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Framework for Enhancement of Labor
Productivity in High-Rise Construction
Projects in Twin Cities

by

Muhammad Mursaleen

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the

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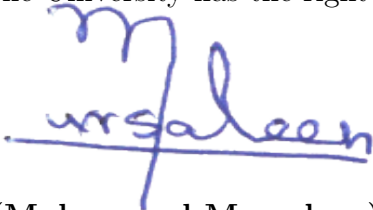
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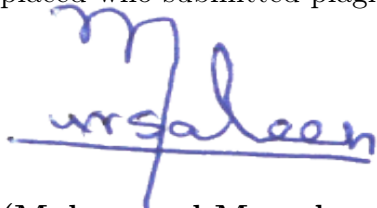
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Abstract

Labor productivity is a key determinant of cost overruns, schedule adherence, and overall performance in high-rise construction projects, yet it remains a persistent challenge in Rawalpindi and Islamabad. This study develops a data-driven framework to improve labor productivity by systematically identifying, validating, and prioritizing the most influential factors affecting on-site performance in the Twin Cities. A structured methodological approach was adopted. An initial pool of 57 factors was identified through an extensive literature review. These factors were refined using a pilot survey ($n = 10$) and a Delphi-based process, resulting in 39 validated factors categorized into manpower, leadership, management, materials/-tools, and site conditions. A questionnaire comprising two sections (demographics and factor ratings on a five-point Likert scale) was distributed, yielding 110 responses, of which 95 were valid (response rate = 86.36%). Reliability analysis demonstrated excellent internal consistency (Cronbach's Alpha = 0.968). Normality tests (Kolmogorov–Smirnov and Shapiro–Wilk) indicated non-normal data ($p < 0.05$), Descriptive statistics indicated moderate-to-high influence across all factors, with mean values ranging from 3.25 to 3.86 and standard deviations between 1.017 and 1.267, reflecting consistent response dispersion among the 95 valid samples. justifying the use of the Relative Importance Index (RII) for ranking. The RII analysis revealed that “lack of skilled manpower” is the most critical factor (RII = 0.874), followed by “delays in salary” (RII = 0.859) and “procurement delays” (RII = 0.844). Other significant factors include “clear and daily task assignments” (RII = 0.815) and “lack of team spirit” (RII = 0.808). Within sub-categories, “lack of periodic meetings” ranked highest in leadership (RII = 0.804), while “lack of coordination between stakeholders” was the most influential project management factor (RII = 0.785). These results quantitatively demonstrate that productivity is governed by an interaction of workforce capability, financial reliability, material availability, and managerial effectiveness. Based on these findings, a practical productivity improvement framework is proposed, emphasizing four priority domains: (1) workforce skill development and allocation, (2) timely wage payment and motivation systems, (3) efficient procurement and material planning,

and (4) structured daily workface planning supported by strong supervision and communication protocols. The study concludes that addressing the top-ranked constraints through targeted, evidence-based interventions can significantly enhance labor productivity in high-rise projects. The framework provides actionable guidance for clients, consultants, and contractors to reduce inefficiencies, improve coordination, and achieve better project outcomes in the Twin Cities.

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Chapter 1

Introduction

1.1 Background

The construction industry plays a pivotal role in national development by providing infrastructure, employment opportunities, and contributions to GDP [1]. In Pakistan, building construction is highly labor-intensive, relying significantly on the productivity of the workforce. However, construction labor productivity (CLP) in Islamabad, as in many other developing regions, remains low due to multiple technical, managerial, and socio-economic challenges. This results in delays, cost overruns, compromised quality, and inefficient resource utilization [2]. The construction industry, being highly labor-intensive, faces persistent challenges in achieving desired productivity levels, leading to delays, cost overruns, and compromised quality. This research introduces a life cycle risk management approach to improve labor productivity in construction projects, offering a comprehensive framework for sustainable project outcomes [3]. This study applies machine learning to identify key factors in RCC slipform productivity, outperforming traditional methods with highly accurate, validated predictions ($R^2 = 0.900$) [4]. Although prior studies have highlighted the ergonomic benefits of exoskeletons, limited research has quantitatively examined their direct impact on construction productivity and motion stability, creating a critical gap this study addresses [5].

This research systematically reviews and meta-analyzes 27 global studies, identifying 66 critical factors and emphasizing regional variations requiring localized management approaches [6]. A business process reengineering lens to show how digital transformation optimizes management processes, reduces redundancies, and significantly enhances labor productivity, particularly in non-state enterprises [7]. This study, unlike prior work, uses CEPI as an exogenous shock to show that vertical supervision significantly improves labor productivity through stronger environmental governance [8]. The construction industry is vital for Pakistan's economy but faces persistent labor productivity challenges in Islamabad & Rawalpindi due to technical, managerial, and socio-economic issues, leading to delays, cost overruns, and poor quality. This research examines critical global and local factors affecting productivity and explores sustainable strategies, including digital transformation, advanced technologies, and managerial improvements, to enhance efficiency and project outcomes.

1.2 Research Motivation

The motivation for this research arises from persistent labor productivity challenges observed in high-rise construction projects within Rawalpindi and Islamabad. Numerous projects in the region experience delays, budget overruns, and performance inefficiencies, with labor-related issues frequently cited as a primary cause. Inefficient workforce utilization, poor planning, lack of motivation, inadequate training, and weak site management practices continue to undermine productivity levels. While labor costs constitute a substantial proportion of total project costs, productivity management often receives less attention compared to material procurement or equipment deployment. Contractors typically focus on controlling direct costs rather than improving workforce efficiency through systematic analysis and planning. This reactive approach limits the ability to proactively address productivity challenges and optimize labor performance. Another significant motivation for this research is the lack of localized studies addressing labor productivity in high-rise construction projects in Pakistan. Much of the existing

literature is based on construction environments in developed countries, where labor regulations, skill levels, technological adoption, and working conditions differ considerably from those in the Twin Cities. Consequently, the direct application of foreign productivity models may not yield effective results in the local context. Therefore, this research is driven by the need to develop a context-specific understanding of labor productivity issues and provide practical solutions tailored to high-rise construction projects in Rawalpindi and Islamabad. By integrating academic research with industry insights, the study seeks to support construction stakeholders in improving project efficiency and overall performance.

1.3 Problem Statement

Labor productivity in high-rise construction projects in Rawalpindi and Islamabad is adversely affected by multiple interrelated factors, including inadequate workforce skills, ineffective supervision, poor planning and scheduling, unfavorable site conditions, and limited use of modern construction methods [9]. These challenges often lead to reduced output rates, increased project duration, cost overruns, and disputes among project stakeholders [10]. Despite the critical role of labor productivity, there is no comprehensive and structured framework available that systematically identifies, prioritizes, and addresses productivity-related factors specific to high-rise construction projects in the Twin Cities. Existing construction practices are largely based on conventional management approaches and personal experience, with limited reliance on empirical data and analytical tools [11].

Furthermore, decision-making related to labor management is often fragmented, reactive, and short-term in nature. This lack of a holistic and evidence-based approach prevents stakeholders from effectively improving labor productivity and achieving sustainable project performance [12]. Therefore, the central problem addressed in this research is the absence of a localized, data-driven framework that can support systematic improvement of labor productivity in high-rise construction projects in Rawalpindi and Islamabad.

1.4 Research Questions

- i. What are the key factors influencing labor productivity in high-rise construction projects in the Twin Cities?
- ii. What strategies and frameworks can be developed to enhance labor productivity for sustainable and timely project delivery?
- iii. How can the proposed framework be effectively implemented to minimize delays and improve overall project performance in high-rise construction?

1.5 Research Objectives

The main objective of this research are:

- i. To identify and prioritize the key factors affecting labor productivity in high-rise construction projects in the Twin Cities.
- ii. Convert the prioritized insights into practical managerial and site-level strategies that can be realistically implemented on high-rise projects in the Twin Cities.
- iii. To develop an empirically grounded framework for improving labor productivity in the local high-rise construction projects.

1.6 Overall Goal and Specific Aim

The goal is to empirically investigate the factors influencing construction labor productivity in Islamabad's high-rise building projects and develop a framework that integrates productivity improvement with sustainability objectives.

The specific aim of this research is to develop and propose an effective framework that enhances labor productivity in high-rise construction projects within the Twin Cities, by addressing key managerial, technical, and workforce-related factors to achieve better project efficiency, cost control, and timely completion.

1.7 Scope of Work and Study Limitations

1.7.1 Scope

- i. Focused on construction labor productivity of building projects in Islamabad & Rawalpindi; includes contractors, consultants, and labor workforce.
- ii. Utilize primary data (surveys, questionnaires) and secondary data (published literature, case studies, building cost records).

1.7.2 Limitations

- i. Limited to data collection within Islamabad due to time and resource constraints.
- ii. Results may not be fully generalizable to other regions with different socio-economic dynamics.

1.8 Research Significance

This research is novel in its focus on developing a localized labor productivity improvement framework specifically tailored for high-rise construction projects in Rawalpindi and Islamabad. Unlike generalized productivity studies, this research integrates expert insights and empirical data to address region-specific challenges.

The study contributes to academic knowledge by providing a structured analysis of labor productivity factors in high-rise construction within a developing country context. It enhances understanding of how managerial, technical, and human factors interact to influence productivity in complex construction environments.

The proposed framework offers practical guidance for contractors, project managers, and policymakers to improve labor productivity. It can be used as a decision-support tool for planning, workforce management, and performance evaluation in high-rise construction projects. Additionally, the findings can inform training programs, policy formulation, and future research in construction productivity enhancement.

1.9 Brief Methodology

This study adopts a mixed-methods research approach to develop a framework for improving labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. The mixed-methods approach is suitable due to the complex nature of labor productivity, which is influenced by managerial, technical, and human factors. The research begins with a systematic literature review to identify labor productivity factors relevant to high-rise construction projects. These factors are then refined and validated through expert consultation using the Delphi technique, ensuring their applicability to the local construction environment. A structured questionnaire survey is subsequently developed and distributed among construction professionals involved in high-rise projects in the Twin Cities. The questionnaire captures respondents' perceptions of the influence and frequency of productivity factors using five-point Likert scales. Purposive and snowball sampling techniques are employed to obtain reliable and experience-based responses. Collected data are analyzed using descriptive statistical methods, reliability testing, and the Relative Importance Index (RII) technique to rank and prioritize labor productivity factors. Based on analytical results, a practical labor productivity improvement framework is developed to support effective decision-making and enhance workforce performance in high-rise construction projects.

1.10 Thesis Structure

This thesis is organized into five chapters, each addressing a specific component of the research.

Chapter 1 presents the background of the study and the motivation for conducting research on labor productivity in high-rise construction projects in Rawalpindi and Islamabad. It also outlines the research problems, aims and objectives, scope, limitations, and provides a brief overview of the research methodology.

Chapter 2 provides a comprehensive review of relevant literature related to labor productivity in the construction industry. It discusses key concepts, definitions, productivity measurement approaches, factors affecting labor productivity

in high-rise construction projects, and existing productivity improvement frameworks, with emphasis on contexts like Pakistan.

Chapter 3 describes the detailed research methodology adopted in this study. It includes research philosophy and design, data collection methods, sampling strategy, questionnaire development, data analysis techniques, and the procedure used for developing the labor productivity improvement framework.

Chapter 4 presents the results of the data analysis, including descriptive statistics, reliability tests, and prioritization of critical labor productivity factors. The chapter also discusses the findings and illustrates the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities.

Chapter 5 concludes the thesis by summarizing the key findings, drawing conclusions based on the research outcomes, and providing practical recommendations for construction stakeholders, along with suggestions for future research.

Chapter 2

Literature Review

2.1 Background

Labor productivity in construction, often abbreviated as CLP, can be viewed as a multidimensional construction that encompasses both quantitative performance metrics and qualitative determinants shaping workforce output [13]. At its core, it relates the amount of output produced to the input of labor hours. However, this seemingly straight forward ratio quickly becomes complex when one accounts for varying work conditions, skill levels, management practices, and contextual factors such as environmental influences [14]. Labor Productivity reflects the overall efficiency of an operating system in utilizing labor, equipment, and capital to transform work effort into useful output; it does not solely represent the capability of labor itself [6], [15] as shown in equation 2.1. Productivity is not just an arithmetic measure; it emerges from the interplay between physical resources, human capital, and organizational systems. Researchers have approached the definition of CLP through frameworks that attempt to isolate and categorize influencing factors. For example, studies have outlined clusters based on management approaches, labor attributes, and external conditions [15]. This points to the need for definitions that extend beyond mere performance outputs and include system-wide considerations. The authors of [14] indicate that many existing studies stop at listing influential factors without digging into the underlying causal mechanisms. A conceptual framework in this context operates as a structured representation of how various factors interrelate and affect labor productivity outcomes.

$$\text{Labor Productivity} = \frac{\text{Total Output}}{\sum \text{of all input Resources}} \quad (2.1)$$

This observation suggests any definition tied strictly to fixed categories may become outdated if evolving conditions are ignored. Therefore, conceptual models must incorporate adaptability, so they remain reflective of actual operational environments [16]. Each element finds partial support across different studies: efficiency ratios form the starting point [14], taxonomies give structural coherence [15], causality modelling sharpens predictive capability [17], and adaptive weighting addresses evolving conditions [6]. There is also a methodological angle: Chaturvedi et al. [17] highlights how intangible aspects such as worker morale or communication quality are harder to quantify but nonetheless affect causality patterns among productivity variables. These intangibles challenge neat numerical definitions; yet ignoring them risks incomplete frameworks incapable of explaining observed deviations between planned and actual outputs [18].

2.1.1 Historical Evolution of Labor Productivity Research

Tracing the historical course of labor productivity research in construction reveals a gradual shift from narrow, output-focused metrics toward more comprehensive and context-sensitive models. In the earlier phases, productivity was largely quantified as simple ratios between outputs and inputs, measured in terms of completed work units per labor hour [19, 20]. Tools such as structural equation modelling allowed researchers to quantify interdependencies between clusters like management quality, workforce competency, and financial control systems [10]. Parallel to these methodological enhancements was the adoption of standardized benchmarking systems for measuring construction labor productivity, responding to the need for consistent definitions and measurement protocols [21, 22]. Benchmarking introduced comparative baselines both regionally and internationally. Later investigations expanded into planning stages to preemptively address risks such as information delays or improper scheduling which had been repeatedly identified as sources of reduced efficiency [23, 24]. Findings that collaborative relationships among workers enhance communication and coordination have infused

socio-cultural awareness into what was once predominantly resource-based analysis [25, 26]. Reflecting on these transitions collectively indicates that early-stage research offered simplicity but lacked explanatory depth; mid-stage studies-built taxonomies and semi-quantitative cause-effect maps, while current approaches lean heavily toward integrative frameworks combining benchmarking with adaptive risk strategies [11]. Field methods evolved from direct observation without much standardization into highly codified processes including multi-evaluator tools aimed at reducing subjectivity in data collection [27].

2.2 Labor Productivity in High-rise Construction Projects

2.2.1 Unique Challenges in High-rise Projects

High-rise projects introduce constraints and logistical complications that differ markedly from low-rise or horizontal construction. Vertical transportation of materials, tools, and personnel consumes a disproportionate amount of productive time due to elevator scheduling, hoist availability, and limited crane reach [27]. This bottleneck in material supply chains is compounded when site storage space is minimal, forcing just-in-time deliveries that risk disruption if upstream suppliers falter [28, 29]. Another persistent challenge lies in labor fatigue patterns. Empirical findings indicate that precision-dependent activities such as rebar installation show marked declines after the first hour of overtime extension due to reduced concentration and accuracy [30]. The point at which maximum performance occurs varies: some studies report optimal efficiency by the sixth or seventh floor, yet others find learning continuing until roughly the sixteenth floor for certain structural activities like rebar work before tapering off [31]. Differences in slab types or support structures influence both workflow organization and equipment need [32]. Misalignments here can block access points or constrain movement paths, delaying dependent tasks [30]. Material supply delays gain amplified impact at altitude. Hoisting systems operating beyond their suggested duty cycles risk breakdowns that halt entire segments of coordinated work [28, 29]. Such interruptions ripple through schedules given the task sequencing; unfinished lower units prevent the

start of dependent upper-level work even if crews there remain idle-ready. Environmental factors also exert differentiated effects as elevation rises.

