

# Perception of Factors Influencing Labor Productivity of Skilled Workers in High-Rise Construction Projects in Bangkok, Thailand

Tewakun Chankampom<sup>1</sup>, Wutipong Kusonkhum<sup>2</sup> and Korb Srinavin<sup>2,\*</sup>

<sup>1</sup> Civil Engineering, Faculty of Engineering, Rajamangala University of Technology Isan Khon Kaen Campus, Nai Muang, Muang, KhonKaen, 40000, Thailand

<sup>2</sup> Civil Engineering, Faculty of Engineering, Khon Kaen University, Nai Muang, Muang, KhonKaen, 40002, Thailand

\*Corresponding Author E-mail: korbsri@kku.ac.th

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## Abstract

The construction industry, particularly high-rise construction projects in major urban areas, is a key driver of national economic growth; nevertheless, persistently low labor productivity continues to constrain project performance. This study investigates skilled construction workers' perceptions of factors influencing labor productivity in high-rise construction projects in Bangkok, Thailand. A quantitative research design was employed using a structured questionnaire administered to skilled workers engaged in high-rise building projects across Bangkok and its metropolitan areas. A total of 346 valid responses were analyzed using multiple regression analysis (MRA). Labor productivity was specified as the dependent variable, while materials, tools, and equipment, health and safety, motivation, construction site area, and weather conditions were modeled as independent variables. The proposed model explained 77.2% of the variance in labor productivity. The results indicate that motivation ( $\beta = 0.786$ ,  $p < 0.01$ ) and health and safety ( $\beta = 0.130$ ,  $p < 0.05$ ) exert statistically significant positive effects on labor productivity. In contrast, the construction site area has a significant adverse effect ( $\beta = -0.154$ ,  $p < 0.01$ ). In contrast, materials, tools, and equipment, and weather conditions do not exhibit statistically significant relationships with labor productivity. The findings underscore the critical role of motivation-oriented management practices and proactive investment in occupational health and safety in enhancing skilled labor productivity, while highlighting productivity losses associated with spatial constraints and inefficient site layouts in high-rise construction projects. Departing from the predominantly managerial focus of prior studies, this research advances the literature by providing worker-centric empirical evidence from high-rise construction projects in Bangkok, Thailand, within a developing-country context. The results offer theoretically grounded, practically actionable insights for improving labor productivity through motivation-driven management, safety-oriented policy interventions, and practical construction site planning in urban high-rise developments.

**Keywords:** Labor productivity, Workers' perception, Skilled workers, High-Rise Construction Projects

## 1. Introduction

The construction industry is a fundamental driver of economic and social development, delivering essential infrastructure and built environments that support national growth. Despite its increasing technical sophistication, the industry continues to face persistent challenges related to low labor productivity, which remains a significant determinant of project performance, influencing cost, schedule, and quality outcomes [1–2]. As labor often accounts for a substantial share of total project expenditures, improving labor productivity has become a central focus for researchers and practitioners seeking to enhance project efficiency and competitiveness.

Existing literature highlights a wide array of factors that influence labor productivity, ranging from managerial practices and site organization to material availability, safety conditions, and environmental constraints [3–4]. Worker-related attributes such as technical skills, experience, attitudes, and motivation have also been shown to play a critical role. Skilled workers, in particular,

contribute directly to the accuracy, efficiency, and quality of construction operations. Their perceptions of productivity-influencing factors offer practical insights into real on-site conditions and can reveal underlying issues that are not immediately apparent from a managerial perspective.

In Thailand, skilled workers represent a key segment of the construction workforce across infrastructure, commercial, and residential projects. However, their productivity is frequently affected by diverse challenges, including inconsistent supervision, varying levels of training, communication barriers in multicultural workgroups, and fluctuating working environments. Capturing how skilled workers perceive these influencing factors is therefore essential for developing targeted strategies that enhance workforce performance and reduce productivity losses [5].

