

Impact Of Workforce Management Practices on Project Delivery Times in Mega Construction Projects

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Abstract—Mega construction projects such as metro systems, highways, airports, industrial facilities and large commercial developments require coordinated deployment of a large and diverse workforce. This study evaluates the influence of workforce management practices on labour productivity and project delivery time using field observations, work sampling, activity-wise productivity measurement and a questionnaire survey. Data were collected from three active RCC construction sites—Sinhgad Guardian, Paranjape Broadway Wakad and Pristine Equilife—with beam, column and slab activities examined in detail. Productive and non-productive time were recorded at regular intervals, while survey responses were analysed using SPSS. The observed productive work percentages were 78.86%, 79.46% and 78.80% for the three sites, respectively, indicating a common productivity gap against the expected 88–89% benchmark. Column work required the highest median execution time at all sites, while beam work showed the greatest variation between locations. The questionnaire scale showed good internal consistency with Cronbach's alpha of 0.858 for 21 items. Regression analysis of psychological factors was statistically significant ($F = 3.390$, $p = 0.021$), although the model explained 9.6% of the variation in labour productivity. Motivation ($p = 0.013$) and job satisfaction ($p = 0.031$) were significant factors. The study concludes that workforce planning, supervision, activity sequencing, resource readiness, safety, motivation and productivity monitoring should be integrated to reduce non-productive time and improve project delivery performance.

Index Terms—Workforce management, Labour productivity, Mega construction projects, Project delivery time, Work sampling, Construction scheduling, SPSS, Workforce optimization

I. INTRODUCTION

Construction projects are major contributors to economic and infrastructure development. Mega

construction projects are distinguished by large capital investment, complex structural systems, multiple trades, extensive interfaces and long execution periods. Examples include metro rail systems, expressways, airports and large commercial or industrial developments. In such environments, timely completion depends not only on materials, equipment and planning but also on the efficient organization and utilization of people.

Workforce management covers resource allocation, scheduling, productivity monitoring, skill development, supervision, motivation, labour relations, safety and welfare. Ineffective workforce management can produce low productivity, idle time, communication gaps, skill mismatch, rework and coordination failures, which accumulate into schedule slippage. The dissertation identifies a research gap because much of the earlier work examines individual productivity factors or smaller projects rather than integrating multiple workforce practices with field measurements and schedule-oriented analysis.

The present study therefore examines actual labour performance on RCC construction activities and combines field observations with survey and statistical analysis to identify practical workforce-management interventions for improving project delivery time.

II. OBJECTIVES OF THE STUDY

- To analyse workforce management practices currently employed in construction projects.

- To evaluate the influence of workforce practices on project delivery time using statistical analysis.
- To identify key workforce factors contributing to project delays.
- To suggest workforce optimization strategies that improve delivery time without compromising cost or quality.

III. LITERATURE REVIEW

Previous research consistently links labour productivity, planning, supervision and resource availability with construction time performance. Hanna et al. [1] reported that prolonged overtime can reduce productivity through fatigue and increased errors. Kaming et al. [2] identified poor labour productivity, inadequate planning and weak coordination among major causes of time overruns. Aibinu and Odeyinka [3] similarly showed that construction delays are multi-factorial, involving manpower, management, materials and planning. Doloi et al. [4] highlighted inefficient site management, coordination and decision-making as important delay drivers in the Indian context. Jarkas and Bitar [5] identified supervision, worker skills, technical information, material availability and work sequencing as important productivity determinants. Enshassi et al. [6] associated productivity losses with material shortages, inadequate supervision, equipment problems and low motivation, while Thomas and Sudhakumar [7], [8] emphasized labour utilization, planning, supervision and material readiness in Indian construction. Recent studies have extended the discussion toward workforce planning, digital training, supervision systems, real-time monitoring, reskilling and productivity measurement [9]–[15]. Industry evidence also highlights labour shortages, low productivity growth and slow digital adoption as significant risks [16]. However, the reviewed literature indicates limited integrated empirical evidence for mega projects that combines field productivity, work sampling, statistical analysis and schedule-oriented interpretation. This study addresses that gap.

IV. METHODOLOGY

The study follows a practical field-based sequential design. Three active RCC construction sites were

selected: Sinhgad Guardian, Paranjape Broadway Wakad and Pristine Equilife. Beam, column and slab activities were observed because they require coordinated skilled and unskilled labour and directly affect construction cycle time. Primary data consisted of site observations, activity-wise labour productivity measurements, work-sampling records and questionnaire responses from construction professionals. Secondary information included labour records, daily progress reports, manpower allocation sheets, construction schedules and activity records.

Work sampling classified observations as productive or non-productive at regular intervals. Productive work included construction operations such as reinforcement fixing, shuttering, concreting, vibrating, levelling and finishing. Non-productive time included waiting, idle periods, unnecessary movement, equipment waiting, rework and coordination gaps. Productivity was evaluated using worker numbers, time and work output. The questionnaire dataset contained 100 respondents and 21 items. Descriptive statistics, reliability analysis, paired-sample testing, correlation and regression were performed using SPSS. Microsoft Project was used in the dissertation for schedule modelling and critical-path visualization. The integrated analysis was used to identify practical workforce optimization measures.

V. RESULTS AND DISCUSSIONS

Field observations showed a relatively consistent productivity level across the three study areas. Sinhgad Guardian recorded 78.86% productive work, Paranjape Broadway Wakad 79.46%, and Pristine Equilife 78.80%. Thus, all three sites remained below the expected 88–89% productivity benchmark. The narrow difference among sites suggests that the productivity gap is not limited to one project location but is associated with recurring workforce-management issues such as time utilization, work sequencing, supervision and idle-time control.