2.2.2 Comparison with Low-rise and Infrastructure Projects

Compared to the high-rise context examined earlier, low-rise and infrastructure projects follow different productivity dynamics owing to their spatial arrangements, operational workflows, and exposure to external influences. Crews, materials, and equipment can move freely across the site without reliance on hoists or service elevators, thereby reducing non-productive time associated with logistical transitions between work zones [16]. These projects extend over large geographical footprints, and productivity depends heavily on synchronized operations across dispersed teams rather than multi-level repetition in confined vertical spaces [33]. Tall towers often integrate mechanical floors and specialized slab types that alter workflows midstream [32], forcing recalibration of crews and equipment at non-standard intervals. Low-rise projects tend toward simpler load-bearing arrangements; mid-project modifications occur less frequently unless client specifications change late in the schedule [27]. Monitoring tools like Building Information Modeling (BIM) integrated with sensor networks operate across all project types but face operational scaling issues depending on site geometry [15]. High-rises concentrate budget inflows into highly sequenced milestones linked tightly to vertical progress markers; delays at critical elevations jeopardize cascading payments downstream [32]. Safety regimes show again how distinction emerges: enforcing compliance protocols at great heights demands extensive training drills and protective gear deployment unique to tall structures, time investments not directly enhancing output rates but necessary for worker survival [9]. Urban-centered high-rises navigate dense municipal permitting layers, including height restrictions and skyline impact assessments, not encountered by rural highway builds [33,34]. Projecting labor productivity requires tailoring measurement frameworks sensitive to each project's geometry, environmental interface scale, repetitiveness nature, supervisory accessibility limits, technology assimilation levels, financing checkpoint structure, and safety protocol intensity [16].

2.3 Factors Affecting Labor Productivity

2.3.1 Worker-related Factors

Worker-related factors encompass a spectrum of attributes, competencies, and conditions that shape individual and collective contributions within construction projects. Skills and experience stand out as primary determinants of labor output. Empirical evaluations show that workforce competence not only improves task efficiency but also reduces error rates, thereby minimizing costly rework [27, 33]. Safety lapses directly remove personnel from active tasks through injury or mandated retraining periods [35]. Inadequate nutrition, dehydration, or prolonged exposure to heat without mitigation measures reduces stamina and cognitive attention span. In Islamabad- Rawalpindi climates, where high summer temperatures may coincide with fast-paced construction schedules, heat stress can slow physical output by increasing rest frequency requirements and raising accident susceptibility [36–38]. For high-rise crews performing critical lifts at elevation, even small losses of focus expand operational risk. Social cohesion among workers also appears linked to labor output [39].

A disciplined crew maintains tool readiness and complies with workflow sequencing without repeated supervisory prompts, reducing start-stop inefficiencies that fragment productive blocks of time [40]. Workforce stability over the duration of a project adds another layer to these considerations. Misallocation, for example posting less experienced personnel to complex formwork adjustments at upper floors, creates bottlenecks since corrections absorb time that skilled deployments might have avoided altogether [41]. Coupled with material availability constraints noted elsewhere in literature [19, 42], mismatched assignments multiply inefficiency because idle time emerges from waiting for either the right tools/supplies or more competent assistance. Effective frameworks must thus integrate human resource strategies explicitly into construction planning processes so that worker-level enhancements translate into measurable improvements at the project scale [27].

2.3.2 Management-related Factors

Management-related factors exert a strong influence on construction labor productivity through the ways in which resources, schedules, communication, and supervision are organized and maintained during project execution [1]. Supervisory quality represents another layer of management influence. Competent supervision consultants are tasked with enforcing quality standards on-site, managing day-to-day progress checks, and addressing operational complications before they escalate into major interruptions [12]. Scheduling logic plays an equally decisive role. Rational planning that aligns workload distribution with realistic timeframes supports steady outputs by avoiding worker strain from over-compressed timelines or idle periods stemming from poor task ordering [41]. Financial incentives tied to milestone completions or performance metrics have been shown to raise workforce enthusiasm while discouraging negative behaviours such as absenteeism or unsafe shortcuts [43]. A noteworthy application of management discipline involves modern scheduling frameworks like the Last Planner System (LPS), which instils predictable workflow rhythms across different crews [44]. Revisions in safety codes or construction standards force alterations in work processes; effective managers anticipate these adjustments early enough to train crews accordingly and modify sequences before disruptions manifest [40]. Material shortages attributable to procurement mismanagement stall progress irrespective of labor readiness [27,45]. These inefficiencies accrue faster than in low-rise builds because access routes are constrained vertically rather than laterally. Neglecting any strand risks unraveling overall productivity gains irrespective of worker capabilities present on-site [16].

2.3.3 Environmental Factors

Environmental factors can exert both direct and indirect effects on construction labor productivity, with impacts varying according to project type, location, and phase of work. Adverse weather conditions, such as storms, heavy rainfall, and extreme temperature ranges, emerge repeatedly as elements capable of slowing or halting operations altogether [19,39]. In high-rise construction contexts, workers at elevated floors face amplified exposure to wind gusts and direct sunlight compared

to ground-level crews. Seasonal extremes require flexible scheduling to shift intensive manual activities into periods with more tolerable climatic conditions [46], yet such adjustments often conflict with contractual timelines unless contingencies are built into planning from the outset [47]. Rainfall produces more immediate physical disruption, halting works like concrete pours or exterior finishing, and introduces secondary issues such as slippery surfaces heightening accident risk [48, 49]. Even highly capable crews succumb to declines in actual measured productivity below theoretical optimal frontiers when persistent adverse conditions hold sway across multiple operational cycles [50]. Working at height inherently necessitates stricter safety compliance; intensified wind speeds aloft mandate temporary stoppages when gust thresholds exceed equipment ratings [39]. The environmental category also encompasses distance from sites to urban centers, a factor tied indirectly to productivity through logistical dependencies [26]. Project managers who incorporate buffer periods around anticipated weather disruptions report steadier productivity trajectories because reactive rescheduling carries less impact than emergency stand-downs enacted without pre-allocation of slack capacity [51, 52]. Macro-environmental elements, such as regional climate stability patterns shifting under longer-term meteorological trends, feed into micro-site realities by redefining what constitutes "extreme" conditions for labor workability [53]. Some impacts reach beyond individual site boundaries via socio-environmental linkages: national regulations governing occupational safety evolve alongside public concerns over climate change's effect on worker health [54]. Proactive strategies include staged material procurement timed against seasonal risks; use of adjustable lighting arrays for safe nightwork; windbreak installations at exposed structural perimeters; and dynamic crew rotation assigning longer-duration outdoor tasks preferentially during lower-risk periods each day [55].

2.3.4 Macroeconomic Factors

Macroeconomic factors impose structural constraints and opportunities that shape labor productivity outcomes in construction projects, particularly in contexts characterized by evolving economic landscapes. These influences operate at scales beyond the immediate site environment but filter down into day-to-day operational

realities through cost structures, resource availability, and competitive pressures. One prominent driver is overall economic growth [25]. The construction industry's output often moves in tandem with national GDP trends; in India, for instance, it contributed roughly 9% to GDP in 2011–2012 with annual growth of 8-10% [13]. Sustained macro-level expansion can stimulate demand for high-rise developments, encourage investment inflows, and justify longer-term commitments from contractors who might otherwise be hesitant under volatile conditions.

This economic buoyancy tends to facilitate capital access for upgrading technology and equipment, an improvement shown to augment labor efficiency through mechanization [56]. As highlighted using an index intended for residential sectors across broader categories leads to underestimation of productivity improvements in non-residential domains [46]. In developing countries with abundant manpower like Pakistan, wage rates tend to be lower compared to developed economies where technological solutions dominate due to high labor costs [57]. While low wages enable larger crew sizes within budgetary limits, they can also mask inefficiency if management does not enforce tight performance standards, more workers do not automatically translate into higher effective output without matching skill quality and logistical support [39]. They calibrate the affordability of advanced technology adoption [7, 46], determine supply chain reliability via commodity and currency stability [45], set wage climates influencing workforce composition [16], and shape funding continuity essential for maintaining momentum across vertical project cycles.

2.4 Strategies for Improving Labor Productivity

2.4.1 Technological Interventions

Technological interventions in construction labor productivity present themselves as both operational enhancements and strategic shifts in management capabilities. Adopting digital technologies such as Building Information Modeling (BIM) and systematic labor tracking offers a tangible starting point. BIM not only serves

traditional design-to-construction coordination but also enables real-time monitoring of progress against planned sequences [58]. In theory, decreasing human fatigue through mechanical assistance should translate to higher sustained output per hour over extended shifts; however empirical validation at actual construction sites remains limited [59]. This improves workflow predictability particularly in finishing stages where variation risks causing cascading delays across concurrent trades. Similarly, drones see increasing application for rapid inspection of high floors or hard-to-access façades [60], which condenses evaluation cycles from days into hours and minimizes downtime linked to waiting for manual inspection results. Artificial intelligence also finds application beyond productivity measurement into hazard identification [24, 45].

Variations in onsite readiness, from network infrastructure availability to workers' digital literacy, determine whether tools improve or impede workflow. A context-sensitive strategy must therefore adapt implementation timelines and training programs based on local maturity levels; premature deployment risks lowering performance if crews struggle with unfamiliar interfaces more than they benefit from data access. Material supply monitoring through integrated platforms can further synchronize procurement with site demands [61]. Emerging forms of automation, such as construction robots for bricklaying or painting, suggest long-term potential but currently face adaptation hurdles related to building designs deviating floor-to-floor in high-rises [9, 32, 62]. Finally, there is merit in noting that technology carries ethical considerations impacting acceptance rates among workers [9, 63]. Surveillance-heavy implementations risk perceptions of mistrust unless balanced with transparency about objectives, whether to improve collective outcomes rather than micromanage individuals.

2.4.2 Organizational and Managerial Practices

Organizational and managerial practices form the structural backbone upon which any technological or human resource strategy rests. Without coherent systems to direct, coordinate, and adapt operational efforts, the potential of workforce capability and technical intervention noted earlier can be undermined [64]. Linking

WBS design directly to incentive schemes fosters reciprocity between organizational objectives and labor performance outcomes; rewarding operatives who exceed benchmarks on critical activities not only motivates individuals but also sets peer performance norms across the site [65]. Although some benefits like union membership or free skill training have low current adoption rates locally, empirical evidence suggests their inclusion could yield marked productivity improvements [66].

Activity-oriented training tailored to site-specific conditions, whether focused on vertical material handling protocols or multi-skilled task adaptability, has demonstrated measurable gains in output alongside reductions in absenteeism and turnover [45]. This is particularly relevant for specialized components whose delayed arrival obstructs critical path activities in vertically staged builds. Some managerial models embed live procurement tracking directly into workflow dashboards so onsite managers can anticipate shortages days ahead rather than hours, allowing rescheduling or temporary reassignment before labor output suffers from inactivity. Finally, there is a need for adaptive governance allowing organizational structures to evolve alongside changing project parameters without losing coherence [67]. Embedding flexibility within organizational rules, while retaining stability of leadership positions, supports resilience against inevitable mid-cycle fluctuations common in complex urban high-rise developments.

2.4.3 Identification of Factor through Literature

Previous studies on building and infrastructure projects were examined to extract recurring themes related to manpower, motivation, site management, materials and equipment, safety, and project planning. From these sources, a consolidated list of factors was prepared, focusing on those most frequently reported as critical in similar construction environments. These literature-derived factors are summarized and organized in Table 2.1, which served as the basis for designing the questionnaire used in this research.

TABLE 2.1: Factor influencing on Construction Labor productivity

Sr. No.	Source	Title of Paper	Factors
1	[3]	Life Cycle Risk Management for Improving Labor Productivity in Construction Projects in Türkiye	<ul style="list-style-type: none"> - Poor pre-work site planning. - Delayed in material delivery. - Design changes during execution.
2	[4]	Forecasting slipform labor productivity in the construction of reinforced concrete chimneys	<ul style="list-style-type: none"> - Poor working conditions. - Manhours. - Temperature variation. - Slip form productivity.
3	[6]	Critical Factors Affecting Construction Labor Productivity: A Systematic Review and Meta-Analysis	<ul style="list-style-type: none"> - Availability of material. - Availability of tool and Equipment. - Lack of Labor. - Overtime/Workload.
4	[7]	Can digital transformation enhance labor productivity in enterprises: An analysis from the perspective of business process reengineering.	<ul style="list-style-type: none"> - Digital technology application. - Digital technology Innovation. - Firm age and size.
5	[37]	Does vertical supervision enhance labor productivity Evidence from China's central environmental protection inspection.	<ul style="list-style-type: none"> - Effective Monitoring. - Poor inspection.
6	[33]	Influence of Energy Intake and Nutritional Status on Work Productivity Among Construction Workers	<ul style="list-style-type: none"> - Time constraint. - Long working hours. - Environmental conditions (heat, noise). - Fatigue. - Poor nutritional intake.
7	[68]	A systematic review of construction labor productivity studies	<ul style="list-style-type: none"> - Worker performance. - Data-driven models. - Project management optimization. - Financial crises during COVID-19. - Carbon emission.

Table 2.1: Continued from Previous

Sr. No.	Source	Title of Paper	Factors
8	[59]	AI and Robotic: About the Transformation of Construction Industry Automation as well as Labor Productivity.	<ul style="list-style-type: none"> - Completion time. - Number of workers. - Fatigue levels. - Quality control.
9	[69]	Enhancing labor productivity as a key strategy for fostering green economic growth	<ul style="list-style-type: none"> - Cost effectiveness. - Labor productivity. - Investment in green technologies. - Renewable energy consumption.
10	[70]	Systematic Review of the Literature on Construction Productivity	<ul style="list-style-type: none"> - Labor motivation (financial, incentive). - Labor availability. - Crew size & Compositions. - Technology (automation & integration).
11	[71]	Labor Productivity Study in Construction Projects Viewed from Influence Factors.	<ul style="list-style-type: none"> - Site locations (Topography). - Reworks. - Design issues. - Field conditions.
12	[14]	A scientometric analysis and review of construction labour productivity research	<ul style="list-style-type: none"> - Overtime. - Payment delays. - Innovation in construction. - Variability.
13	[72]	Analysis of Key Factors Affecting Labor Productivity in General Construction Projects in Pakistan.	<ul style="list-style-type: none"> - Benchmarking. - Motivation. - Labor and personal issues. - Lack of leadership style.
14	[73]	Structural Equation Model of the Factors Affecting Construction Labor Productivity.	<ul style="list-style-type: none"> - Payment delays. - Late arrival, early quit. - Crew size and composition. - Variation/change orders.
15	[74]	Dynamic Modeling of Multifactor Construction Productivity for Equipment-Intensive Activities.	<ul style="list-style-type: none"> - Lack of coordination. - Inadequate site staff. - Lack of training. - Late payments.

Table 2.1: Continued from Previous

Sr. No.	Source	Title of Paper	Factors
16	[75]	Critical Success Factors and Dynamic Modeling of Construction Labour Productivity	<ul style="list-style-type: none"> - Project duration. - Crew size. - Crew skill level. - Material availability.
17	[39]	Labor Productivity in the Construction Industry of Pakistan	<ul style="list-style-type: none"> - Balance between labor and equipment. - Leadership skills. - Shortage of experienced labor. - Physical fatigue.
18	[76]	Improving Labor Productivity: An Attribute Case Study of Building Sector Projects in Pakistan	<ul style="list-style-type: none"> - Shortage of material. - Work overtime. - Unsafe working conditions. - Rework.
19	[35]	Factors Influencing Construction Labor Productivity in Egypt	<ul style="list-style-type: none"> - Poor health of workers. - Low wages. - Lack of advanced methods. - Labor strikes.
20	[47]	Factors Affecting Construction Labor Productivity in Kuwait.	<ul style="list-style-type: none"> - Personal clashes. - Labor frustration. - Labor absenteeism. - Delays in salary.
21	[51]	Intrinsic Workforce Diversity and Construction Worker Productivity in Pakistan	<ul style="list-style-type: none"> - Poor wages. - Lack of team spirit. - Delays in inspection. - Lack of periodic meetings.
22	[52]	Training of Construction Workers in Pakistan.	<ul style="list-style-type: none"> - Crew size. - Lack in coordination. - Poor management. - Inferior working conditions.
23	[77]	Determinants of labor productivity for building projects in Pakistan.	<ul style="list-style-type: none"> - Buildability. - Lack of incentive scheme. - Inspection delays.

