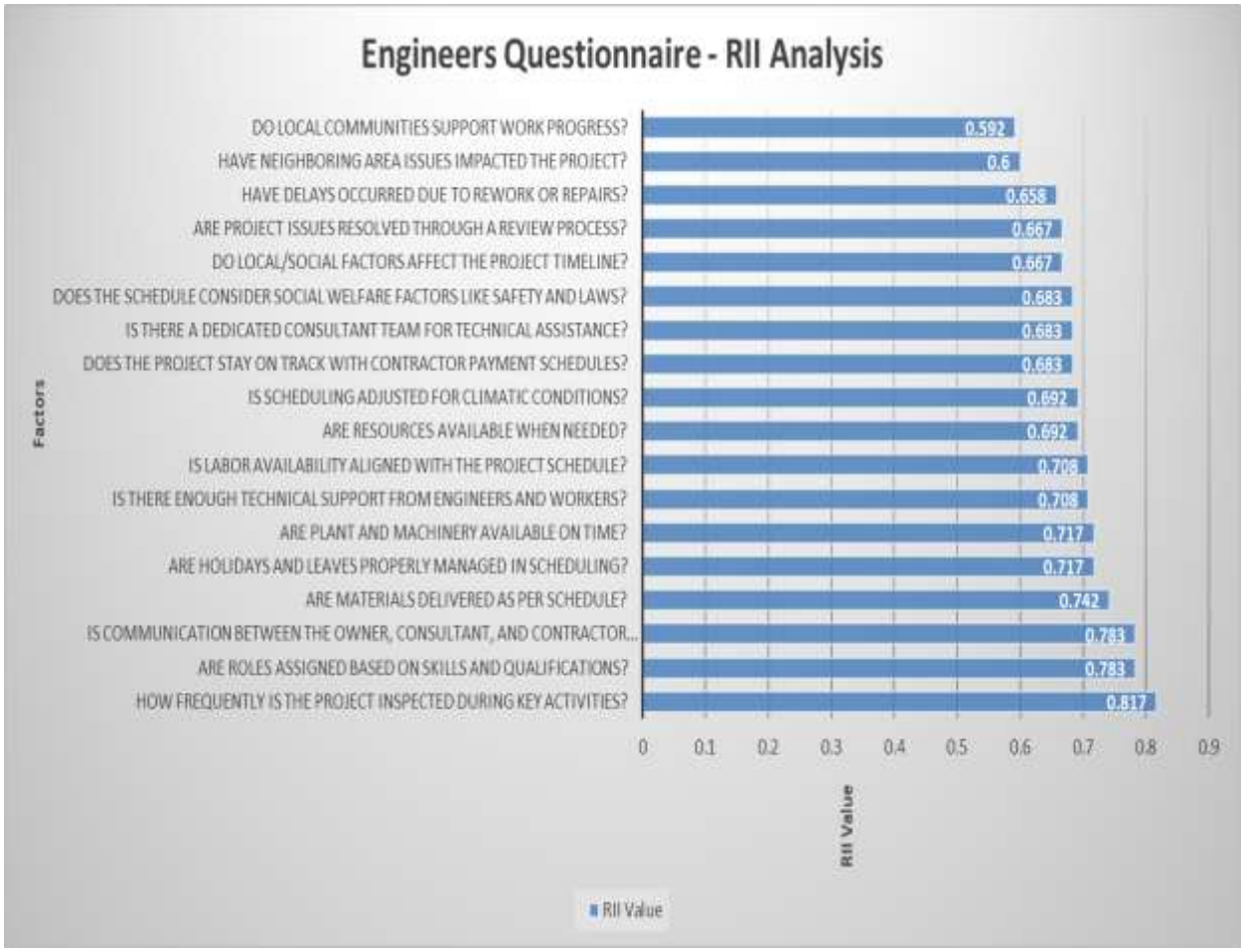

Fig. No 1 Visualization of RII (Engineers Survey)