Accordingly, this study investigates skilled construction workers' perceptions of the factors influencing labor productivity within the Thai construction industry. The research aims to identify

the most significant perceived factors and provide empirical insights that support more effective labor management practices. The findings are expected to inform contractors, project managers, and policymakers in designing interventions to improve productivity and strengthen the sector's overall efficiency and competitiveness.

Although extensive research has examined factors influencing construction labor productivity, most existing studies rely primarily on managerial or contractor-oriented assessments and generalized factor-ranking approaches. Empirical evidence derived directly from skilled workers' perceptions particularly within high-rise construction projects in Thailand remains limited, and prior studies often provide insufficient insight into the relative magnitude and combined effects of productivity determinants. This study addresses these limitations by adopting a worker-centric, perception-based approach and empirically testing a statistically validated model using multiple regression analysis. By quantifying the direction and strength of key influencing factors as perceived by skilled workers, the research advances productivity theory and offers actionable guidance for labor management, safety policy development, and construction site planning in the Thai construction industry.

## 2. Literature Review

### 2.1 Factors Influencing Construction Labor Productivity

A review of existing literature, encompassing both domestic and international studies, was conducted to identify the key determinants affecting labor productivity in construction projects. This review provided a systematic synthesis of variables commonly examined in productivity research, enabling the classification of relevant factors into major thematic groups. By analyzing recurring concepts, comparative findings, and theoretical perspectives across previous studies, essential factors influencing on-site productivity were clearly outlined. These factors reflect not only technical aspects such as materials, tools, and work methods, but also human and managerial dimensions, including supervision quality, worker motivation, planning efficiency, and safety conditions.

The classifications also highlight the multidimensional nature of productivity in construction work, where the interactions between workers, resources, site environments, and external conditions shape performance. For example, inadequate planning can intensify rework, poor site conditions can obstruct workflow, and insufficient motivation may reduce worker efficiency despite the availability of resources. Thus, categorizing the factors into groups provides a structured basis for empirical investigation and supports the development of an analytical framework for evaluating productivity performance. The nine groups identified from the literature are presented in **Table 1**.

**Table 1** Categories of Factors Influencing Construction Labor Productivity

Items	Categories of Factors	Reference
1	Material Factors	[6–8]
2	Equipment and Tools Factors	[6],[9–10]
3	Health and Safety Factors	[9–11]
4	Supervision Factors	[10],[12]
5	Management and Planning Factors	[6–7],[12–13]
6	Motivation Factors	[6,9]
7	Site Conditions Factors	[6],[12],[14]
8	Rework Factors	[9],[13–15]
9	Weather Conditions Factors	[8],[14],[16]

Although previous studies have consistently identified motivation, safety, construction site conditions, and other related factors as influential determinants of labor productivity, relatively few studies have empirically quantified the magnitude and comparative significance of these factors from the direct perspective of skilled workers. Moreover, limited attention has been given to translating these findings into actionable site-level management strategies, particularly within the context of high-rise construction projects.

### 2.2 Measurement Model and Variable Extraction

In productivity research, latent constructs are commonly measured using multiple observed indicators. To ensure that these indicators appropriately represent their underlying constructs, previous studies have recommended assessing construct reliability and convergent validity using indices such as the Construct Reliability and Average Variance Extracted [17–18].

Construct reliability refers to the degree to which a set of observed variables consistently measures an underlying latent construct. According to Bagozzi et al. [17] and Hair et al. [18], construct reliability values exceeding 0.60 indicate acceptable internal consistency and low measurement error. This approach has been widely applied in construction management and productivity studies to validate measurement models before empirical analysis.

Average Variance Extracted (AVE) is used to assess the extent to which a latent construct accounts for the Variance among its observed indicators. An AVE value greater than 0.50 suggests that more than half of the indicator variance is captured by the construct rather than by measurement error, indicating adequate convergent validity [18]. AVE has been widely adopted in structural and regression-based productivity studies to support the validity of latent variable measurement.