Table 2.1: Continued from Previous

Sr. No.	Source	Title of Paper	Factors
24	[9]	Labor Productivity Assessment Using Activity Analysis on Semi High-Rise Building Projects in Pakistan.	<ul style="list-style-type: none"> - Coordination among disciplines. - Rework. - Working overtime. - Delays in wages.
25	[39]	Factors Affecting the Labor Productivity in Construction Projects of Pakistan.	<ul style="list-style-type: none"> - Satisfactory wage plan. - Well paid overtime. - Uneven distribution of work. - Well defined tasks.
26	[72]	Assessment of Labor Productivity in Road Construction Projects of Pakistan.	<ul style="list-style-type: none"> - Skills of workers. - Emerging technology. - Importance of vocational training. - Lack of skills to use technology.
27	[78]	Influence of Internal Workforce Diversity Factors on Labor Productivity	<ul style="list-style-type: none"> - Rework. - Poor workmanship. - High turnover rate. - Shortage of skilled labor.
28	[79]	Relationship between Job Satisfaction and Employee Performance	<ul style="list-style-type: none"> - Unclear instruction to labor. - Lack of labor supervision. - Reworks due to errors. - Delays in responding to RFI.
29	[30]	The impact of overtime duration variations on labor productivity	<ul style="list-style-type: none"> - Financial condition of contractor. - High absenteeism of labor. - Use of tools/equipment. - Material handling.
30	[1]	Analyzing Influencing Factors Affecting Labor Productivity in Remote Areas.	<ul style="list-style-type: none"> - Clear instruction to labor. - Tools and equipment shortages. - Weather changes. - Labor disloyalty.

2.5 Summary

This chapter presented a comprehensive review of the existing literature related to labor productivity in the construction industry, with particular emphasis on high-rise construction projects. The review examined fundamental concepts of labor productivity, common definitions, measurement approaches, and the significance of productivity in achieving project success in terms of time, cost, quality, and safety. The chapter critically analyzed previous studies to identify key factors influencing labor productivity, including workforce-related factors, management and supervision practices, planning and scheduling issues, site conditions, equipment and technology, and external environmental and organizational influences.

Existing labor productivity improvement models and frameworks were also reviewed, revealing that most studies either focus on generalized construction projects or are developed for contexts that differ significantly from Pakistan's construction industry. The review identified a clear research gap in the availability of a localized, high-rise specific productivity improvement framework for the Twin Cities.

Based on the reviewed literature, the chapter established a theoretical foundation for the identification and classification of labor productivity factors, which informed the research methodology and data collection process described in Chapter 3. The insights gained from this chapter justify the need for the present study and support the development of a context-specific framework aimed at improving labor productivity in high-rise construction projects in Rawalpindi and Islamabad.

Chapter 3

Research Methodology

3.1 Introduction

This chapter presents a detailed explanation of the research methodology adopted to develop a comprehensive framework for improving labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. Labor productivity is a critical determinant of project success, directly influencing construction time, cost, quality, and overall project performance [32]. Given the increasing number of high-rise developments in the Twin Cities, there is a pressing need to systematically identify, analyze, and prioritize the factors affecting labor productivity in this specific regional and industrial context. The research methodology is structured as a sequential mixed-methods approach, integrating qualitative and quantitative research techniques to ensure a comprehensive and reliable investigation [32]. This approach enables the exploration of labor productivity issues from both theoretical and practical perspectives, allowing for the development of a framework that is empirically validated and industry oriented.

The methodological framework comprises five interrelated phases [23]. These include: (i) an extensive literature review to establish a theoretical foundation and identify productivity-related factors, (ii) refinement and validation of these factors through expert consultation using the Delphi method, (iii) development of structured questionnaire and empirical data collection from industry professionals, (iv) application of statistical and index-based analytical techniques to prioritiz

productivity factors, and (v) development of a labor productivity improvement framework tailored to high-rise construction projects in Rawalpindi and Islamabad. The primary objective of this methodology is to produce a structured, practical, and scalable framework that can support contractors, project managers, consultants, and policymakers in enhancing labor productivity and overall project efficiency. The detailed methodological procedures employed in this study are discussed in the following sections.

3.2 Research Philosophy and Design

This study is philosophically grounded in pragmatism, which emphasizes practical problem solving and the generation of actionable knowledge. Pragmatism is particularly well-suited to construction management research, where the goal is not only to understand complex phenomena but also to propose solutions that can be implemented in real project environments [1]. Since labor productivity is influenced by a combination of human, managerial, technical, and environmental factors, a pragmatic philosophy allows flexibility in selecting methods that best address the research objectives.

The research design adopted is descriptive analytical in nature. The descriptive aspect focuses on identifying and describing the factors affecting labor productivity in high-rise construction projects, while the analytical aspect involves examining the relative importance and influence of these factors using empirical data. This combination ensures both depth and rigor in the investigation [80]. The study integrates qualitative and quantitative research methods to achieve methodological triangulation. The qualitative component consists of a systematic literature review and expert consultations using the Delphi technique, providing contextual understanding and expert insight into productivity issues. The quantitative component involves the use of structured questionnaires and statistical analysis, enabling empirical validation and generalization of findings [10].

A hybrid deductive inductive research approach is employed. Initially, deductive reasoning is used to identify labor productivity factors from existing theories and

previous studies. Subsequently, inductive reasoning is applied through the collection and analysis of primary data from construction professionals, allowing for refinement and contextualization of these factors. This iterative approach ensures that the final framework is both theoretically grounded and empirically validated. The overall methodological flow is illustrated in Figure 3.1.

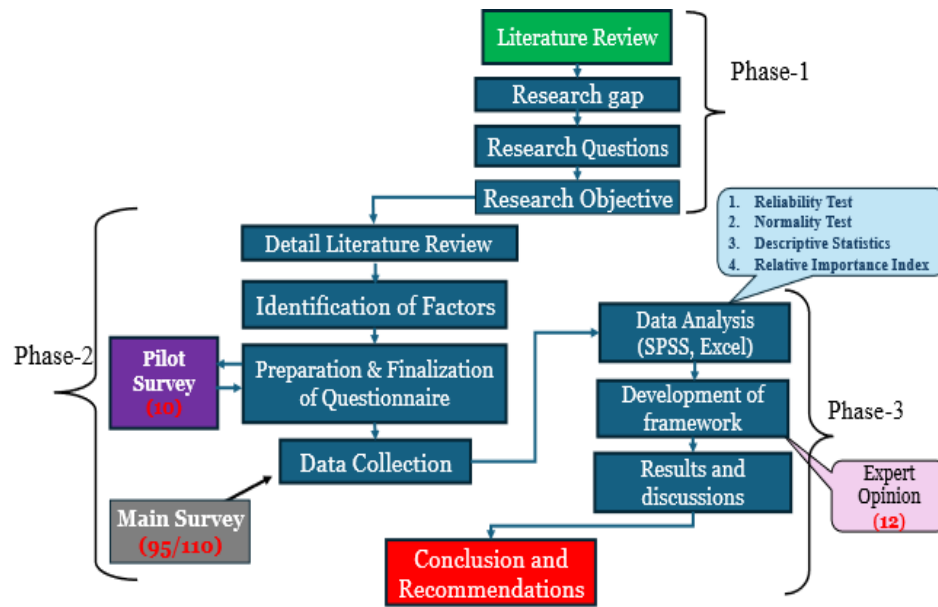


FIGURE 3.1: Systematic Diagram of Methodology

3.3 Preliminary Investigation and Literature Review

The preliminary investigation commenced with a comprehensive and systematic literature review aimed at identifying factors that influence labor productivity in high-rise construction projects. The review focused on both international studies and research conducted in developing countries, with particular attention to contexts similar to Pakistan's construction industry. Major academic databases, including Scopus, Web of Science, and Google Scholar, were searched for relevant publications from 2014 to 2025 to ensure the inclusion of recent and up-to-date research. Keywords such as construction labor productivity, high-rise buildings, workforce efficiency, construction management practices, and productivity improvement strategies were used to retrieve relevant literature.

The initial search yielded a substantial number of publications, which were subsequently screened based on predefined inclusion criteria. These criteria included relevance to labor productivity, focus on high-rise or large-scale construction projects, methodological rigor, and practical applicability. After the screening process, more than 80 journal articles, conference papers, industry reports, and case studies were selected for detailed analysis.

The synthesis of the selected literature involved systematic extraction and categorization of productivity-related factors. These factors were grouped into six major domains: Workforce Skills and Motivation, Management and Supervision Practices, Project Planning and Scheduling, Equipment and Technology Utilization, Site Conditions and Safety, and External and Organizational Factors. As a result, an initial list of approximately 57 labor productivity factors was developed, forming the basis for further refinement through expert consultation.

3.4 Risk Factor Refinement using Delphi Method

The Delphi method was employed to refine, validate, and contextualize the identified labor productivity factors for high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. Despite the heading's reference to "risk factors," this phase focuses specifically on productivity-related factors that act as constraints or drivers of labor performance. A panel of experts was carefully selected to ensure diverse representation across the construction industry. The panel included senior contractors, project managers, site engineers, consulting engineers, and academic experts specializing in construction management. All panel members had a minimum of ten years of professional experience in high-rise construction projects within Pakistan. The Delphi process was conducted in multiple rounds [45]. In each round, experts were asked to evaluate the relevance, clarity, and impact of each productivity factor and to suggest modifications, eliminations, or additions where necessary. Feedback from each round was anonymized and summarized before being redistributed to the panel for further evaluation. This iterative process continued until a satisfactory level of consensus was achieved.

3.5 Questionnaire Design and Data Collection

3.5.1 Questionnaire Structure

A structured questionnaire was developed as the primary instrument for collecting quantitative data from construction industry professionals. The questionnaire was designed to capture respondents' perceptions regarding the influence and occurrence of labor productivity factors in high-rise construction projects. The questionnaire consisted of 4 main sections. Section 1 collected demographic and professional background information, including years of experience, job designation, organization type, educational qualifications, and involvement in high-rise projects. This information was used to assess the diversity and representativeness of the respondent sample. Section 2 Factors Related to the Effect on Labor Productivity: Labor Motivation, Inappropriate Supervision and Safety/Weather. This section assesses how worker motivation and supervisory practices affect labor productivity in high-rise construction projects. Section 3 Factors Related to the Effect on Labor Productivity: Materials/Tools Handling and Time. Section 4 Factors Related to the Effect on Labor Productivity: Human (Manpower), Project Management, and Leadership. Section 3-4 comprised the 39 validated labor productivity factors, each accompanied by a brief operational definition to ensure consistent interpretation. Respondents were asked to rate each factor using five-point Likert scales: the degree of influence on labor productivity (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree).

3.5.2 Sampling and Distribution

In this research, the sample size is determined using the formula proposed by Harris (1985), which is widely recognized in survey-based studies involving multiple factors. This formula has also been adopted in previous research for determining adequate sample size in construction management and related studies [81]. According to this formula, shown in Equation (3.1), the required sample size (N) is calculated as:

$$N = 50 + p \quad (3.1)$$

where:

N = Required sample size

p = Number of factors included in the study

This approach provides a practical and efficient means of estimating the minimum number of respondents necessary to capture reliable and valid data for all considered factors.

The target sample size was set at approximately 89 respondents, determined using Cochran's formula [?] with a 95% confidence level and a 5% margin of error, considering the estimated population of relevant professionals.

The questionnaire was distributed through online platforms and professional networks. Follow-up reminders were issued to enhance response rates and ensure balanced participation across different professional roles and organizational types.

3.6 Data Analysis Methods

3.6.1 Descriptive Analysis using SPSS

Data analysis was carried out using IBM SPSS Statistics software. Descriptive statistics were used to summarize respondents' demographic characteristics through frequency distributions and percentages [67]. This analysis provided insights into the composition and representativeness of the survey sample.

For each labor productivity factor, mean values and standard deviations were calculated to assess perceived influence and frequency. Frequency distributions were examined to identify response patterns and detect potential outliers. Comparative analyses were also conducted to examine variations in perceptions across different demographic groups, such as experience level and job role.

3.6.2 Reliability and Normality Tests

The reliability and internal consistency of the questionnaire scales were assessed using Cronbach's Alpha coefficient. Separate analyses were conducted for the influence and frequency scales, with values exceeding the acceptable threshold of 0.70, indicating satisfactory reliability [16].

The normality of the data was evaluated using the Shapiro–Wilk test, which indicated that most variables were not normally distributed ($p < 0.05$). Consequently, non-parametric statistical methods and index-based analytical techniques were deemed appropriate for further analysis.

3.6.3 Relative Importance Index -RII

The Relative Importance Index (RII) method was employed to rank and prioritize labor productivity factors based on survey responses. The RII was calculated using the following formula [26]:

$$RII = \frac{\sum W}{A \times N} \quad (3.2)$$

where W is the weight assigned by respondents (1–5), A is the highest possible weight (5), and N is the total number of respondents.

RII values range from 0 to 1, with higher values indicating greater importance. Separate RII values were calculated for influence and frequency dimensions, and composite indices were derived to establish an overall ranking of productivity factors. These rankings formed the basis for identifying critical productivity issues and informed the development of the proposed productivity improvement framework.

3.7 Framework Development

This section presents the conceptual framework developed to improve labor productivity in high-rise construction projects in the Twin Cities of Islamabad and

Rawalpindi. The framework is derived from the factors identified in the literature and refined through the pilot survey and Delphi process discussed earlier in this chapter. It groups critical influences into major domains such as manpower capability, labor motivation, supervision and leadership, project management, materials and tools, time management, and safety/weather conditions. The relationships among these domains are structured to show how managerial and site-level interventions can address root causes of low productivity rather than only their symptoms.

3.8 Summary

This chapter presented a detailed overview of the research methodology adopted to develop a framework for improving labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. The study employed a pragmatic research philosophy and a descriptive analytical mixed methods design to ensure both theoretical rigor and practical relevance. A systematic literature review and Delphi-based expert consultation were used to identify and validate key labor productivity factors, while a structured questionnaire survey provided empirical data from industry professionals.

Statistical analysis using SPSS, reliability and normality testing, and the Relative Importance Index method were applied to analyze and prioritize productivity factors. The methodological approach established in this chapter provides a solid foundation for the subsequent analysis and discussion of results presented in the next chapter, ultimately leading to the development of a practical labor productivity improvement framework.

Chapter 4

Results and Analysis

4.1 Introduction

This chapter presents a detailed analysis of the data collected to achieve the objectives of this study and to develop a framework for improving labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. The results discussed in this chapter are derived from a structured questionnaire survey conducted among construction professionals with direct experience in high-rise projects, including contractors, project managers, site engineers, and consultants. The analysis aims to transform raw survey data into meaningful insights that explain the key factors influencing labor productivity within the local construction context.

The chapter begins by examining the demographic and professional characteristics of the respondents to ensure that the sample is representative of the construction industry in the Twin Cities. This initial analysis provides an understanding of respondents' experience levels, organizational roles, and involvement in high-rise construction, thereby establishing the credibility of the collected data. Descriptive statistical techniques are then employed to analyze respondents' perceptions regarding labor productivity factors, including their level of influence and frequency of occurrence on construction sites.

To ensure the reliability and validity of the results, the chapter includes reliability testing using Cronbach's Alpha and data normality assessment. These test

confirm the internal consistency of the measurement scales and determine the suitability of the data for subsequent analysis techniques. Based on the nature of the data, appropriate analytical methods are selected to ensure accurate interpretation of the results. The Relative Importance Index (RII) method is applied to rank and prioritize the identified labor productivity factors. This approach enables the identification of critical factors that have the greatest impact on labor productivity in high-rise construction projects. The ranked results are analyzed and discussed in relation to existing literature and current construction practices in Rawalpindi and Islamabad.