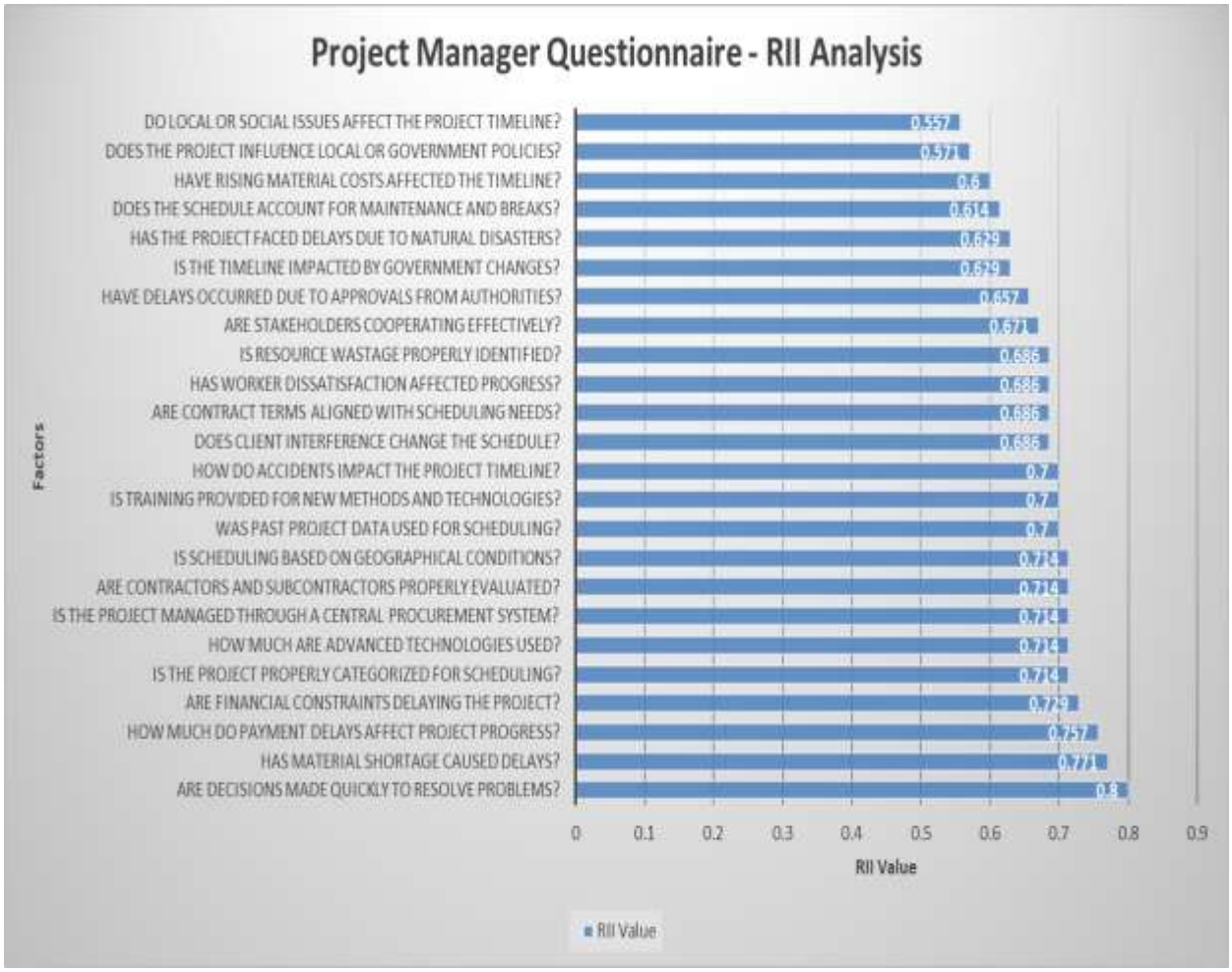

Fig. No 2 Visualization of RII (Project Manager Survey)

The Engineer Survey focused on 18 specific parameters related to day-to-day site operations, technical resource availability, inspection frequency, communication, labor alignment, and material logistics. The highest-ranked factor was the frequency of inspection during key activities (RII = 0.817), followed closely by the alignment of roles with skills (RII = 0.783) and effective communication among stakeholders (RII = 0.783). These findings highlight the engineers' emphasis on real-time supervision, clear role delegation, and team coordination as vital to maintaining project timelines. Other moderately important factors included material delivery schedules, availability of labor, and climatic adjustments in scheduling, while community influence and neighborhood disruptions were considered less impactful.

In contrast, the Project Manager Survey encompassed 24 broader managerial and strategic factors, including financial delays, procurement systems, contractor evaluation, stakeholder coordination, and decision-making speed. Again, utilizing RII, the analysis revealed that swift decision-making to resolve problems was the top factor (RII = 0.800), followed by material shortages (RII = 0.771), payment delays (RII = 0.757), and financial constraints (RII = 0.729). These results reflect project managers' focus on timely administrative actions, financial planning, and resource procurement as primary scheduling influencers. Both surveys provided a dual perspective on project scheduling efficiency—where engineers emphasized operational discipline and project managers stressed strategic responsiveness.