Based on these established measurement principles and the synthesis of previous studies, the relevant productivity-related variables were extracted and classified into six principal constructs: 1) Materials, 2) Tools and Equipment, 3) Health and Safety, 4) Motivation, 5) Construction Site Conditions, and 6) Weather Conditions. These constructs form the basis for the conceptual framework and subsequent empirical analysis presented in this study.

### 3. Conceptual Framework

Labor productivity is a critical determinant of performance, efficiency, and competitiveness in the construction industry. Due to the labor-intensive nature of construction work, the productivity of skilled workers has a direct impact on project duration, cost, and overall quality. In many developing countries, including those in Southeast Asia, the construction sector faces persistent challenges such as low productivity, labor shortages, and high turnover rates. These issues have prompted researchers and practitioners to investigate various factors influencing labor productivity, including material availability, equipment efficiency, safety conditions, worker motivation, site management, and environmental conditions.

Understanding these factors and how workers perceive their influence is essential for improving project performance and ensuring sustainable growth in the construction industry. Previous studies have provided valuable insights into the determinants of labor productivity; however, most have focused on managerial perspectives rather than workers' perceptions. This study, therefore, aims to address this gap by examining skilled workers' perceptions of the key factors that influence labor productivity in construction projects.

Labor productivity in the construction industry is influenced by multiple interrelated factors that have been widely discussed in previous studies. Among these, the availability of materials and equipment plays a fundamental role. Insufficient or delayed material supply often causes interruptions and idle time, while timely delivery and proper maintenance of equipment help sustain workflow and efficiency [3],[19]. Effective management of these resources ensures smooth project progress and minimizes cost overruns.

Health and safety conditions are another critical determinant of productivity. Unsafe working environments and frequent accidents not only disrupt work but also create psychological stress among workers. Prior research [20–21] found that implementing safety programs and providing adequate protective equipment improve workers' confidence and overall efficiency. A well-established safety culture, therefore, directly enhances both well-being and productivity.

Motivation also strongly influences workers' performance. According to Herzberg's motivation–hygiene theory [22], both intrinsic and extrinsic factors, such as fair wages, recognition, and job satisfaction, contribute to productivity. Motivated workers demonstrate higher discipline and commitment to project goals [4], whereas low motivation leads to absenteeism and decreased output. Hence, maintaining equitable reward systems and recognizing workers' contributions are essential to fostering sustained productivity.

The organization of the construction site further affects productivity outcomes. Inefficient site layout, congestion, and limited workspace can restrict

movement and lead to increased time losses. Studies by Olomolaiye et al. [23] and Salah et al. [24] emphasized that proper site planning, accessibility, and clear work zoning promote coordination and reduce workflow disruptions, resulting in greater efficiency.

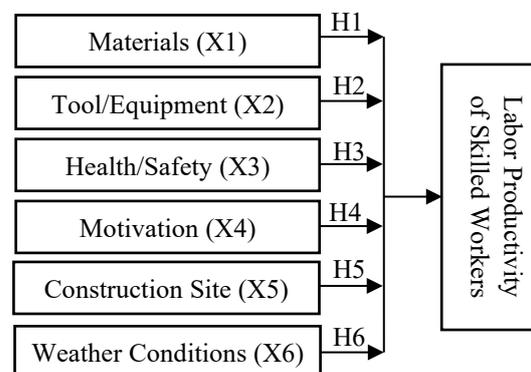
Finally, weather conditions are external yet significant influences on labor productivity. Extreme temperatures, heavy rainfall, and high humidity have been shown to reduce workers' physical performance and working hours [25–26]. Adjusting project schedules and providing adequate protection against adverse weather can therefore mitigate productivity losses.

In summary, prior research suggests that labor productivity is influenced by a combination of physical, psychological, environmental, and managerial factors, including materials and equipment, health and safety, motivation, site management, and weather conditions. These insights provide a foundation for developing the conceptual framework and examining the interrelationships among the variables in this study.