The findings presented in this chapter provide empirical evidence to support the identification of key productivity challenges and opportunities for improvement. These results serve as a foundation for the development of the proposed labor productivity improvement framework, which is discussed in subsequent sections of this chapter and further synthesized in the concluding chapter.

4.2 Development of Questionnaire

A structured questionnaire was developed as the primary tool for collecting data on factors affecting labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. The questionnaire design was based on an extensive review of relevant literature and expert input to ensure its relevance to the local construction environment.

The questionnaire consisted of two main sections. Section A collected demographic and professional information of respondents, including experience, job role, organization type, and involvement in high-rise construction projects. This information was used to assess the representativeness of the respondents and support comparative analysis. Section B included the validated labor productivity factors identified through literature review and expert consultation. Each factor was accompanied by a brief description to ensure consistent understanding. Respondents rated each factor using five-point Likert scales based on its level of influence on labor productivity and frequency of occurrence on construction sites. The questionnaire was

reviewed and pilot tested to improve clarity and reliability before final distribution. The finalized questionnaire provided a systematic and reliable means of capturing industry perceptions for subsequent data analysis and framework development.

4.3 Analysis of Pilot Survey and Delphi Technique

A pilot survey was conducted as a preliminary step to assess the suitability, clarity, and relevance of the identified labor productivity factors prior to the full-scale questionnaire survey. The pilot survey also supported the Delphi process by ensuring that the respondents involved possessed adequate academic qualifications, professional experience, and direct exposure to high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. A total of ten experienced construction professionals participated in the pilot survey. Table 4.1 presents the highest level of education of the pilot survey respondents. The results indicate that the majority of respondents were well qualified, with 40% holding post-graduate degrees and 10% possessing PhD-level qualifications. Graduates and diploma holders constituted 30% and 20% of the sample, respectively. This distribution reflects a strong academic foundation among the respondents, ensuring that feedback provided during the pilot survey and Delphi rounds was informed, analytical, and technically sound.

TABLE 4.1: Highest Level of Education of Respondents in the Pilot Survey

Qualification	Number	Percentage %
Diploma Holder DAE	2	20%
Graduation	3	30%
Post-Graduation	4	40%
PhD	1	10%
Total	10	100%

The professional roles of the respondents are summarized in Table 4.2. Project Managers formed the largest group (30%), followed by Construction Managers and Assistant Managers (20% each). Site Engineers, Planning Engineers, and Site Supervisors each represented 10% of the respondents. The diversity of designations ensured balanced input from both managerial and site-execution perspectives, which is essential for identifying practical labor productivity issues in high-rise construction projects.

TABLE 4.2: Designation of Respondent in Pilot Survey

Designation	Number	Percentage %
Project Manager	3	30%
Construction Manager	2	20%
Assistant Manager	2	20%
Site Engineer	1	10%
Planning Engineer	1	10%
Site Supervisor	1	10%
Total	10	100%

Table 4.3 shows the pilot respondents' experience: most participants fall in the 11–15 years and 21–25 years brackets (3 respondents each, 30% + 30%), while 6–10 years has 2 respondents (20%) and 16–20 years and >25 years have 1 respondent each (10% each); no respondent was below 5 years. This distribution indicates the pilot survey mainly captured mid- to-senior professionals, which strengthens the quality of expert feedback used to refine the productivity factors.

Table 4.4 indicates organization type: consultants are the largest group (5, 50%), followed by contractors (3, 30%) and clients (2, 20%). This mix ensures the pilot inputs reflect multiple stakeholder perspectives (planning/monitoring from consultants, execution from contractors, and oversight from clients). Table 4.5 shows

TABLE 4.3: Years of Experience of Respondents in the Pilot Survey

Experience (Years)	Number	Percentage %
< 5	0	0%
6 – 10	2	20%
11 – 15	3	30%
16 – 20	1	10%
21 – 25	3	30%
More than 25	1	10%
Total	10	100%

project location coverage: 6 respondents (60%) were working in Islamabad and 4 (40%) in Rawalpindi. Hence, the pilot survey adequately represents the Twin Cities context, with slightly higher representation from Islamabad-based high-rise projects. As a result of the Pilot Survey and Delphi analysis, overlapping and less relevant factors were eliminated, and closely related factors were consolidated,

TABLE 4.4: Organization Type of Respondents in the Pilot Survey

Organization Type	Number	Percentage %
Client	2	20%
Consultant	5	50%
Contractor	3	30%
Total	10	100%

TABLE 4.5: Location of Current High-Rise Projects in the Pilot Survey

Location	Number	Percentage %
Islamabad	6	60%
Rawalpindi	4	40%
Total	10	100%

refining the initial list of approximately 57 factors to 39 key labor productivity factors that are most relevant to high-rise construction projects in Rawalpindi and Islamabad. The pilot survey further confirmed that the respondents possessed appropriate academic qualifications, professional roles, and experience levels to contribute meaningfully to this refinement process. Feedback obtained from the pilot survey and successive Delphi rounds was used to improve the clarity of questionnaire items, remove ambiguity, and finalize the list of critical labor productivity factors, thereby enhancing the reliability and contextual relevance of the questionnaire used in the main survey.

4.4 Main Survey

In this part the results of the main survey obtained are discussed in details.

4.4.1 Sample Size

The sample size for the questionnaire survey was determined using the formula presented in Eq. (3.1). According to this guideline:

$$N = p + 50 \quad (4.1)$$

where p represents the number of variables (factors). Substituting $p = 39$:

$$N = 39 + 50 = 89 \quad (4.2)$$

Thus, the minimum required sample size for the study is 89 respondents.

To achieve this, a total of 150 participants were invited through a combination of in-person distribution and online questionnaires (Google Forms shared via WhatsApp). Out of these, 110 responses were received, yielding a response rate of 73.33%. An inclusion criterion was applied, considering only respondents with a minimum of three years of professional experience to ensure the reliability of expert judgment. After screening, 95 responses met this criterion and were retained for the final analysis.

4.4.2 Demographic Detail of Respondents

This section provides a detailed explanation of the demographic characteristics of the respondents who participated in the questionnaire survey. Demographic analysis is essential to evaluate the reliability, diversity, and representativeness of the data collected for developing the labor productivity improvement framework. The demographic profile of respondents is presented through Figures 4.1 to 4.5 and includes educational qualification, organization type, professional experience, job designation, and the location of current high-rise construction projects.

4.4.3 Educational Qualification of Respondents

Figure 4.1 illustrates the educational qualifications of the respondents. The results indicate that the majority of respondents possess strong academic backgrounds. Graduates constitute the largest group, accounting for (56.84%) of the total respondents. This is followed by respondents holding post-graduate degrees, who represent (33.68%) of the sample. Diploma holders (DAE) account for (7.37%), while respondents with PhD qualifications constitute (2.11%).

The dominance of graduate and post-graduate respondents (over 90%) demonstrates that the majority of participants have adequate academic and technical

knowledge of construction practices. This strengthens the credibility of the responses related to labor productivity issues in high-rise construction projects.

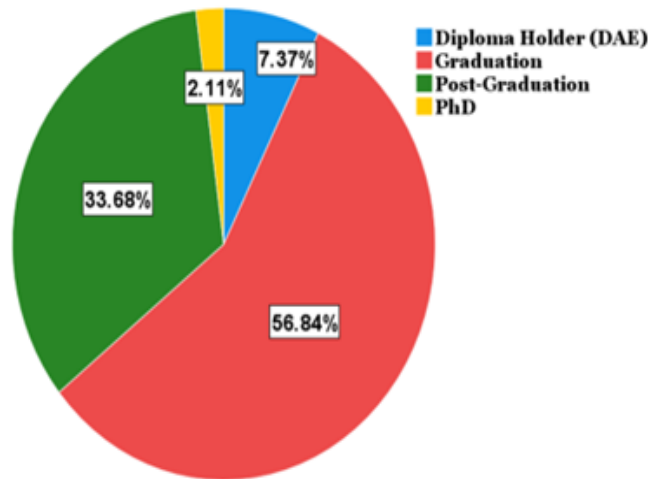


FIGURE 4.1: Education Level of Respondents

4.4.4 Organization Type of Respondents

The organizational affiliation of respondents is shown in Figure 4.2. Consultants form the largest group, representing (42.11%) of the respondents, followed by clients (29.47%) and contractors (28.42%). This balanced representation from key construction stakeholders ensures that the survey findings reflect diverse perspectives, including planning, supervision, and execution stages of high-rise construction projects.

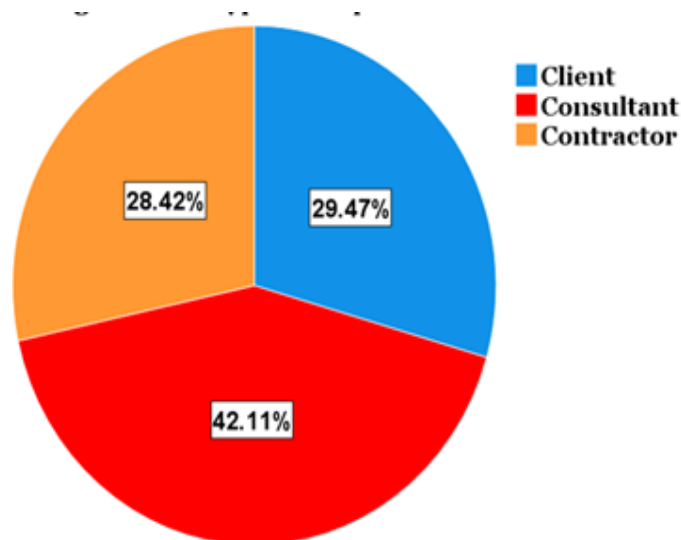


FIGURE 4.2: Organization Type of Respondents

4.4.5 Professional Experience in the Construction Industry

Figure 4.3 illustrates the distribution of respondents based on their professional experience in the construction industry. The largest proportion of respondents (46.32%) have less than 5 years of experience, indicating significant participation from early-career professionals. Respondents with 6 - 10 years of experience account for (26.32%), while those with 11 - 15 years of experience represent (14.74%). More experienced professionals are also represented, with (4.21%) having 16–20 years, (7.37%) having 21 - 25 years, and (1.05%) having more than 25 years of experience. This combination of junior and senior professionals provides both contemporary and experience- based insights into labor productivity challenges, enhancing the overall depth of the analysis.

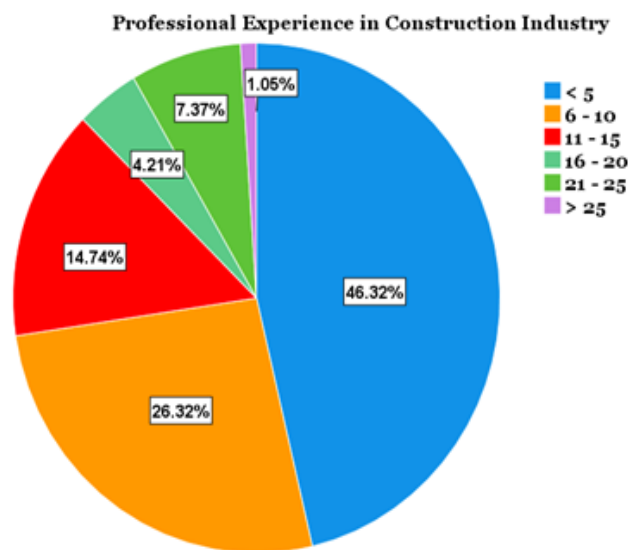


FIGURE 4.3: Professional Experience in the Construction Industry

4.4.6 Job Designation of Respondents

Figure 4.4 presents the job designations of the respondents. Site Engineers form the largest group, accounting for 31.58%, reflecting strong representation from site-level execution staff. Assistant Managers and Planning Engineers each represent 12.63% of the respondents. Design Engineers account for 8.42%, while Project Managers and Architects/Designers each constitute 7.37%. Other designations include Construction Managers and Project Directors at 5.26% each,

General Managers at 1.05%, BIM Managers at 1.05%, Quantity Estimating Engineers at 1.05%, Academia at 1.05%, and Site Supervisors at 1.05%. The wide range of job roles ensures that the collected data reflects both strategic management and on-site operational perspectives, which is crucial for accurately assessing labor productivity factors in high-rise construction projects.

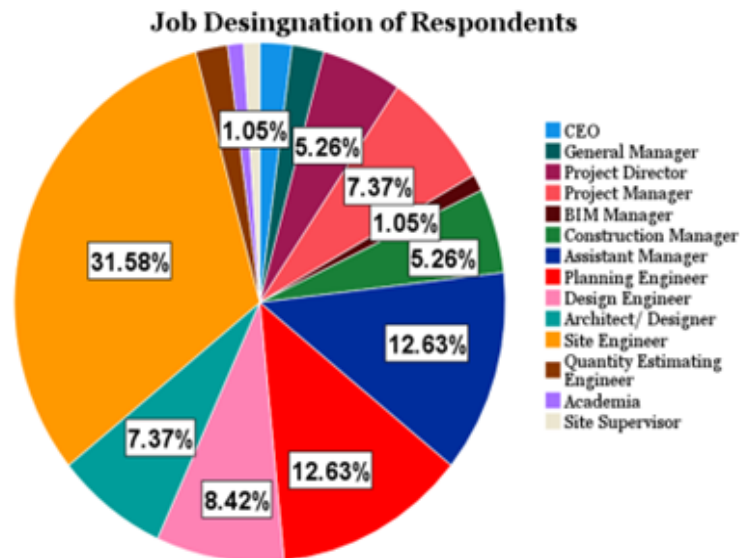


FIGURE 4.4: Job Designation of Respondents

4.4.7 Current Job Location of High-Rise Projects

Figure 4.5 shows the geographical distribution of respondents based on the location of their current high-rise construction projects. The majority of respondents (58.95%) are involved in projects located in Islamabad, while (41.05%) are working on projects in Rawalpindi. This distribution confirms that the survey adequately covers the Twin Cities and that the findings are representative of high-rise construction practices in both urban contexts.

The demographic analysis demonstrates that the respondents possess suitable academic qualifications, professional experience, and industry representation to provide credible insights into labor productivity issues. The balanced participation across organizations, job roles, experience levels, and project locations strengthens the validity of the survey results and supports the subsequent analysis and development of the labor productivity improvement framework.

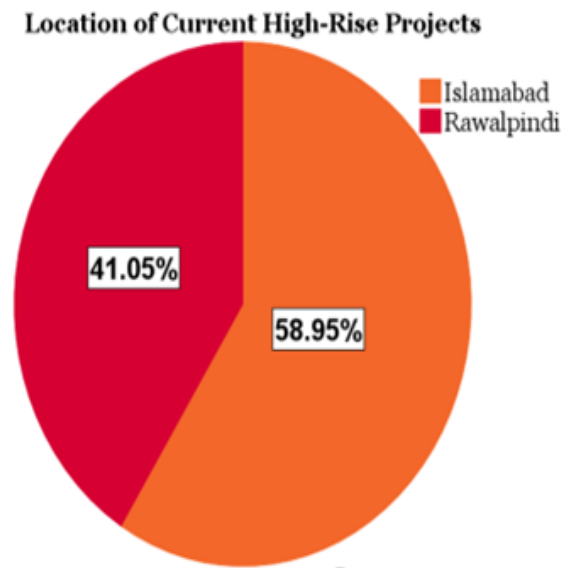


FIGURE 4.5: Current Job Location of High-Rise Projects

4.5 Statistical Analysis

Statistical analysis was carried out to ensure the accuracy, consistency, and reliability of the data collected through the questionnaire survey. Given that the study relies on respondents' perceptions to evaluate factors affecting labor productivity in high-rise construction projects, it was essential to verify that the collected data were suitable for further quantitative analysis. This section presents the reliability assessment of the survey data prior to applying advanced analytical techniques.