Judging by the thorough survey analysis employed with the help of the Relative Importance Index (RII) technique, both engineers and project managers contributed the crucial information as to the factors influencing scheduling of construction projects held in Kolhapur City. Engineer Survey, consisting of 18 parameters, showed that the RII values were between 0.592 and 0.817 that gave the possibilities to be classified in terms of high, middle, and low impacts groups. Frequent inspection during important practices (RII = 0.817), selection of jobs due to skill and qualification (RII = 0.783), effective interaction among

stakeholders (RII = 0.783) were found to be the most influential in this case. These high impact components demonstrate the working relevance of monitoring, highly qualified manpower deployment and coordination of stakeholders in upholding integrity of schedules. Delivery of the material within the designated schedule (RII = 0.742) and leave and holidays (RII = 0.717) were other factors that were significant. The medium-impact issues like technical support, availability of labor and climate-responsive timetable displayed moderate influences whereas external social factors like local community support (RII = 0.592) and neighborhood disruptions (RII = 0.600) were deemed to have the least scheduling effects.

The development of rankings based on RII allowed grouping factors into high, medium, low impact variables, High impact issues were primarily headed by the speed of decision-making (RII = 0.800) that was ranked the most critical factor by project managers, since fast decision-making to resolve issues of the given site is critical to preventing cascading delays. This was immediately followed by material deficiencies (RII = 0.771), delays in payments (RII = 0.757) and financial limitations (RII = 0.729), and these three factors directly disrupt the distribution of resources and processes. Other variables that had RII = 0.714 were being in possession of centralized procurement systems, the advanced level of technology use, the evaluation of contractor, and the consideration of geographical conditions which indicates the rising significance of systematic, tech-enabled planning. The other important yet less ranked determinants such as utilization of previous project records, workforce training and accident effects mitigation (RII = 0.700) indicated the need to have data driven and agile project teams.

Medium-impact factors (RII: 0.686–0.699) such as client interference, dissatisfaction of workers, work term mismatch and detection of resources waste emphasized the need to ensure that processes within an organization are harmonious to prevent throw off in schedules. Meanwhile, stakeholder collaboration (RII = 0.671), government policy shifts (RII = 0.629), and natural calamities (RII = 0.629) are some of the low-impact factors, which had been regarded as less impactful but should be considered in the risk management plans. Of note, the increase in the costs of material (0.600), the scheduling of maintenance and breaks (RII = 0.614), and local or social issues (RII = 0.557) ranked last in the RII scale, in acknowledgement of their reduced perceived control by managers though having potential to develop into big problems unless managed.

4. Project Timelines and Completion Rates

In order to determine how different factors, affect project schedules and completion rates, above two structured surveys data were used:

4.1 Impact Analysis

- **Engineer Perspective**

From RII values were between 0.592 and 0.817 as per Engineer Survey. These are top issues that have a strong impact on timelines:

- Inspection Frequency (RII = 0.817): Inspection is not carried out in a regular manner creating quality problems and rework that result to huge time losses.
- Skill-Based Role Assignment (RII = 0.783): Lack of role assignment based on qualifications slows down the pace of productivity and also generates a bottleneck.
- Communication Effectiveness (RII = 0.783): Miscommunication leads to errors and delays in execution.
- Material Delivery Timeliness (RII = 0.742): Delays in the delivery of materials is a direct stopper to work.

Impact on Completion Rates: With other repetitive issues, projects take long due to which there is also a threat of missing deadlines.

- **Project Manager Perspective**

According to Project Manager Survey, RII was 0.557 to 0.800. The most important issues affecting completion and schedules:

- Quick Decision-Making (RII = 0.800): Delayed approvals and changes will hamper use of critical path activities.
- Material Shortages (RII = 0.771): SC does not have a proper timely supply of the material and leads to numerous points of stoppage and downstream delay.
- Payment Delays (RII = 0.757): Delayed payments by the contractors results in suspension of work and a delay in the mobilization of resources.
- Financial Constraints (RII = 0.729): Limited funds halt procurement and labor deployment.

Impact on Completion Rates: A project that has a long-term financial or material delay will experience low levels of successful completion within the estimated timelines.