Based on the review of relevant literature, a conceptual framework was developed to illustrate the hypothesized relationships among the study variables. The framework identifies labor productivity (Y) as the dependent variable influenced by six independent variables: materials (X1), tools and equipment (X2), health and safety (X3), motivation (X4), construction site area (X5), and weather conditions (X6).

Previous studies have demonstrated that these factors collectively shape workers' performance and project efficiency in the construction industry. For instance, having adequate materials and equipment enhances workflow and minimizes idle time, while effective health and safety management promotes workers' well-being and reduces absenteeism. Worker motivation contributes to higher commitment and job satisfaction, whereas site layout and environmental conditions determine the physical feasibility and comfort of work execution.

Accordingly, this study proposes that improvements in each of these independent variables will lead to higher levels of labor productivity among skilled workers in construction projects. The conceptual framework is presented in **Figure 1**.



**Figure 1** Conceptual Framework

### 3.1 Research Hypotheses

Based on the literature review and the proposed conceptual framework, the following research hypotheses are formulated:

**H1:** Materials have an effect on labor productivity among skilled workers in construction projects.

**H2:** Tools and equipment have an effect on labor productivity among skilled workers in construction projects.

**H3:** Health and safety have an effect on labor productivity among skilled workers in construction projects.

**H4:** Motivation has an effect on labor productivity among skilled workers in construction projects.

**H5:** Construction site area has an effect on labor productivity among skilled workers in construction projects.

**H6:** Weather conditions have an effect on labor productivity among skilled workers in construction projects.

## 4. Methodology

The research procedures of this study were divided into five stages as follows.

### 4.1 Research Design

This study employed a quantitative research design using a structured questionnaire to examine skilled workers' perceptions of factors influencing labor productivity in high-rise construction projects in Bangkok, Thailand. The overall research process consisted of five main steps, as outlined below.

**Step 1:** Identification of labor productivity-related factors through an extensive review of relevant literature.

**Step 2:** Development of a structured questionnaire based on the identified factors and validated measurement items.

**Step 3:** Data collection from skilled workers engaged in high-rise construction projects in Bangkok and its metropolitan areas.

**Step 4:** Statistical analysis of the collected data using multiple regression analysis.

**Step 5:** Interpretation of results and testing of the proposed research hypotheses (H1–H6).

A quantitative approach was deemed appropriate because it allows for systematic measurement of variables and statistical examination of relationships between independent factors and labor productivity. This approach enhances objectivity, enables data collection from a large sample, and supports generalizing findings across similar construction contexts [27]. The use of a structured survey instrument also ensures consistency in responses and reduces measurement bias when assessing perceptual constructs [28]. Despite its limitation in capturing in-depth contextual insights, the quantitative survey approach remains methodologically robust for identifying significant productivity-related factors and generating empirical evidence to inform construction management practices [29].

### 4.2 Population and Sample

The study population comprised skilled workers employed on high-rise construction projects in Bangkok and its metropolitan areas.

**Step 1:** Identification of eligible high-rise construction sites that were actively under construction during the data collection period.

**Step 2:** Selection of skilled workers from major construction trades, including masonry and plastering, electrical work, carpentry, painting, steel work, and concrete work.

**Step 3:** Distribution of questionnaires to the selected skilled workers at the construction sites.

A total of 346 valid questionnaires were returned and used for data analysis. The final sample size was considered adequate for multiple regression analysis, as suggested in the methodological literature, exceeding commonly recommended minimum sample size requirements for statistical analysis.

All respondents were Thai nationals. The surveyed construction sites predominantly employed local skilled workers; therefore, the sample lacked diversity in nationalities.

### 4.3 Research Instrument

The research instrument was a structured questionnaire developed based on conceptual frameworks and findings from previous studies on factors affecting labor productivity in the construction industry. The questionnaire consisted of 56 items and was divided into three sections: Section A (demographic information) and Section B (factors influencing labor productivity). The questionnaire consisted of three main sections.