4.5.1 Analysis of Data for Reliability

Reliability analysis was conducted to assess the internal consistency and adequacy of the collected questionnaire responses. Reliability refers to the degree to which a measurement instrument produces stable and consistent results. In this study, reliability testing was performed to ensure that the responses obtained from the survey were dependable and could be used confidently for subsequent statistical analysis and interpretation. Table 4.6 presents the summary of the reliability analysis. A total of 110 questionnaires were received during the survey process. Out of these, 95 responses (86.36%) were identified as valid cases and included in the statistical analysis. These valid responses were complete and met the predefined criteria for analysis. The remaining 15 responses (13.64%) were excluded due to

incomplete information, inconsistent responses, or missing data that could potentially affect the reliability of the results. The high percentage of valid responses

TABLE 4.6: Reliability Analysis (Case Processing Summary)

Sr. No	Category	N	Percentage (%)
01	Valid Cases	95	86.36%
02	Excluded	15	13.64%
03	Total	110	100.0%

indicates a strong response quality and reflects the respondents' understanding of the questionnaire items. An inclusion rate of over 85% is considered satisfactory in construction management research and suggests that the collected data are reliable and suitable for further analysis, such as descriptive statistics and ranking of labor productivity factors.

The exclusion of invalid responses helped enhance the overall quality and integrity of the dataset. By ensuring that only complete and consistent responses were analyzed, the study minimized potential bias and strengthened the credibility of the findings. Consequently, the validated dataset provided a reliable foundation for identifying and prioritizing critical labor productivity factors in high-rise construction projects in Rawalpindi and Islamabad.

Table 4.7 presents the reliability statistics of the questionnaire used in this study, evaluated using Cronbach's Alpha coefficient. Cronbach's Alpha is a widely accepted statistical measure used to assess the internal consistency of a measurement scale, indicating how closely related a set of items are in measuring the same underlying construct. In the context of this research, it was applied to evaluate the reliability of the 39 labour productivity factors included in the questionnaire.

TABLE 4.7: Reliability Statistics (Cronbach's Alpha)

Cronbach's Alpha	N of Items
0.968	39

The results show a Cronbach's Alpha value of 0.968 for the 39 items. This value is significantly higher than the commonly accepted threshold of 0.70, which indicates

acceptable reliability in social science and construction management research [10]. Values above 0.90 are generally considered to reflect excellent internal consistency, demonstrating that the questionnaire items are highly correlated and consistently measure the concept of labour productivity in high-rise construction projects. The high Cronbach's Alpha value suggests that the respondents interpreted the questionnaire items consistently and that the factors included in the survey are coherent and well-structured. It also indicates that the questionnaire instrument is stable and reliable for assessing labour productivity factors in the context of high-rise construction projects in Rawalpindi and Islamabad. Furthermore, the inclusion of 39 items in the reliability analysis confirms that all identified and validated labour productivity factors contributed meaningfully to the measurement scale. The strong internal consistency observed implies that the questionnaire does not contain redundant or ambiguous items that could distort the results. Consequently, the reliability of the instrument supports the validity of subsequent statistical analyses, including factor ranking and framework development. Overall, the results presented in Table 4.7 confirm that the questionnaire used in this study is a highly reliable research instrument, providing a robust foundation for further analysis and interpretation of labour productivity factors in high-rise construction projects in the Twin Cities.

4.5.2 Descriptive Statistics

The descriptive statistics ($N = 95$) for respondents' perceptions of labor productivity related factors in high-rise projects, showing that most items have mean values above the mid-point, indicating they are generally viewed as important contributors to productivity issues. Overall variability is moderate (Std. Deviation ≈ 1.0 – 1.27), meaning respondents share similar views but with some dispersion across projects and roles as shown in Table 4.8. The highest mean scores fall under the Leadership group, led by "Lack of communication between labor and supervisors" (LF-3, Mean = 3.86, SD = 1.117), followed by "Lack of labor surveillance" (LF-1, Mean = 3.80, SD = 1.017) and "Lack of periodic meetings" (LF-2, Mean = 3.77, SD = 1.086). These results indicate that site leadership practices (communication, monitoring, and

routine coordination) are perceived as the strongest levers affecting labor productivity. Among labor motivation and manpower issues, “Poor wages of workers” (LM-2, Mean = 3.72), “Lack of incentive scheme” (LM-3, Mean = 3.72), and “Unskilled workforce” (MF-1, Mean = 3.71) also rank high, showing that both compensation structures and skill levels are major concerns.

In the Material & Tools category, “Procurement delays” (M&TF-6, Mean = 3.69) and “Inefficiency of equipment” (M&TF-5, Mean = 3.63) suggest supply-chain and equipment performance are notable productivity constraints. In Project Management, “Lack of coordination between stakeholders” (PMF-4, Mean = 3.66) stands out, reinforcing the importance of coordination and planning interfaces on high-rise sites. The comparatively lower means include “Unsuitable material storage at the site” (M&TF-2, Mean = 3.25), “Reallocation of laborers” (ISF-5, Mean = 3.36), and “Labor strikes” (MF-4, Mean = 3.36), implying these are perceived as less frequent or less impactful than the leadership, motivation, and procurement-related issues.

TABLE 4.8: Descriptive Statistics

Factors Related to CLP in Coding High-Rise Projects	N	Mean	Std. Deviation
(Labor Motivation Factor)	95	3.60	1.267
Poor Wages of workers	95	3.72	1.217
Lack of incentive scheme	95	3.72	1.117
Lack of training sessions	95	3.59	1.225
Lack of place for eating and relaxation	95	3.60	1.161
Lack of team spirit	95	3.56	1.218
Change in drawings and specifications during execution	95	3.45	1.099
Delays in inspections	95	3.39	1.114

TABLE 4.8: Descriptive Statistics – Continued from previous page

Factors Related to CLP in High-Rise Projects	Coding	N	Mean	Std. Deviation
Rework	ISF-3	95	3.59	1.087
Clear and daily task assignments	ISF-4	95	3.65	1.050
Reallocation of laborers	ISF-5	95	3.36	1.148
Working at height	S&WF-1	95	3.39	1.123
Insufficient lighting at site	S&WF-2	95	3.39	1.266
Weather conditions	S&WF-3	95	3.66	1.078
Shortage of materials	M&TF-1	95	3.45	1.261
Unsuitable material storage at the site	M&TF-2	95	3.25	1.229
Shortage of tools and equipment	M&TF-3	95	3.65	1.218
Obsolete tools and equipment	M&TF-4	95	3.51	1.175
Inefficiency of equipment	M&TF-5	95	3.63	1.130
Procurement delays	M&TF-6	95	3.69	1.082
Low Quality of raw materials	M&TF-7	95	3.38	1.231
Continuous work without break	TF-1	95	3.65	1.174
Working overtime	TF-2	95	3.63	1.149
Project size	TF-3	95	3.40	1.206
Crew size	TF-4	95	3.54	1.165
Unskilled workforce	MF-1	95	3.71	1.175
Labor absenteeism	MF-2	95	3.51	1.138

TABLE 4.8: Descriptive Statistics – Continued from previous page

Factors Related to CLP in Coding High-Rise Projects	N	Mean	Std. Deviation
Lack of skilled manpower	95	3.60	1.152
Labor strikes	95	3.36	1.202
Labor disloyalty	95	3.55	1.109
Working in a confined space	95	3.52	1.080
Political interference	95	3.47	1.147
Labor shortage	95	3.59	1.135
Lack of coordination between stakeholders	95	3.66	1.097
Site restricted access/topography	95	3.52	1.110
Performing work at night	95	3.57	1.088
Lack of labor surveillance	95	3.80	1.017
Lack of periodic meetings	95	3.77	1.086
Lack of Communication between labor and supervisors	95	3.86	1.117
Valid N (listwise)	95		

Since leadership items have both high means and relatively lower SDs (e.g., LF-1 SD = 1.017), the findings suggest broad respondent agreement that improving supervision quality, communication routines, and on-site monitoring should be central in the productivity improvement framework. In parallel, the framework should include practical mechanisms for wage/incentive alignment (LM-2, LM-3) and workforce upskilling (MF-1, MF-3), along with procurement planning controls to reduce material/equipment-related waiting time (M&TF-6, M&TF-3).

4.5.3 Normality Analysis

Normality analysis was conducted to examine the distribution characteristics of the data collected for the factors related to construction labour productivity (CLP). Assessing data normality is an essential prerequisite in statistical analysis, as it determines the suitability of parametric or non-parametric statistical techniques. In this study, normality was evaluated using two widely accepted tests: the Kolmogorov–Smirnov (K–S) test and the Shapiro–Wilk (S–W) test, as presented in Table 4.9. The Kolmogorov–Smirnov test compares the empirical distribution of the data with a normal distribution, while the Shapiro–Wilk test is considered more sensitive and reliable, particularly for small to medium sample sizes. For both tests, the null hypothesis assumes that the data are normally distributed. A significance value (Sig.) less than 0.05 indicates rejection of the null hypothesis, implying that the data do not follow a normal distribution.

TABLE 4.9: Normality Tests

Factors Related to CLP	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Delays in salary	0.249	95	0.000	0.860	95	0.000
Poor Wages of workers	0.288	95	0.000	0.835	95	0.000
Lack of incentive scheme	0.233	95	0.000	0.872	95	0.000
Lack of training sessions	0.260	95	0.000	0.866	95	0.000
Lack of place for eating and relaxation	0.231	95	0.000	0.882	95	0.000
Lack of team spirit	0.253	95	0.000	0.875	95	0.000
Change in drawings and specifications during execution	0.213	95	0.000	0.892	95	0.000
Delays in inspections	0.231	95	0.000	0.899	95	0.000
Rework	0.244	95	0.000	0.887	95	0.000

TABLE 4.9: Normality Tests – Continued from previous page

Factors Related to CLP	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Clear and daily task assignments	0.226	95	0.000	0.888	95	0.000
Reallocation of laborers	0.240	95	0.000	0.894	95	0.000
Working at height	0.192	95	0.000	0.909	95	0.000
Insufficient lighting at site	0.244	95	0.000	0.884	95	0.000
Weather conditions	0.219	95	0.000	0.884	95	0.000
Shortage of materials	0.251	95	0.000	0.870	95	0.000
Unsuitable material storage at the site	0.230	95	0.000	0.896	95	0.000
Shortage of tools and equipment	0.287	95	0.000	0.848	95	0.000
Obsolete tools and equipment	0.278	95	0.000	0.868	95	0.000
Inefficiency of equipment	0.246	95	0.000	0.879	95	0.000
Procurement delays	0.271	95	0.000	0.866	95	0.000
Low Quality of raw materials	0.184	95	0.000	0.901	95	0.000
Continuous work without break	0.245	95	0.000	0.870	95	0.000
Working overtime	0.233	95	0.000	0.880	95	0.000
Project size	0.234	95	0.000	0.890	95	0.000
Crew size	0.256	95	0.000	0.872	95	0.000

TABLE 4.9: Normality Tests – Continued from previous page

Factors Related to CLP	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unskilled workforce	0.280	95	0.000	0.849	95	0.000
Labor absenteeism	0.265	95	0.000	0.869	95	0.000
Lack of skilled manpower	0.322	95	0.000	0.832	95	0.000
Labor strikes	0.274	95	0.000	0.873	95	0.000
Labor disloyalty	0.308	95	0.000	0.849	95	0.000
Working in a confined space	0.245	95	0.000	0.882	95	0.000
Political interference	0.193	95	0.000	0.901	95	0.000
Labor shortage	0.285	95	0.000	0.863	95	0.000
Lack of coordination between stakeholders	0.302	95	0.000	0.850	95	0.000
Site restricted access/topography	0.265	95	0.000	0.880	95	0.000
Performing work at night	0.293	95	0.000	0.861	95	0.000
Lack of labor surveillance	0.312	95	0.000	0.832	95	0.000
Lack of periodic meetings	0.319	95	0.000	0.825	95	0.000
Lack of Communication between labor and supervisors	0.272	95	0.000	0.834	95	0.000

As shown in Table 4.8, the significance values (Sig.) for all labour productivity factors are 0.000 for both the Kolmogorov–Smirnov and Shapiro–Wilk tests. This result indicates that the data for all examined variables significantly deviate from a normal distribution at the 95% confidence level. Additionally, the Shapiro–Wilk test statistics

for the variables range below the threshold typically associated with normality, further confirming the non-normal nature of the data. The observed non-normal distribution of the data can be attributed to the subjective nature of perception-based survey responses, which are common in construction management research. Respondents' evaluations of labour productivity factors are influenced by individual experience, organizational context, and project conditions, leading to skewed or clustered response patterns rather than a symmetrical normal distribution.

Based on the results of the normality tests, the study concludes that parametric statistical methods are not appropriate for further analysis of the collected data. Consequently, non-parametric and index-based analytical techniques, such as the Relative Importance Index (RII), were adopted to analyze and rank the labour productivity factors. This methodological choice ensures the validity and robustness of the subsequent analysis and supports reliable interpretation of the results.

4.6 Analysis of Relative Importance Index - RII Results

The Relative Importance Index (RII) analysis was conducted to prioritize the labour productivity factors identified in this study based on their perceived significance in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. Since the normality tests confirmed that the data were non-normally distributed, the RII method was considered an appropriate and reliable technique for analyzing and ranking the factors. The RII method converts respondents' Likert-scale ratings into a standardized index value ranging between 0 and 1, where higher values indicate greater importance of a factor in influencing labour productivity. This method is widely used in construction management research due to its simplicity, robustness, and suitability for perception-based survey data.

In this study, the RII was calculated for each labour productivity factor using the formula from Section 3.6.3 Relative Importance Index (RII):

$$RII = \frac{\sum W}{A \times N} \quad (4.3)$$

where W represents the weight assigned to each factor by respondents (ranging from 1 to 5), A is the highest possible weight (5), and N is the total number of respondents. The

resulting RII values were then used to rank the factors in descending order of importance. The RII results reveal clear differences in the relative importance of labour productivity factors. Factors with higher RII values represent critical issues that significantly affect labour productivity and require immediate attention from construction stakeholders. Conversely, factors with lower RII values, while still relevant, have comparatively less impact on productivity and may be addressed with lower priority.

The ranked results provide valuable insights into the most influential labour productivity challenges in high-rise construction projects within the Twin Cities. These findings reflect respondents' practical experiences and perceptions and highlight key areas related to workforce management, site conditions, planning, coordination, and resource availability.

Overall, the RII analysis serves as a crucial step in identifying and prioritizing critical labour productivity factors. The results obtained from this analysis form the foundation for developing the proposed labour productivity improvement framework. By focusing on high-ranked factors, the framework aims to offer targeted and effective strategies for enhancing labour productivity in high-rise construction projects in Rawalpindi and Islamabad.

4.6.1 Factors Main Groups with Average RII

Factors Main Groups with average RII shows that, at the group level, Motivational Factors have the highest average RII (0.784) and are ranked 1st, indicating that payment/motivation -related issues are the most influential overall on labor productivity in Twin Cities high-rise projects. This is followed by Leadership Factors (0.779; Rank 2) and Manpower/Human Factors (0.766; Rank 3), highlighting that supervision/communication routines and skilled workforce availability are also critical drivers as shown in Table 4.10. The remaining groups Inappropriate Supervision, Material & Tools, Project Management, Safety/Weather, and Time have comparatively lower average RII values, suggesting they remain important but should be addressed after the top three priority groups in the improvement framework.

4.6.2 Labor Motivational Factor Prioritization by RII

The Relative Importance Index (RII) analysis was used to prioritize labour motivational factors affecting labour productivity in high-rise construction projects in Rawalpindi

TABLE 4.10: Factors Main Groups with average RII

Factors Main Groups	Coding	Average RII	Rank
Labor Motivational Factors	LM	0.784	1
Leadership Factors	LF	0.779	2
Human Factors (Manpower)	MF	0.766	3
Factor Related to inappropriate Supervision	ISF	0.750	4
Material/Tools Related Factors	M&TF	0.740	5
Project Management related Factors	PMF	0.730	6
Safety/Weather Factors	S&WF	0.712	7
Time Factors	TF	0.711	8

and Islamabad. Table 4.11 presents the ranking of these factors based on respondents' perceptions, including their coding, RII values, overall ranks, and group ranks.