4.2 Insights

Common themes between engineers and managers:

- Material Management: Material delays were one issue that was of high priority in both groups.
- Decision-Making and Communication: Effectiveness of decision-making and communication go a long way in ensuring timeliness in sticking to the schedules.
- Human Resource Management: Availability of resource and skilled labor influence the speed of implementation.

Interpretation:
The risks that are related to high-impact factors (RII 0.70 or higher) misalign with the project schedule and decrease the chances of the successful completion of the project. The medium- and low-impacts have a lower rate of contribution but may go into delays over time.

❖ Link to Timelines & Completion

- High RII factors (>= 0.70): produce direct interruptions in work sequences, such that schedule overruns and missed deadlines occur.
- Medium RII factors (0.65 0.69): cause secondary delays which impact efficiency.
- Low RII factors (<0.65): These play somewhat little direct role but the risk concerning these factors should be observed.

5. Common Challenges

Construction projects often follow a series of interdependent phases, which include pre-construction planning, construction implementation, project completion, and final handover, all these phases are significant in defining the overall performance of a construction project in terms of time, expense, and quality. It is vital that each phase is completed on time because any slackness at one stage can have a domino effect and derail the rest of the activities, leading to misuse of resources, cost escalation and poor quality. The increasing complexity of projects in the current construction landscape due to design changes, resource constraints, regulatory approvals, and unanticipated site conditions only increases these risks and can even result in stakeholder conflicts or project termination. To solve these problems, will examine five real life case studies in Kolhapur, Maharashtra by mapping them against 24 critical phases that are commonly used in the construction lifecycle. The purpose of the study is to categorize the delay-prone stages, explore the root causes, find patterns and differences between the projects and finally, give a practical recommendation on how to reduce the risk of delays and increase the efficiency of scheduling. With this structured, phase-based

approach, the provides a useful insight on what project managers, contractors, and developers should do in order to deliver projects with more reliability and predictability. Fig. No 3 & 4 shows the various responses received from 5 real world case studies.

The construction lifecycle consists of 24 interdependent stages and all of them are critical to timely and successful delivery of a project. This study is a systematic analysis of the delay prone nature of each stage based on five real life case studies in Kolhapur, Maharashtra. Footing & Raft Work and Site Clearance, Excavation, Brick/Block Masonry, External Plastering, Flooring, and Doors/Windows Installation were the most common stages that were delayed (5/5 builders reported delays in the former and 4/5 builders in latter). Conditions on the site are likely to interfere with these phases through unexpected strata, material, labor shortages, and boundary conflicts. Other stages such as Pre-Construction Approvals and Design & Drawings are also susceptible, as government clearances, regulations, and client-driven revisions at the last minute delay each other. Poor coordination, shuttering delays, and material delivery lags are the causes of bottlenecks in structural elements such as Ground Beams, Columns, and Roof Slabs. During the finishing stages, Painting, Tiling, Plumbing, and Electrical Works are characterized by lack of skilled labor, logistics, and rework on quality terms. Interestingly, the Final Handover stage had the least delay though it was still susceptible to bureaucratic barriers such as completion certificates. This stage-by-stage evaluation does not only outline the most at risk stages, but also points at the underlying operational and managerial causes, which can be used to improve the scheduling, resource allocation, and risk management throughout the project schedule.