Study area	Productive work (%)	Non-productive work (%)
Sinhgad Guardian	78.86	21.14
Paranjape Broadway	79.46	20.54

Wakad		
Pristine Equilife	78.80	21.20

Table 1. Comparison of productive and non-productive work

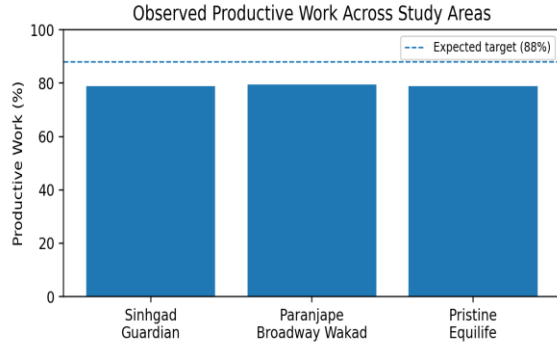


Fig. 1. Observed productive work across the three study areas

Activity	Sinhgad Guardian	Paranjape Broadway Wakad	Pristine Equilife
Beam	63.47	104.58	119.43
Column	193.67	195.12	199.02
Slab	131.49	132.29	132.77

Table 2. Median execution time by activity (minutes)

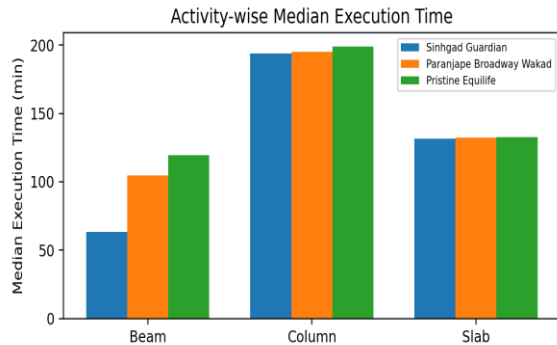


Fig. 2. Activity-wise median execution time

Column work was the most time-consuming activity at all three sites, with median total execution times of 193.67, 195.12 and 199.02 minutes. Beam work showed the greatest site-wise variation, increasing from 63.47 minutes at Sinhgad Guardian to 119.43 minutes at Pristine Equilife. Slab work was comparatively stable at approximately 131–133 minutes. These findings indicate that column reinforcement and formwork preparation should receive priority in workforce planning, while beam

work can benefit from standardized shuttering, pre-marking and repetitive crew allocation. Slab operations benefit from continuous RMC supply, pump readiness, vibration availability and dedicated finishing labour.

The manpower analysis further indicates that trade-specific deployment is more important than total headcount alone. For example, the study reports requirements of 3 masons and 23 unskilled labourers for 10 m³ of RCC and 2 masons and 20 unskilled labourers for PCC, while shuttering and reinforcement require specialist trades. Consequently, a project may have sufficient total labour but still suffer productivity losses if the required trade mix is unavailable.

The survey reliability was strong (Cronbach's alpha = 0.858). The paired-sample result ($p = 0.007$) supports the importance of measuring actual productive time rather than relying solely on perceived productivity. The regression model was statistically significant, but its R^2 of 0.096 shows that psychological factors explain only a limited share of productivity variation. Motivation and job satisfaction were significant, indicating that worker-focused practices should complement technical planning. Weather showed a strong relationship with safety downtime ($r = 0.981$), while site organization was strongly related to safety measures ($r = 0.720$).

Parameter	Result
Cronbach's Alpha (21 items)	0.858
Paired-sample test	$p = 0.007$
Regression model	$F = 3.390$; $p = 0.021$
Regression R^2	0.096 (9.6%)
Motivation	$p = 0.013$; significant
Job satisfaction	$p = 0.031$; significant
Weather vs. safety downtime	$r = 0.981$
Site organization vs. safety measures	$r = 0.720$

Table 3. Key statistical results

The study proposes increasing productive work from approximately 79% toward the expected 88–89% level. Supervisors should prepare work fronts before labour arrival, stage materials and equipment in advance, control restart periods after breaks and monitor critical activities separately. For beams,

standardized formwork modules, pre-marking and repetitive crew allocation are recommended. For columns, reinforcement cages, starter formwork and alignment checks should be prepared in advance. For slabs, RMC continuity, pump readiness, vibration and finishing labour should be synchronized.

Motivational and welfare measures such as daily target boards, recognition of high-performing gangs, safety rewards and grievance feedback can support morale and reduce avoidable disruption. Digital attendance, productivity dashboards, look-ahead schedules and mobile progress reporting can help identify idle time early; however, the study emphasizes that digital tools must be combined with practical planning and effective field supervision.

VI. CONCLUSION

The study concludes that effective workforce management directly supports labour productivity and timely delivery of mega construction projects. Field observations across three RCC sites found approximately 78–80% productive work, leaving a meaningful opportunity to reduce non-productive time. Column activities were the most time-consuming, while beam activities showed the greatest variation among sites. Trade-specific manpower planning, strong supervision, material and equipment readiness, sequencing, safety management and worker motivation are therefore central to improving delivery performance. The statistical results confirm reliable survey measurement and significant effects for motivation and job satisfaction, while also demonstrating that workforce psychology alone cannot explain productivity. A combined approach covering technical planning, workforce allocation, site organization, safety, motivation and digital monitoring is recommended for improving schedule performance.

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