The results indicate that delays in salary (LM-1) is the most critical motivational factor, with the highest RII value of 0.859, ranking 2nd overall and 1st within the labour motivation group. This finding highlights the strong dependence of labour productivity on timely wage payments, as salary delays directly reduce worker morale, commitment, and efficiency. The second most significant factor is lack of team spirit (LM-6), with an RII value of 0.808, ranking 5th overall and 2nd within the group, emphasizing the importance of teamwork and coordination in high-rise construction activities. The lack of incentive scheme (LM-3) ranked 3rd within the group, with an RII value of 0.798 and an overall rank of 8, indicating that the absence of reward mechanisms limits workers' motivation to improve performance. Similarly, lack of training sessions (LM-4), with an RII value of 0.775, ranked 4th within the group and 11th overall, demonstrating the role of skill development and continuous learning in enhancing labour motivation and productivity.

TABLE 4.11: Ranking of factors related to Labor Motivational as per RII Values

Factors Related to Labor Motivational	Coding	W	A*N	RII	Overall Rank	Group Rank
Delays in salary	LM-1	408	475	0.859	2	1
Lack of team spirit	LM-6	384	475	0.808	5	2
Lack of incentive scheme	LM-3	379	475	0.798	8	3
Lack of training sessions	LM-4	368	475	0.775	11	4
Poor Wages of workers	LM-2	353	475	0.743	17	5
Lack of place for eating and relaxation	LM-5	342	475	0.720	25	6

The factors poor wages of workers (LM-2) and lack of place for eating and relaxation (LM-5) received comparatively lower RII values of 0.743 and 0.720, ranking 17th and 25th overall, respectively. Although less critical than the top-ranked factors, these issues still influence workers' satisfaction and sustained performance on construction sites. Overall, the results show that financial stability, teamwork, incentive mechanisms, and training opportunities are the most influential labour motivational factors affecting productivity. Addressing these issues should be a priority for construction stakeholders and forms a key component of the proposed labour productivity improvement framework.

4.6.3 Factors Related to Inappropriate Supervision, Prioritized by RII

The Relative Importance Index (RII) analysis was applied to prioritize factors related to inappropriate supervision affecting labour productivity in high-rise construction projects in Rawalpindi and Islamabad. The ranked results presented in Table 4.12 highlight the supervisory issues that most significantly influence labour performance.

The findings show that clear and daily task assignments (ISF-4) is the most critical supervisory factor, with the highest RII value of 0.815, ranking 4th overall and 1st within the supervision group. This indicates that effective communication and clear direction from supervisors are essential for maintaining productivity, especially in high-rise projects where work sequencing and coordination are critical. Lack of clear task allocation often leads to confusion, idle labour, and inefficiencies on site. The second most significant factor is rework (ISF-3), which achieved an RII value of 0.760, ranking 15th overall and 2nd within the group. This reflects the consequences of weak supervision on work quality, as insufficient monitoring and guidance frequently result in errors that require rework, thereby increasing time and labour costs.

Change in drawings and specifications during execution (ISF-1) ranked 3rd within the group, with an RII value of 0.743 and an overall rank of 17, highlighting the disruptive effect of design changes when not properly managed by site supervision. Similarly, delays in inspections (ISF-2), with an RII value of 0.720 and an overall rank of 25, indicate that slow approval processes interrupt work flow and reduce labour efficiency. The factor reallocation of laborers (ISF-5) recorded the lowest RII value of 0.714, ranking 28th overall and 5th within the group. Although less influential than other supervisory factors, frequent labour reassignment still negatively affects productivity by disrupting

TABLE 4.12: Ranking of factors related to Inappropriate Supervision as per RII Values

Factors Related to Inappropriate Supervision	Coding	W	A*N	RII	Overall Rank	Group Rank
Clear and daily task assignments	ISF-4	387	475	0.815	4	1
Rework	ISF-3	361	475	0.760	15	2
Change in drawings and specifications during execution	ISF-1	353	475	0.743	17	3
Delays in inspections	ISF-2	342	475	0.720	25	4
Reallocation of laborers	ISF-5	339	475	0.714	28	5

work continuity and team coordination. Overall, the results demonstrate that effective supervision particularly clear task communication, quality control, and timely coordination plays a crucial role in improving labour productivity. Addressing skill shortages through training programs, improving labor relations, and reducing absenteeism should therefore be prioritized in the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities.

4.6.4 Factors Related to Safety and Weather, Prioritized by RII

This section presents the prioritization of safety and weather-related factors affecting labour productivity in high-rise construction projects in Rawalpindi and Islamabad using the Relative Importance Index (RII) method. Table 4.13 summarizes these factors along with their coding, RII values, overall ranks, and group ranks.

The results indicate that weather conditions (S&WF-3) is the most influential factor within this category, with the highest RII value of 0.733, ranking 19th overall and 1st within the safety and weather group. This finding reflects the significant impact of adverse weather conditions, such as extreme temperatures and rainfall, on labour efficiency and work continuity in high-rise construction projects. Weather-related disruptions often lead to work stoppages, reduced productivity, and safety concerns, particularly in outdoor and elevated construction activities. The second most significant factor is working at height (S&WF-1), which recorded an RII value of 0.724, ranking 24th overall and 2nd within the group. This highlights the productivity challenges associated with high-rise construction, where working at elevated levels requires additional safety measures,

cautious movement, and specialized equipment. These requirements, while essential for safety, often slow down work progress and reduce labour output.

TABLE 4.13: Ranking of factors related to Safety and Weather as per RII Values

Factors Related to Safety and Weather	Coding	W	A*N	RII	Overall Rank	Group Rank
Weather conditions	S&WF-3	348	475	0.733	19	1
Working at height	S&WF-1	344	475	0.724	24	2
Insufficient lighting at site	S&WF-2	322	475	0.678	38	3

The factor insufficient lighting at site (S&WF-2) ranked 3rd within the group, with an RII value of 0.678 and an overall rank of 38. Although comparatively less critical than other safety and weather-related factors, inadequate lighting still affects visibility, work accuracy, and worker safety, particularly during early morning, evening, or night-time operations. Overall, the RII results demonstrate that environmental and safety conditions play a noticeable role in influencing labour productivity, although their impact is comparatively lower than motivational and supervisory factors. These findings emphasize the importance of effective weather planning, enhanced safety measures for working at height, and adequate site lighting as part of the proposed labour productivity improvement framework for high-rise construction projects in the Twin Cities.

4.6.5 Factors Related to Material and Tools, Prioritized by RII

This section presents the prioritization of material and tools-related factors affecting labor productivity in high-rise construction projects in Rawalpindi and Islamabad using the Relative Importance Index (RII) method. Table 4.14 summarizes these factors along with their coding, RII values, overall ranks, and group ranks.

The results show that procurement delays (M&TF-6) is the most critical factor within this category, with the highest RII value of 0.844, ranking 3rd overall and 1st within the material and tools group. This highlights that delays in material procurement significantly disrupt construction schedules, cause work stoppages, and lead to underutilization of labor resources, thereby reducing overall productivity in high-rise projects. The second most significant factor is unsuitable material storage at the site (M&TF-2), which

achieved an RII value of 0.806, ranking 6th overall and 2nd within the group. Poor storage practices often result in material damage, handling delays, and inefficient workflow, all of which negatively affect labor performance.

Shortage of tools and equipment (M&TF-3) ranked 3rd within the group, with an RII value of 0.731 and an overall rank of 20, indicating that insufficient availability of tools causes idle time and reduces worker's efficiency. Similarly, inefficiency of equipment (M&TF-5) recorded an RII value of 0.726, ranking 22nd overall and 4th within the group, emphasizing that poorly maintained or underperforming equipment slows down construction activities.

TABLE 4.14: Ranking of factors related to Material and Tools as per RII Values

Factors Related to Material/Tools	Coding	W	A*N	RII	Overall Rank	Group Rank
Procurement delays	M&TF-6	401	475	0.844	3	1
Unsuitable material storage at the site	M&TF-2	383	475	0.806	6	2
Shortage of tools and equipment	M&TF-3	347	475	0.731	20	3
Inefficiency of equipment	M&TF-5	345	475	0.726	22	4
Low Quality of raw materials	M&TF-7	341	475	0.718	27	5
Obsolete tools and equipment	M&TF-4	333	475	0.701	34	6
Shortage of materials	M&TF-1	309	475	0.651	39	7

The factors of low quality of raw materials (M&TF-7) and obsolete tools and equipment (M&TF- 4) obtained RII values of 0.718 and 0.701, ranking 27th and 34th overall, respectively. Although less critical than the top-ranked factors, these issues still contribute to productivity loss by increasing rework and reducing work efficiency. The least influential factor within this group is shortage of materials (M&TF-1), with an RII value of 0.651, ranking 39th overall and 7th within the group. Overall, the findings indicate that effective procurement planning, proper material storage, and availability of efficient tools and equipment are crucial for enhancing labor productivity. Addressing material and tools related issues should therefore be a key component of the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities.

4.6.6 Factors Related to Time, Prioritized by RII

This section presents the prioritization of time-related factors affecting labor productivity in high-rise construction projects in Rawalpindi and Islamabad using the Relative Importance Index (RII) method. The ranking of these factors, along with their coding, RII values, overall ranks, and group ranks, is summarized in Table 4.15. The results indicate that continuous work without break (TF-1) is the most critical time-related factor, with an RII value of 0.731, ranking 20th overall and 1st within the time factor group. This finding suggests that prolonged working hours without adequate rest negatively affect workers' physical endurance, concentration, and efficiency, leading to reduced productivity on high-rise construction sites. The second most significant factor is working overtime (TF-2), which recorded an RII value of 0.726, ranking 22nd overall and 2nd within the group. While overtime is often used to accelerate project progress, excessive overtime can lead to worker fatigue, increased errors, and safety risks, ultimately reducing labor productivity. Crew size (TF-4) ranked 3rd within the group, with

TABLE 4.15: Ranking of factors related to Time as per RII Values

Factors Related to Time	Coding	W	A*N	RII	Overall Rank	Group Rank
Continuous work without break	TF-1	347	475	0.731	20	1
Working overtime	TF-2	345	475	0.726	22	2
Crew size	TF-4	336	475	0.707	31	3
Project size	TF-3	323	475	0.680	37	4

an RII value of 0.707 and an overall rank of 31. This indicates that inappropriate crew sizing either too large or too small affects work coordination, task distribution, and efficiency, thereby influencing labor output. The factor project size (TF-3) was ranked 4th within the time-related group, with the lowest RII value of 0.680 and an overall rank of 37. Although project size has a comparatively lower impact, larger and more complex projects often require additional coordination and time management efforts, which can indirectly influence labor productivity. Overall, the findings demonstrate that work duration management, adequate rest periods, controlled overtime, and appropriate crew sizing are important time-related considerations for improving labor productivity. These results highlight the need for effective time management strategies to be incorporated into the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities

4.6.7 Factors Related to Manpower, Prioritized by RII

This section presents the prioritization of manpower-related factors affecting labor productivity in high-rise construction projects in Rawalpindi and Islamabad using the Relative Importance Index (RII) method. The ranking of these factors, including their coding, RII values, overall ranks, and group ranks, is summarized in Table 4.16. The results indicate that lack of skilled manpower (MF-3) is the most critical manpower-related factor, with the highest RII value of 0.874, ranking 1st overall among all labor productivity factors and 1st within the manpower group. This finding highlights the severe shortage of skilled workers in the local construction industry, particularly for high-rise projects that require specialized skills, technical knowledge, and adherence to safety standards. The absence of skilled labor significantly reduces work quality, efficiency, and productivity.

The second most influential factor is labor strikes (MF-4), which recorded an RII value of 0.779, ranking 10th overall and 2nd within the group. Labor strikes disrupt project schedules, cause work stoppages, and create uncertainty on construction sites, thereby adversely affecting productivity and project continuity. Unskilled workforce (MF-1) ranked 3rd within the manpower group, with an RII value of 0.766 and an overall rank of 13. This indicates that reliance on untrained or inexperienced workers leads to inefficiencies, increased rework, and slower task execution, all of which negatively impact labor productivity.

TABLE 4.16: Ranking of factors related to Manpower as per RII Values

Factors Related to Manpower	Coding	W	A*N	RII	Overall Rank	Group Rank
Lack of skilled manpower	MF-3	415	475	0.874	1	1
Labor strikes	MF-4	370	475	0.779	10	2
Unskilled workforce	MF-1	364	475	0.766	13	3
Labor disloyalty	MF-5	337	475	0.709	30	4
Labor absenteeism	MF-2	333	475	0.701	34	5

The factor labor disloyalty (MF-5) achieved an RII value of 0.709, ranking 30th overall and 4th within the group, suggesting that lack of worker commitment ensures inconsistent performance and reduced motivation. Similarly, labor absenteeism (MF-2) was

ranked 5th within the group, with the lowest RII value of 0.701 and an overall rank of 34, indicating that frequent worker absence, although comparatively less critical, still affects workflow continuity and labor output. Overall, the results demonstrate that workforce skill availability and stability are among the most influential determinants of labor productivity. Addressing skill shortages through training programs, improving labor relations, and reducing absenteeism should therefore be prioritized in the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities.

4.6.8 Factors Related to Project Management, Prioritized by RII

The Relative Importance Index (RII) analysis was used to rank project management related factors affecting labor productivity in high-rise construction projects in Rawalpindi and Islamabad, as presented in Table 4.17. The results show that lack of coordination between stakeholders (PMF-4) is the most influential factor, with an RII value of 0.785, ranking 9th overall and 1st within the group. This highlights the critical role of effective coordination among clients, consultants, contractors, and site teams in maintaining productivity.

The second most significant factor is labor shortage (PMF-3), with an RII value of 0.766, ranking 13th overall and 2nd within the group, indicating that insufficient workforce availability disrupts work continuity and reduces efficiency. Working in a confined space (PMF-1) ranked 3rd within the group, with an RII value of 0.728 and an overall rank of 22, reflecting productivity constraints due to limited working space in high-rise projects. Similarly, performing work at night (PMF-6) recorded an RII value of 0.714, ranking 29th overall, showing the adverse effects of fatigue and safety concerns on labor output. The factors site restricted access/topography (PMF-5) and political interference (PMF-2) obtained lower RII values of 0.703 and 0.695, ranking 33rd and 36th overall, respectively. Although comparatively less critical, these factors still influence project execution and productivity. Overall, the results emphasize that strong coordination and effective workforce planning are essential for improving labor productivity in high-rise construction projects.

TABLE 4.17: Ranking of factors related to Project Management as per RII Values

Factor Related to Project Management	Coding	W	A*N	RII	Overall Rank	Group Rank
Lack of coordination between stakeholders	PMF-4	373	475	0.785	9	1
Labor shortage	PMF-3	364	475	0.766	13	2
Working in a confined space	PMF-1	346	475	0.728	22	3
Performing work at night	PMF-6	339	475	0.714	29	4
Site restricted access/-topography	PMF-5	334	475	0.703	33	5
Political interference	PMF-2	330	475	0.695	36	6

4.6.9 Factors Related to Leadership, Prioritized by RII

This section presents the prioritization of leadership related factors affecting labor productivity in high-rise construction projects in Rawalpindi and Islamabad using the Relative Importance Index (RII) method, as summarized in Table 4.18. The results indicate that lack of periodic meetings (LF- 2) is the most influential leadership factor, with an RII value of 0.804, ranking 7th overall and 1st within the leadership group. This finding highlights the importance of regular meetings in aligning teams, resolving issues promptly, and ensuring smooth coordination between site staff and management. The second most significant factor is lack of communication between labor and supervisors (LF-3), which recorded an RII value of 0.773, ranking 12th overall and 2nd within the group. Ineffective communication leads to misunderstandings, improper task execution, and delays, all of which negatively affect labor productivity.

Lack of labor surveillance (LF-1) ranked 3rd within the leadership group, with an RII value of 0.760 and an overall rank of 15. Insufficient monitoring reduces accountability and work discipline, resulting in lower efficiency and productivity on construction sites. Overall, the findings emphasize that effective leadership through regular meetings, clear communication, and active supervision is essential for improving labor productivity. Strengthening leadership practices should therefore be an integral part of the proposed labor productivity improvement framework for high-rise construction projects in the Twin Cities.