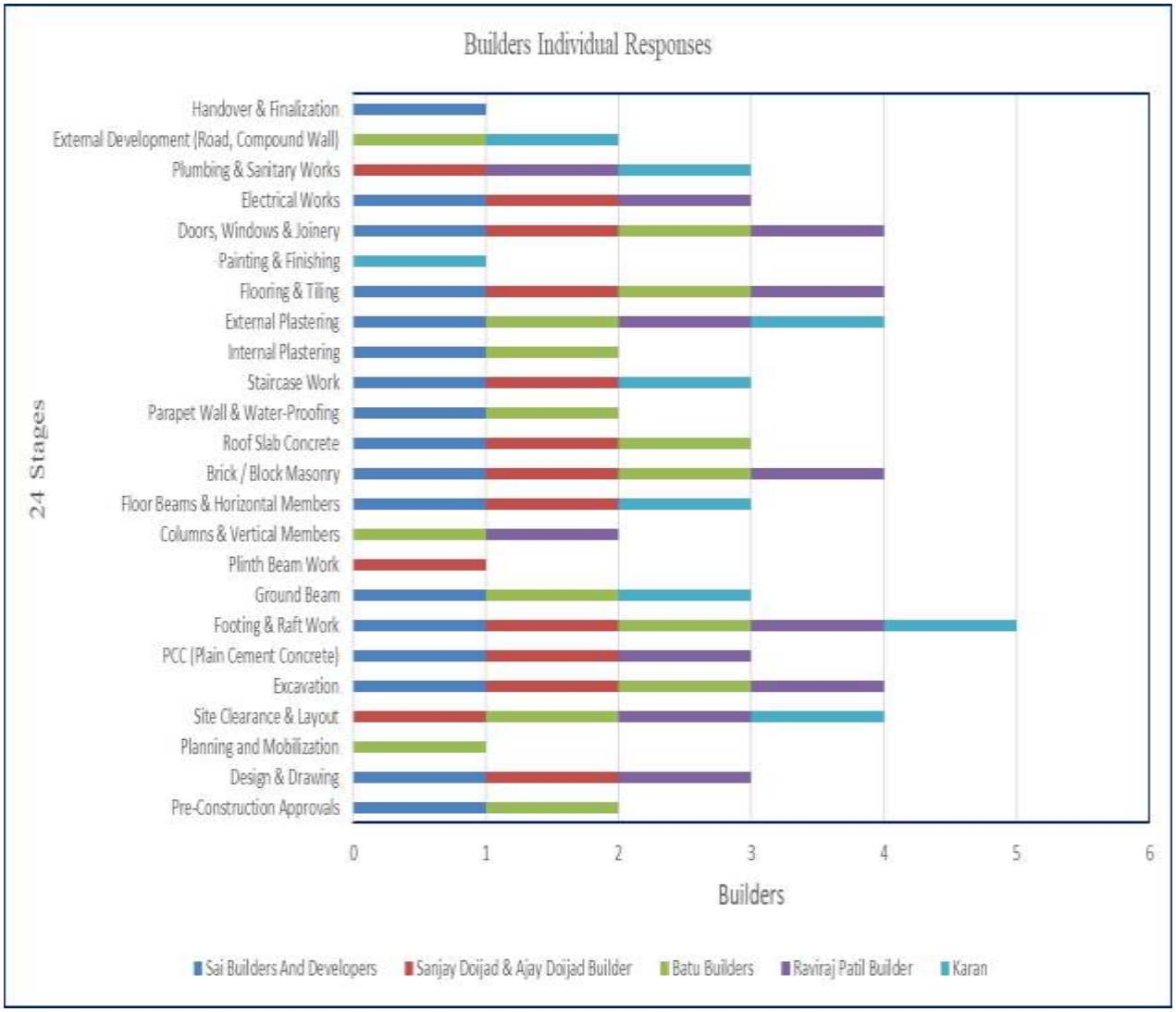

Fig No 3 Builders Individual Responses

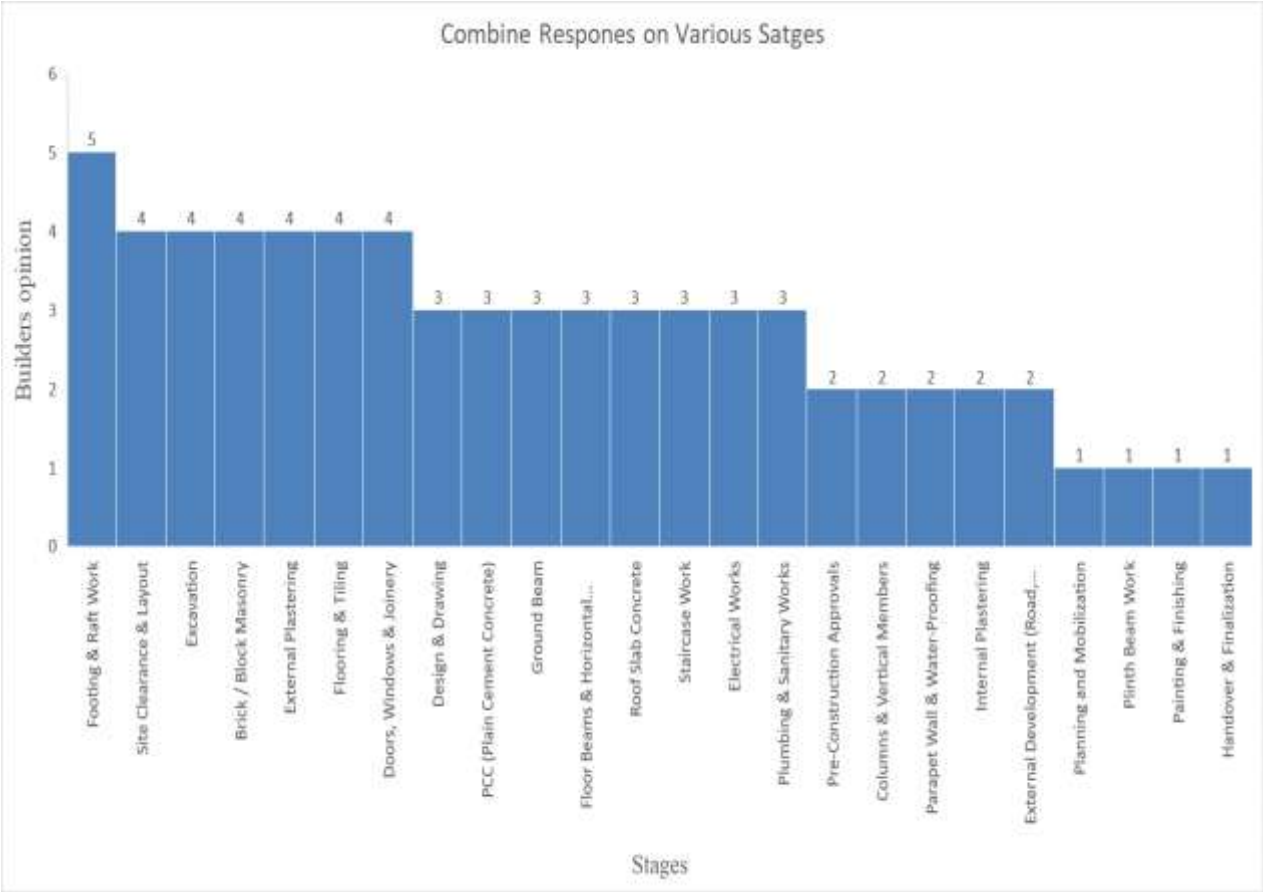

Fig No 4 Analysis of 24 Stages

6. Innovative Strategies

The results presented in point 4 & 5 indicated that the delay is cumulated in critical path activities, including Foundation works, Superstructure elements, and Finishing activities with a powerful correlation to managerial aspects such as speed of decision-making, material supply, and quality assurance (as pointed by RII). This chapter offers radical measures that can directly mitigate these pain points through the application of digitalization, lean and superior procurement systems and methods, collaborative delivery schemes. To give strategies various clusters are formed which are explained below.

6.1 Strategic Interventions for Improving Construction Scheduling

- **Digital Transformation for Early-Phase Precision**

Structural delays are commonly facilitated by frequent inspections (top RII-ranked factor of 0.817) and effective communication (0.783) as related to poor inspection cycles and late design changes that it can take place in structural stages like Footing & Raft Work and Columns. Clash detection, 4D planning, and overall active combination of construction activities are made possible through implementation of Building Information Modeling (BIM) and implementation of BIM relates to synchronization of design with what is happening in the field. Through IoT-based solutions like real-time monitoring and corrective curing, the errors in foundational concrete construction can be cut by leaps and bounds with AI-powered predictive scheduling software being able to pinpoint risks during the finishing and masonry work. The digital method will enhance the accuracy in the superstructure execution and offers viewing live progress, and has fewer cascading effects during the later phases.