TABLE 4.18: Ranking of factors related to Leadership as per RII Values

Leadership Factors Related to CLP	Coding	Total	A*N	RII	Overall Rank	Group Rank
Lack of periodic meetings	LF-2	382	475	0.804	7	1
Lack of Communication between labor and supervisors	LF-3	367	475	0.773	12	2
Lack of labor surveillance	LF-1	361	475	0.760	15	3

4.7 Overall Ranking Based on Relative Importance Index

The table summarizes the Relative Importance Index (RII) ranking of factors affecting construction labor productivity in high-rise projects, where higher RII indicates greater perceived impact. The top constraints are lack of skilled manpower (MF-3, RII = 0.874, Rank 1), delays in salary (LM-1, 0.859, Rank 2), and procurement delays (M&TF-6, 0.844, Rank 3), followed by clear/daily task assignments (ISF-4, 0.815, Rank 4) and lack of team spirit (LM-6, 0.808, Rank 5) as shown in Table 4.19. These results show productivity is mainly driven by workforce capability, timely wage payments, supply-chain reliability, and effective daily site supervision/planning.

TABLE 4.19: Overall Ranking Based on Relative Importance Index

Factors Related to Construction Labor Productivity	Coding	Total	A*N	RII	Overall Rank
Lack of skilled manpower	MF-3	415	475	0.874	1
Delays in salary	LM-1	408	475	0.859	2
Procurement delays	M&TF-6	401	475	0.844	3
Clear and daily task assignments	ISF-4	387	475	0.815	4

TABLE 4.19: Continued from previous page

Factors Related to Construction Labor Productivity	Coding	Total	A*N	RII	Overall Rank
Lack of team spirit	LM-6	384	475	0.808	5
Unsuitable material storage at the site	M&TF-2	383	475	0.806	6
Lack of periodic meetings	LF-2	382	475	0.804	7
Lack of incentive scheme	LM-3	379	475	0.798	8
Lack of coordination between stakeholders	PMF-4	373	475	0.785	9
Labor strikes	MF-4	370	475	0.779	10
Lack of training sessions	LM-4	368	475	0.775	11
Lack of Communication between labor and supervisors	LF-3	367	475	0.773	12
Unskilled workforce	MF-1	364	475	0.766	13
Labor shortage	PMF-3	364	475	0.766	13
Rework	ISF-3	361	475	0.760	15
Lack of labor surveillance	LF-1	361	475	0.760	15
Poor Wages of workers	LM-2	353	475	0.743	17
Change in drawings and specifications during execution	ISF-1	353	475	0.743	17
Weather conditions	S&WF-3	348	475	0.733	19
Shortage of tools and equipment	M&TF-3	347	475	0.731	20

TABLE 4.19: Continued from previous page

Factors Related to Construction Labor Productivity	Coding	Total	A*N	RII	Overall Rank
Continuous work without break	TF-1	347	475	0.731	20
Working in a confined space	PMF-1	346	475	0.728	22
Inefficiency of equipment	M&TF-5	345	475	0.726	23
Working overtime	TF-2	345	475	0.726	23
Working at height	S&WF-1	344	475	0.724	25
Lack of place for eating and relaxation	LM-5	342	475	0.720	26
Delays in inspections	ISF-2	342	475	0.720	26
Low Quality of raw materials	M&TF-7	341	475	0.718	28
Reallocation of laborers	ISF-5	339	475	0.714	29
Performing work at night	PMF-6	339	475	0.714	29
Labor disloyalty	MF-5	337	475	0.709	31
Crew size	TF-4	336	475	0.707	32
Site restricted access/topography	PMF-5	334	475	0.703	33
Obsolete tools and equipment	M&TF-4	333	475	0.701	34
Labor absenteeism	MF-2	333	475	0.701	34
Political interference	PMF-2	330	475	0.695	36
Project size	TF-3	323	475	0.680	37
Insufficient lighting at site	S&WF-2	322	475	0.678	38

TABLE 4.19: Continued from previous page

Factors Related to Construction Labor Productivity	Coding	Total	A*N	RII	Overall Rank
Shortage of materials	M&TF-1	309	475	0.651	39

4.8 Discussion

The SPSS-based results provide an evidence driven basis to explain why labor productivity in high-rise projects of Rawalpindi and Islamabad is constrained more by “people process supply” linkages than by any single isolated issue. Since the dataset was found non-normally distributed (Sig. = 0.000 for all variables in both Kolmogorov–Smirnov and Shapiro–Wilk tests), the study appropriately emphasizes index/ranking-based interpretation (RII) rather than parametric inference. The questionnaire also demonstrates excellent internal consistency (Cronbach’s Alpha = 0.968 for 39 items), strengthening confidence that the ranked factors reflect a coherent measurement of productivity constraints in the local high-rise context.

The most critical finding is that “Lack of skilled manpower” (MF-3) ranks 1st overall with RII = 0.874, indicating that skill scarcity is perceived as the strongest productivity limiter in Twin Cities high-rise construction. This aligns with the practical reality of high-rise execution where specialized trade competence (e.g., formwork, rebar fixing, finishing, MEP installation) directly determines output rate, quality, and rework frequency, which in turn affects schedule adherence and labor efficiency [1, 13, 39]. In the same group, “Labor strikes” (MF-4, RII = 0.779, overall rank 10) and “Unskilled workforce” (MF-1, RII = 0.766, overall rank 13) reinforce that productivity losses are also driven by workforce instability and uneven competency on site.

Within labor motivation, “Delays in salary” (LM 1) ranks 2nd overall with RII = 0.859. Further, the ‘payment delay by owner to contractor is identified as the 2nd largest factor affecting labor productivity [58]. High rankings for “Lack of team spirit” (LM 6, RII = 0.808, overall rank 5) and “Lack of incentive scheme” (LM 3, RII = 0.798, overall rank 8)

indicate that beyond basic pay, productivity in high-rise projects is strongly influenced by group cohesion and performance reinforcement mechanisms. “Lack of training sessions” (LM 4, RII = 0.775, overall rank 11) further links motivation with capability development, suggesting that workers’ perceived growth and learning opportunities are part of the productivity equation in the Twin Cities environment. The relationship between management and workers, along with job security and incentive mechanisms such as premiums and bonuses, constitutes key drivers for motivating the labor workforce [?,67]. From the supervision-related factors, “Clear and daily task assignments” (ISF 4) ranks 4th overall with RII = 0.815, highlighting that day-to-day work packaging, clarity of targets, and sequencing discipline are essential to maintain labor flow in vertical construction. Leadership-related rankings also show that management routines matter: “Lack of periodic meetings” (LF 2, RII = 0.804, overall rank 7) and “Lack of communication between labor and supervisors” (LF 3, RII = 0.773, overall rank 12) demonstrate that weak coordination forums and communication channels translate into idle time, misinterpretation, and avoidable rework.

The project management result “Lack of coordination between stakeholders” (PMF 4, RII = 0.785, overall rank 9) confirms that interface management among client–consultant–contractor–subcontractors is a decisive productivity driver in high-rise delivery. The study identified several key problems commonly encountered on building projects, including lack of clear site instructions, Lack of coordination between stakeholders, inadequate site safety planning , rework due to errors, poor planning, and negative workforce attitudes on site [?, 41].

In the material/tools domain, “Procurement delays” (M&TF 6) ranks 3rd overall with RII = 0.844, showing that even when labor is available, productivity collapses if the supply chain fails to feed the workforce on time [49]. “Unsuitable material storage at the site” (M&TF 2, RII = 0.806, overall rank 6) indicates that productivity is also lost inside the project boundary through poor logistics, double handling, material damage, and time wasted in locating/issuing materials. While safety/weather and time factors have comparatively lower overall ranks, the results still point to important enabling controls e.g., “Weather conditions” (S&WF 3, RII = 0.733) and “Continuous work without break” (TF 1, RII = 0.731) which imply that fatigue management and environmental planning should support (not replace) the higher-ranked interventions in manpower, payment, procurement, and daily control.

In terms of aligning these findings with your thesis objective (a framework for improvement), the discussion implies that the framework should prioritize: (i) skilled labor development and retention (top overall constraint), (ii) wage-payment reliability and structured incentives (strong motivation signals), (iii) procurement planning and site logistics (workface readiness), and (iv) daily planning/communication routines supported by regular coordination meetings and stakeholder alignment (leadership + project management interface). These priorities are consistent with your results narrative that high-rise productivity losses in the Twin Cities arise from the combined effect of workforce capability, cashflow/payment practices, supply-chain performance, and frontline supervisory planning.

4.9 Framework Development for Enhancing Labor Productivity

Results & Analysis (RII-based) indicate that a “Framework Development for Enhancing Labor Productivity” for high-rise projects in Rawalpindi–Islamabad should prioritize interventions around manpower capacity, timely payments, procurement planning, and day-to-day site control, because these factors achieved the highest Relative Importance Index (RII) and overall ranks in your SPSS outputs.

The framework is evidence-driven, developed from twelve industry expert responses and directly linked to the top-ranked factors identified through RII analysis. It translates these critical factors into structured, actionable strategies for enhancing labor productivity. The overall top-ranked constraints are: lack of skilled manpower (MF-3, RII = 0.874, Rank 1), delays in salary (LM-1, RII = 0.859, Rank 2), procurement delays (M&TF-6, RII = 0.844, Rank 3), unclear/daily task assignments (ISF-4, RII = 0.815, Rank 4), and lack of team spirit (LM-6, RII = 0.808, Rank 5). These results show that productivity losses are driven less by a single category and more by a combined effect of workforce capability, cashflow/payment practices, supply-chain performance, and frontline supervisory planning.

A practical framework for improvement can be structured into eight implementation pillars aligned with the factor groups used in your analysis, with actions weighted by the highest RII items in each group as shown in Figure 4.6.

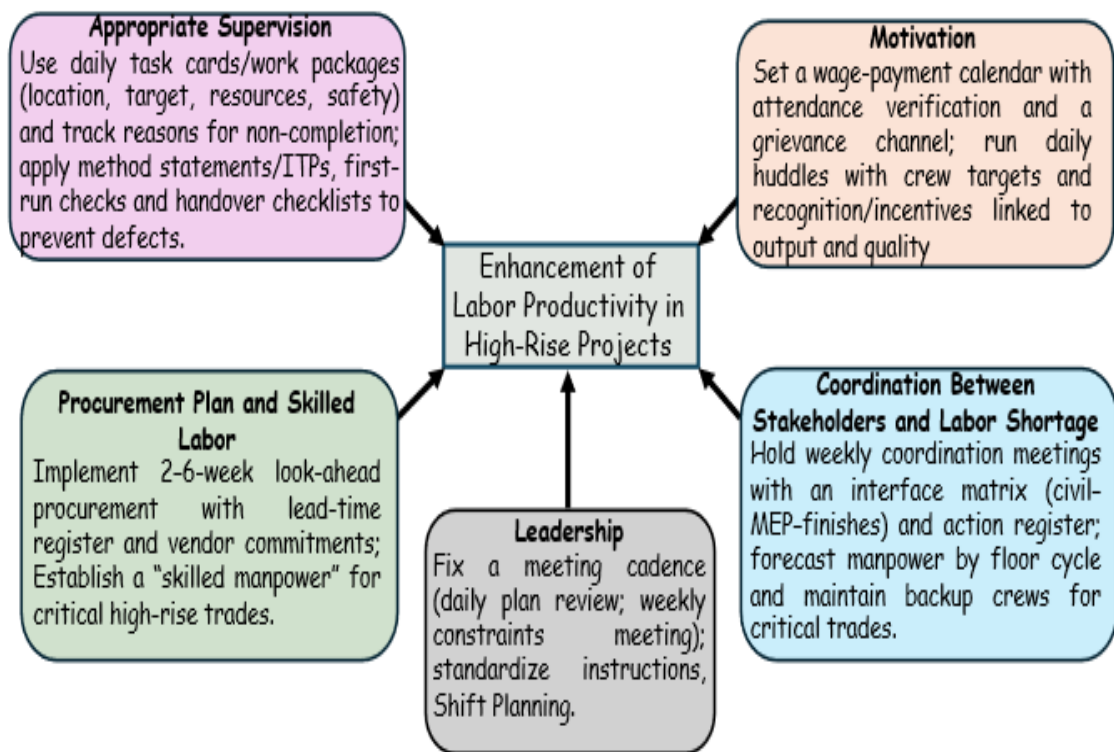


FIGURE 4.6: Framework for Labor Productivity in High-Rise projects

4.9.1 Strategies for Contractors and Site Teams - Execution-focused

- i. Establish a "skilled manpower plan" for critical high-rise trades (formwork, rebar, concreting, finishing, and MEP interfaces) to directly address the top-ranked constraint of lack of skilled manpower.
- ii. Implement trade testing at mobilization and a site skill-matrix for crew allocation to reduce inefficiencies associated with unskilled labor and to stabilize work quality and outputs.
- iii. Introduce a daily work planning routine with clear output targets, crew-wise task allocation, and constraints checks to address unclear/daily task assignments as a top-ranked factor.
- iv. Strengthen quality control at activity handoffs and supervision checklists to reduce rework impacts identified within the supervision-related factors.
- v. Create a procurement look-ahead (2–6 weeks) linked to the construction program and site demand, because procurement delays were ranked among the most critical constraints.

4.9.2 Strategies for Project Management - Coordination and Governance

- i. Enforce structured coordination between stakeholders (client – consultant – contractor – subcontractors) because lack of coordination between stakeholders was a high-priority factor in the RII ranking.
- ii. Institutionalize periodic meetings and action tracking, since lack of periodic meetings and weak leadership communication practices were emphasized in the leadership prioritization.
- iii. Use weekly coordination meetings for upcoming inspections, approvals, and work interfaces to reduce workflow interruptions linked to inspection delays and design/specification changes.

4.9.3 Strategies for Clients and Owners - Payment and Project Environment

- i. Ensure timely certification and payment flow to reduce wage delays at the labor level, because delays in salary were ranked as the most critical motivational factor and 2nd overall.
- ii. Require contractors to submit a wage-payment plan and monitor compliance as part of project governance, as payment reliability is directly linked to labor motivation factors highlighted in the findings.

4.9.4 Strategies for Consultants - Inspections and Information Flow

- i. Provide predictable inspection schedules and timely feedback cycles to minimize stoppages and uncertainty at the workplace, consistent with the supervision-related findings.
- ii. Improve clarity of instructions and maintain controlled issuance of drawings/specifications during execution to reduce disruption caused by changes and miscommunication.

4.9.5 Strategies for Industry and Policy Stakeholders - Capacity Building

- i. Encourage structured training pathways and short-site upskilling programs (especially for high-rise trades) because skill shortage was the most dominant constraint in the overall RII ranking.
- ii. Promote standardized site productivity practices (daily planning, coordination cadence, and procurement look-ahead) as common requirements in high-rise projects to address the recurring top-ranked constraints identified by the respondents.

4.10 Framework Summary

For Manpower, the framework should focus on skill availability and retention because “lack of skilled manpower” is the top overall factor (MF-3, RII = 0.874) and “unskilled workforce” also scores high (MF-1, RII = 0.766). This pillar can include: competency-based hiring, trade testing before mobilization, targeted upskilling for key high-rise trades, and maintaining a skill-matrix to ensure the right crew composition at critical activities (e.g., formwork, rebar, MEP rough-ins).

For Labor motivation, the framework should directly address payment reliability and incentive mechanisms because “delays in salary” (LM-1, RII = 0.859) and “lack of incentive scheme” (LM-3, RII = 0.798) are among the top overall constraints, and “lack of team spirit” (LM-6, RII = 0.808) ranks very high. Recommended actions include a wage-payment control plan (fixed pay dates, verification workflow, and grievance channel), plus a transparent productivity-linked incentive tied to measurable outputs and quality compliance. Team cohesion can be supported through short daily huddles and recognition practices aligned with output and safety behavior, addressing the team-spirit issue highlighted in the rankings.

For Material & tools, the framework should prioritize supply-chain planning since “procurement delays” is ranked 3rd overall (M&TF-6, RII = 0.844), and tools/equipment shortages and inefficiencies are also notable (M&TF-3 RII = 0.731; M&TF-5 RII = 0.726). A procurement pillar can include a look-ahead material schedule (2–6 weeks), minimum stock levels for fast-moving items, vendor lead-time tracking, and coordination between planning, store, and site execution teams to avoid idle labor due to missing

inputs. For Inappropriate supervision / site control, your results emphasize the importance of daily clarity because “clear and daily task assignments” (ISF-4, RII = 0.815) is ranked 4th overall, and “rework” is also significant (ISF-3, RII = 0.760). This pillar should include daily work planning (work packages, targets per crew, required resources), method statements/ITPs alignment, and supervision checklists that reduce rework and waiting time. It also links strongly with the Project management pillar, where “lack of coordination between stakeholders” (PMF-4, RII = 0.785) is ranked 9th overall, suggesting that interface management (client–consultant–contractor– subcontractor) is essential in high-rise environments.

For Leadership, the framework should institutionalize coordination routines because “lack of periodic meetings” (LF-2, RII = 0.804) is highly ranked overall and is the top within the leadership group. These supports implementing structured meeting cadence (daily toolbox/daily plan review; weekly coordination meeting), action registers, and communication protocols between labor, foremen, and engineers to strengthen alignment on targets and constraints. Finally, Time constraints and Safety/weather pillars can be treated as enabling controls: “continuous work without break” (TF-1, RII = 0.731) and “weather conditions” (S&WF-3, RII = 0.733) indicate the need for fatigue management, shift planning, and weather-contingency scheduling to sustain productivity without increasing incidents or rework.

4.11 Theoretical and Managerial Implications

This study contributes to the existing body of knowledge on construction labor productivity by demonstrating that productivity loss in high-rise projects emerges from an interacting system of human, leadership, and operations constraints rather than a single “resource” problem. The results empirically support a multi-pillar conceptual model in which workforce capability, payment/motivation stability, supply-chain reliability, and frontline planning/supervision jointly shape workforce readiness and workflow reliability key theoretical mechanisms that link management inputs to labor output. Group ranking results (e.g., Motivational and Leadership groups being highest on average) indicate that “soft” constructs such as fairness of payment, communication routines, and leadership discipline have explanatory strength comparable to (or greater than) traditional “hard” constructs like time pressure or weather, at least in the Twin Cities context. Methodologically, your study also strengthens the argument that RII is a suitable theory-building

and prioritization approach for perception-based construction datasets when normality assumptions are violated, as your normality testing justified non-parametric/index-based interpretation. Finally, your reliability result (Cronbach's Alpha = 0.968 for 39 items) provides theoretical assurance that the factor set is internally consistent for representing the broader construct of "labor productivity environment" in local high-rise projects.

The findings of this study offer the framework into management routines, governance controls, and KPIs that practitioners can adopt to improve productivity on site. Based on this ranked constraints, managerial focus should shift toward protecting workforce stability (retain skilled crews and reduce turnover), ensuring wage timeliness (to prevent morale/attendance decline), and improving workface readiness (materials/tools/-drawings/access before mobilizing labor) so labor time converts into output rather than waiting. For high-rise operations, you can recommend a standard production-control cycle: daily huddles and task cards (ISF/LF), weekly look-ahead planning and constraint log closure (PMF), and procurement tracking tied to the schedule (M&TF), each with clear ownership (project manager, planning engineer, procurement, foremen). You should also propose measurable KPIs aligned with your framework (e.g., wage timeliness %, PPC/plan reliability, rework hours, procurement lead-time compliance, skilled-to-unskilled ratio by trade), and explain that management's role is to institutionalize these controls so productivity improvement is repeatable across floors and projects.

4.12 Summary

This Chapter 4 presented the results and analysis of the questionnaire survey (N = 95) conducted to identify and prioritize factors affecting labor productivity in high-rise construction projects in the Twin Cities (Rawalpindi and Islamabad). Descriptive statistics showed that respondents generally agreed that multiple constraints influence productivity, with leadership, manpower, motivation, procurement, and day-to-day planning issues emerging strongly across the measured items. The internal consistency of the questionnaire instrument was assessed using reliability analysis in SPSS. The results indicate a Cronbach's Alpha of 0.968 for 39 items, confirming that the scale demonstrates very strong reliability for subsequent analysis and interpretation. Descriptive statistics indicated that respondents generally perceived multiple constraints as influential, with leadership- and management-related items showing comparatively higher central tendencies and moderate dispersion, reflecting consistent agreement across the sample.

To ensure appropriate analytical treatment, data normality was tested using Kolmogorov–Smirnov and Shapiro–Wilk tests. All variables reported Sig. = 0.000 (i.e., $p < 0.001$), indicating non-normal distributions and supporting the use of ranking/importance-based interpretation. Finally, the Relative Importance Index (RII) method was applied to rank critical productivity constraints and to provide an evidence base for the proposed improvement framework. The highest-ranked factors were lack of skilled manpower (MF-3, RII = 0.874; Rank 1), delays in salary (LM-1, RII = 0.859; Rank 2), procurement delays (M&TF-6, RII = 0.844; Rank 3), and unclear/daily task assignments (ISF-4, RII = 0.815; Rank 4), indicating that workforce capability, wage/payment reliability, supply-chain performance, and frontline planning/supervision are the dominant productivity levers in Twin Cities high-rise projects.

Chapter 5

Conclusion and Recommendations

This chapter presents the conclusions and recommendations derived from the results reported in Chapter 4 for improving labor productivity in high-rise construction projects in the Twin Cities of Rawalpindi and Islamabad. It consolidates the key empirical findings from the questionnaire survey of construction professionals and translates them into practical actions for clients, consultants, contractors, and site management teams working in the local construction environment.

5.1 Conclusion

The study confirmed that labor productivity in Twin Cities high-rise projects is influenced by a combination of workforce capability, motivation/payment issues, materials and tools availability, supervision practices, project management coordination, time pressures, and leadership routines. The questionnaire instrument used to assess these factors demonstrated excellent internal consistency, with Cronbach's Alpha = 0.968 across 39 items, indicating that the measurement scale was reliable for further analysis and interpretation. From the main survey, 110 questionnaires were received and 95 were valid (86.36%), providing the final dataset used for statistical analysis.

The demographic analysis showed broad representation of key industry stakeholders (consultants 42.11%, clients 29.47%, contractors 28.42%) and coverage of both project locations (Islamabad 58.95% and Rawalpindi 41.05%), supporting th

credibility of the collected responses for the Twin Cities context. Educationally, most respondents were graduates (56.84%) or post-graduates (33.68%), indicating strong technical understanding among participants. In terms of experience, a large proportion of respondents had less than 5 years of experience (46.32%) while experienced professionals were also represented (e.g., 11–15 years: 14.74%; 21–25 years: 7.37%; >25 years: 1.05%), providing a combination of contemporary and experience-based perspectives.

Normality testing (Kolmogorov–Smirnov and Shapiro–Wilk) showed Sig. = 0.000 for all variables, indicating non-normal data distributions and supporting the use of non-parametric or index-based approaches for prioritization. Based on this, the Relative Importance Index (RII) method was applied to rank and prioritize the labor productivity factors for high-rise projects in the Twin Cities.

- i. Motivational Factors (LM) Average RII = 0.784: Shows that incentives, morale-related problems, and wage/payment reliability are the main drivers of productivity; therefore, financial stability and motivation systems should be given priority.
- ii. Leadership Factors (LF) Average RII = 0.779: Emphasizes the importance of communication, regular meetings, and active supervision/monitoring in bringing crews together and swiftly removing obstacles in high-rise projects.
- iii. Human Factors / Manpower (MF) Average RII = 0.766: Indicates output and work quality are directly impacted by skilled labor availability, workforce stability, and labor discipline, necessitating training and retention.
- iv. Inappropriate Supervision (ISF) Average RII = 0.750: Indicates that work continuity and efficiency on site are greatly impacted by daily task clarity, inspection flow, and rework control.
- v. Material/Tools Related Factors (M&TF) (average RII = 0.740) demonstrate how important logistics dependability and workface preparedness are to productivity. Procurement delays (M&TF-6), inappropriate on-site material storage (M&TF-2), and insufficient or ineffective tools and equipment

(M&TF-3, M&TF-5) show how supply and handling issues introduce waiting time and interfere with the intended workflow.

- vi. Project Management Related Factors (PMF) With an average RII = 0.730, indicating the importance of multi-party coordination in high-rise construction. Given the significance of the labor shortage (PMF-3) and the lack of coordination among stakeholders (PMF-4), interface failures (client–consultant–contractor–subcontractors) and inadequate resource planning lower sequencing efficiency and result in stoppages.
- vii. Safety/Weather Factors (S&WF) With an average RII = 0.712, indicating that safety and environmental factors serve as enabling constraints for high-rise construction. Due to the need for safety precautions, decreased visibility, and weather-related disruptions, weather conditions (S&WF-3), working at height (S&WF-1), and inadequate lighting (S&WF-2) can all slow production, particularly in outdoor and elevated activities.
- viii. Time Factors (TF) had the lowest average RII = 0.711, they nevertheless exert a significant operational pressure on worker performance. Working overtime (TF-2) and continuously without breaks (TF-1) indicate a loss of productivity due to fatigue, as long hours can eventually slow down, increase errors, and indirectly raise rework and safety hazards.

Overall, this study finds that focusing on the development of timely wage/payment systems, competent labor, trustworthy procurement planning, and strict daily site monitoring and coordination can greatly increase labor productivity in high-rise projects in Rawalpindi and Islamabad. The recommended productivity improvement framework has a solid practical basis thanks to the RII-based findings, which give stakeholders a clear, evidence-based path to follow when implementing focused interventions that cut down on delays, rework, and idle time.

5.2 Recommendations

The recommendations below are aligned with the highest-ranked RII factors and the factor groups reported in Chapter 4, so they directly support the proposed framework for improving labor productivity in Rawalpindi & Islamabad high-rise

projects. Establish a “skilled manpower plan” for critical high-rise trades (formwork, rebar, concreting, finishing, and MEP interfaces) to directly address the top-ranked constraint of lack of skilled manpower. Implement trade testing at mobilization and a site skill-matrix for crew allocation to reduce inefficiencies associated with unskilled labor and to stabilize work quality and outputs. Introduce a daily work planning routine with clear output targets, crew-wise task allocation, and constraints checks to address unclear/daily task assignments as a top-ranked factor. Strengthen quality control at activity handoffs and supervision checklists to reduce rework impacts identified within the supervision-related factors. Create a procurement look-ahead (2–6 weeks) linked to the construction program and site demand, because procurement delays were ranked among the most critical constraints.

Enforce structured coordination between stakeholders (client – consultant – contractor – subcontractors) because lack of coordination between stakeholders was a high-priority factor in the RII ranking. Institutionalize periodic meetings and action tracking, since lack of periodic meetings and weak leadership communication practices were emphasized in the leadership prioritization. Use weekly coordination meetings for upcoming inspections, approvals, and work interfaces to reduce workflow interruptions linked to inspection delays and design/specification changes. Ensure timely certification and payment flow to reduce wage delays at the labor level, because delays in salary were ranked as the most critical motivational factor and 2nd overall. Require contractors to submit a wage-payment plan and monitor compliance as part of project governance, as payment reliability is directly linked to labor motivation factors highlighted in the findings.

Provide predictable inspection schedules and timely feedback cycles to minimize stoppages and uncertainty at the workplace, consistent with the supervision-related findings. Improve clarity of instructions and maintain controlled issuance of drawings/specifications during execution to reduce disruption caused by changes and miscommunication.

Encourage structured training pathways and short-site upskilling programs (especially for high-rise trades) because skill shortage was the most dominant constraint in the overall RII ranking. Promote standardized site productivity practices

(daily planning, coordination cadence, and procurement look-ahead) as common requirements in high-rise projects to address the recurring top-ranked constraints identified by the respondents.

5.3 Future Research Directions

Following future research area are recommended below:

- i. Validate the framework through on-site case studies in Rawalpindi & Islamabad by comparing productivity before and after implementation.
- ii. Extend the analysis to infrastructural and industrial projects to compare productivity
- iii. Expand future research to other Pakistani cities and project types while maintaining the validated factors from pilot survey and Delphi analysis.
- iv. Apply advanced modelling techniques (e.g., Fuzzy-AHP, SEM) to analyze cause-effect relationships among key factors.
- v. Explore the role of digital tools (BIM, mobile supervision apps, IoT) enhancing labor productivity in high-rise construction.

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Appendix-A - Questionnaire

Framework for Improvement of Labor Productivity in High-Rise Construction Projects in Twin Cities.

Dear Respondent,

I am a student of MS Civil Engineering (Construction Engineering & Management) at Capital University of Sciences & Technology, Islamabad. I am conducting research on the title: **Framework for Improvement of Labor Productivity in High-Rise Construction Projects in Twin Cities.**

This survey consists of four sections

focusing on key factors that influence labor productivity in high-rise construction projects:

1. Personal Information
2. Labor Motivation, Inappropriate Supervision and Safety/Weather
3. Materials/Tools Handling and Time
4. Human (Manpower), Project Management, and Leadership

Please take 6-10 minutes to complete the following survey. Your responses will contribute significantly to a better understanding of this research. Please note that all information provided will be kept strictly confidential and used solely for academic purposes.

Thank you for your time and cooperation.

Best Regards,
Muhammad Mursaleen
MS Civil Engineering
CUST, Islamabad
mursaleenmuhammadjh@gmail.com

1. Email *

2. What is your highest educational qualification?

Mark only one oval.

- Diploma Holder (DAE)
- Graduation
- Post-Graduation
- PhD

3. What is the nature of your job?

Mark only one oval.

- Client
- Consultant
- Contractor

4. Job Designation

Mark only one oval.

- CEO
- Project Director
- Project Manager
- Construction Manager
- Assistant Manager
- Planning Engineer
- Site Engineer
- Site Supervisor
- Architect/ Designer
- Other: _____

5. How many years of professional experience do you have in the construction industry?

Mark only one oval.

- < 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- > 25

6. Please specify the area of your project experience

Mark only one oval.

- Islamabad
- Rawalpindi
- Other: _____

Factors Related to the Effect on Labor Productivity: Labor Motivation and Inappropriate Supervision

This section assesses how worker motivation and supervisory practices affect labor productivity in high-rise construction projects.

The survey uses a five-point Likert scale where **1 represents Strongly Disagree**, **2 represents Disagree**, **3 represents Neutral**, **4 represents Agree**, and **5 represents Strongly Agree**.

7.

Mark only one oval per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Delays in salary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Wages of workers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of incentive scheme	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of training sessions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of place for eating and relaxation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of team spirit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change in drawings and specifications during execution	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Delays in inspections	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rework	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear and daily task assignments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reallocation of laborers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working at height	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Insufficient lighting at site	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weather conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Factors Related to the Effect on Labor Productivity: Materials/Tools Handling and Time

This section focuses on the availability, quality, and management of materials and tools. Efficient material delivery, proper handling, storage, and access to tools are essential for maintaining productivity in high-rise construction environments.

8.

Mark only one oval per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Shortage of materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unsuitable material storage at the site	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shortage of tools and equipments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Obsolete tools and equipments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inefficiency of equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Procurement delays	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low Quality of raw materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Continuous work without break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working overtime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Project size	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Crew size	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unskilled workforce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Factors Related to the Effect on Labor Productivity: Human (Manpower), Project Management, and Leadership

This section examines how manpower skills, coordination, planning, project management practices, and leadership influence productivity. It covers worker experience, teamwork, scheduling, communication, and decision-making in high-rise construction projects.

9.

Mark only one oval per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Labor absenteeism	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of skilled manpower	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Labor strikes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Labor disloyalty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working in a confined space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Political interference	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Labor shortage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of coordination between stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Site restricted access/topography	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Performing work at night	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of labor surveillance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of periodic meetings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Communication between labor and supervisors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>