- **Lean Construction to Eliminate Waste and Sequencing Delays**

Heavy-finishing tasks such as Brick Masonry, External Plastering, and Tiling had been lagged at higher rates and most of the time it was resulted of site congestion and sequencing incompatibility. Lean building methods like the Last Planner System endorse a business-minded approach of shared-planning, trade-based planning which is synergetic with genuine site preparation. Moreover, delivery in Just-In-Time (JIT) formats involves less clutter within the site, and this is useful in ensuring that items such as tiles and aggregates arrive at the right place at the exact time to be used. The practices facilitate interdependent trades to be streamlined, enhance MEP integration and reduce wastes, which leads the congested site activities to be executed more efficiently.

- **Advanced Procurement and Inventory Systems**

The unavailability of materials continues to be at the top of the concerns, and this is corroborated by RII = 0.771 by project managers. Stages such as Flooring, Rafting, and Roof Slabs are usually shut down because of lack of stock of either steel, cement or tiles. To address this, the implementation of Digital Procurement Platforms enables tracking of inventory and forecasting of lead time, and Vendor-Managed Inventory (VMI) shifts the stock ownership to the vendors. In addition, smart contracts on blockchain are more transparent and build confidence in suppliers of payments. Such innovations minimize procurement lags in both structural core work as well as in unterrifiable. This is done to maintain schedule integrity.

- **Workforce Optimization through Skills and Automation**

With Having role assignments under skills that are ranked as highly important by both engineers and project managers (RIII = 0.783), the stages such as Masonry, Plastering, and MEP works are worst hit when assigned to labor that is not as per the standards that it should be. In response, matters of multi-skill workforce training are being advanced to increase the flexibility in labor of different trades as well as automated systems are developed to the level of faster, repetitive structural work, such as robotic bricklaying and 3D printing. Such gains will increase output in the superstructure and service intensive activities, minimize rework and lessen reliance on highly skilled human capital.

- **Sustainability and Prefabrication for Weather-Resilient Execution**

In climatic condition such as the monsoons of Kolhapur, wet trades taking particular account of external plastering and tiling will be plagued through the interruption caused by weather. The use of prefabricated elements including precast slabs and walls, precast staircase and others helps to evade dependence on labor force on-site and minimize construction time. Utilization of recycled aggregates promotes sustainable supply of materials in addition to easing the pressure on the natural resources. Such solutions can speed up the progress of foundations and superstructure and provide weather-proof options in the area of completion processes enhancing resilience and project sustainability.

- **Collaborative Project Delivery for Decision-Speed and Integration**

The initial stage blockage on approvals and design finalization often causes the downstream delays on execution, and this is where the decision-speed (RII = 0.800) is essential. Use of Integrated Project Delivery (IPD) involves the contractors and suppliers earlier in the planning process thus lowering the risk of rework as well as reducing the number of missed expectations. Simultaneously, more flexible and responsive frameworks of contracting have been built on models of incentives which are based on milestones. These activities shorten the time spent waiting before construction starts and during planning activities, and enhance the synchronization of activities between projects, especially in structural works to finishing processes.

7. Result and Discussion

The findings integrate both the Relative Importance Index (RII) of the analysis managerial issues and technical problems and the analysis of 24 construction stages of five real life case studies occurrence. The two methods will aid in the enhanced understanding of the dynamic of interaction between specific operation factors and activity clusters that result to delays. The interpretation of those outcomes is described in the discussion, the relative importance of these drivers is drawn, and the implications they entail on the effective construction planning and controlling are analyzed.

7.1 Results of RII Analysis

Top-ranked factors for Engineers:

- Frequent inspections during key activities (RII = 0.817)
- Role allocation based on skill (RII = 0.783)
- Effective communication among stakeholders (RII = 0.783)

Top-ranked factors for Project Managers:

- Quick decision-making (RII = 0.800)
- Material shortages (RII = 0.771)
- Payment delays (RII = 0.757)

Analysis: The monitoring and inspection, the speed of communications and decision making take central stage in scheduling performance. The bottlenecks related to resource such as the availability of material and circulation of finances are also significant satisfying that there are delays as much because of management thresholds of responsiveness as site-level limits.

7.2 Delay Dynamics Across 24 Stages

The stage analysis clearly represents the following picture of the delays: The delays are focused and not random in that there is maximum impact on the activities that are on the critical-path thus subjecting projects to greater risks. Patterns observed:

❖ Foundation Cluster (Excavation → PCC → Footing & Raft)
These stages have universal effects in defining structure timelines. In all the five projects, Footing & Raft work was delayed meaning that there is vulnerability in the system. The typical delays involved shortage of shuttering material and delays in rebar deliveries and lack of curing. Management failure of planning procured materials also added to the problems to the extent of operation, reflecting the procurement availability and inspection criteria which came top in RII.

❖ Superstructure Cluster (Columns → Beams → Masonry)
The delays experienced were moderate but continuous as a result of dependence on labor as well as sequencing rigidity. Brick/Block Masonry resulted in delays in four projects because it is one of the chokepoints that slow the progress of work being done and raise non-jaded costs. It specifies that the resource optimization techniques and the parallelization of the tasks during the practice is also uncommon.

❖ Finishing Cluster (Plastering → Tiling → Painting)
It is not considered that the delays that are caused in completion are that severe however according to this research, there are severe cumulative effects. There is the spreading of the previous structural slippages to finishing works experienced in Flooring & Tiling (4 projects) and External Plastering (4 projects). All these weak points are added with the issues of materials availability (tiles, adhesives) delays, climatic conditions (rain at the stages of plastering).

❖ MEP & External Works

The Moderate delays were recorded in the electrical and plumbing stages (3 projects) which apparently caused delay in integrating with the civil works. This is a sign of ancient lack of connectivity between the MEP and structures groups a systemic failure such that it could be eased by BIM-based planning being developed.

7.3 Correlation Between RII and Stage Vulnerability

A notable finding is the alignment of high-RII managerial factors with high-delay construction activities:

- Material Availability (RII = 0.771) goes hand-in-hand with masonry and finishing delays whereby times of no work due to scarcity of supply may take long.
- Inspection Frequency (RII = 0.817) comes out as being determinant in concreting of footing and slabs-mistakes at this point would lead to reworking resulting to a costly schedule acceleration in future.
- Speed of Decision-Making (RII = 0.800) also has an impact on pre-construction approvals, design revisions slowed down, although these delays happen very rarely, their overall systemic effects are acute.

Interpretation: Delays cannot be purely technical and exist as a system, entrenched as they are in managerial foresight and flexibility of planning. This strengthens the importance of real-time monitoring, active material planning and rapid decision-making.

7.4 Integration of Findings with Innovative Strategies

The analysis overview and the RII outcomes show an obvious trend: delays are caused both by managerial and technical issues. Foundation and structural stages are affected by the shortage of materials, delays in inspection, and bad sequencing, whereas finishing and MEP stages are burdened by interruptions in the workflow and skills gaps. These weaknesses correlate with the best RII variables like regular checks (RII = 0.817), the rate of decision (RII = 0.800) and availability of materials (RII = 0.771).

The solutions proposed in Chapter 7: Innovative Strategies directly address these systemic weaknesses:

- Digital Transformation (BIM, IoT, AI): Targets inspection and communication gaps, ensuring real-time monitoring of critical foundation and superstructure works.
- Lean Construction Practices: Lean Construction Practices: Overcomes the inefficiency in the work flow that happens in masonry/ finishing related works where the delay was witnessed in majority of the projects (up to 4 out of 5 projects).
- Advanced Procurement Systems: Remove material bottlenecks which are associated with high RII impact especially on masonry and tiling phases.
- Skill Development: Mitigates dependency on specialized trades in finishing and MEP clusters.
- Prefabrication: Saves wet-trades which are known to be time-consuming and susceptible to monsoon interruptions.
- Collaborative Delivery Models: Speed up the process of design approvals and lessen the ripple effects that occur due to the decision.

8. CONNCLUSION

The study aimed at examining the determinants of project scheduling efficiency and to determine the delay-sensitive construction phases in Kolhapur, following an unified approach which takes into consideration, not only Relative Importance Index (RII) analysis but also delay occurrence per construction stage against 24 critical activities. Delays are found to be greatly clustered in foundation works, superstructure works, and finishing works and the managerial issues like frequent checks (RII = 0.817), speed in taking a decision (RII = 0.800), and material allowance (RII = 0.771) are the most dominant factors that influence schedule performance.

The analysis of stages demonstrated that a delay in the initial-stage excavation and casting of PCC and footing has cascade effects on the structural and finishing processes, whereas use of improper workflow and a shortage of workers on the masonry site, plastering, and tiling will only increase the risk of a project overrunning. The outcomes reveal that the issues of construction delays are system-based and not singular, and they are as a result of uncoordinated activities, unresponsive planning, and the lack of proper management of resources.

These findings indicate that it will be necessary to incorporate some novel solutions to manage those, namely digital transformation through BIM, IoT, and AI to enable real-time management and pre-schedule the work; ideas behind lean construction, e.g., the Last Planner System and Just-In-Time Supply to streamline the workflow; operating more sophisticated procurement procedures, e.g., vendor-managed inventory and blockchain contracts that will ensure material reliability; and collaborative contracting practices, e.g., Integrated Project Delivery (IPD) will enable more rapid decision-making and accountability.

Moreover, the prefabrication of the structural elements and the improvement of the workforce skills can decrease the need of the labor dependency significantly and decrease the number of uncertainties based at the site. Through the incorporation of such solutions, the construction industry will shift to a predictive and performance-based delivery, hence timely completion and optimization of costs, sustainability. The future studies are suggested to be dedicated to the application of machine learning to delay forecasting, conducting comparative surveys in different regions, or assessment of the economic and environmental advantages of prefabrication and digital tools.

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