**Step 1:** Section A collected demographic information of the respondents, including gender, age, type of skilled work, and construction experience.

**Step 2:** Section B measured labor productivity as the dependent variable (Y).

**Step 3:** Section C measured independent variables (X1–X6), including materials, tools, and equipment, health and safety, motivation, construction site area, and weather conditions.

All measurement items were assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), a commonly adopted approach for capturing respondents' perceptions and the perceived degree of influence of each factor. The questionnaire employed closed-ended perceptual statements designed to elicit skilled workers' perceptions regarding factors influencing labor productivity in construction projects. The items were developed based on constructs identified from prior productivity studies and relevant theoretical frameworks. Each statement asked respondents to indicate the extent to which specific site conditions, such as material availability, adequacy of tools and equipment, safety practices, motivational support, adequacy of working space, and weather conditions, affected their on-site work performance. To ensure that the questions accurately reflected workers' real working experiences, the wording emphasized observable site conditions and routine operational situations commonly encountered in

high-rise construction projects. This design enabled respondents to express their perceived influence of each factor on their productivity, thereby capturing subjective evaluations essential to understanding human centered drivers of labor productivity.

Before the primary survey, the questionnaire was evaluated to ensure its validity and reliability. Content validity was assessed by five experts using the Index of Item-Objective Congruence (IOC). All items achieved IOC values greater than 0.50, with an overall IOC score of 0.78, indicating acceptable content validity [30]. Subsequently, a pilot test was conducted with 30 respondents who were not part of the main sample but shared similar characteristics. The instrument's internal consistency was evaluated using Cronbach's alpha, which yielded a value of 0.923, indicating high reliability [31].

**4.4 Data Collection**

A total of 500 questionnaires were distributed as the primary data collection instrument to skilled workers employed in high-rise construction projects located in Bangkok and its metropolitan areas. The questionnaires were administered directly at active construction sites to workers from major construction trades, including masonry and plastering, carpentry, steel work, concrete work, electrical work, and finishing trades. The distribution process aimed to ensure adequate representation of key skilled occupations commonly involved in high-rise construction activities. This approach enhanced coverage of diverse work roles, contributing to labor productivity, while maintaining practical feasibility under site-based survey conditions. Of the 500 questionnaires distributed, 346 were completed and returned, yielding a response rate of 69.2%. According to Baruch [32], a response rate exceeding 60% for self-administered questionnaires is considered satisfactory and adequate for subsequent statistical analysis.

The questionnaire was originally developed in Thai to ensure clarity and ease of understanding for construction workers, who use Thai as their primary language in daily communication at construction sites. The measurement items were formulated based on constructs identified in previous international and local studies on construction labor productivity, with wording adapted to reflect the Thai construction context. To ensure linguistic clarity and content accuracy, the draft questionnaire was reviewed by five experts in construction management and occupational health and safety. Their feedback was used to refine item wording, eliminate ambiguity, and enhance contextual relevance before pilot testing.

**4.5 Data Analysis**

The collected data were coded, organized, and analyzed using the Statistical Package for the Social Sciences (SPSS). The data analysis procedure was conducted systematically as follows.

**Step 1:** Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' demographic characteristics and describe skilled workers' perceptions of factors influencing labor productivity.

**Step 2:** Reliability analysis was conducted using Cronbach's alpha coefficient to assess the internal consistency of the measurement scales.

**Step 3:** Before hypothesis testing, diagnostic tests were performed to verify the assumptions required for multiple regression analysis. These included assessments of linearity, multicollinearity, homoscedasticity, and residual independence. Multicollinearity was examined using Tolerance and Variance Inflation Factor (VIF) values, while the Durbin–Watson statistic was used to assess residual independence [33],[34].

**Step 4:** Multiple regression analysis was conducted to examine the relationships between the independent variables and labor productivity. The regression model's explanatory power was evaluated using the coefficient of determination (R<sup>2</sup>).

**Step 5:** Research hypotheses (H1–H6) were tested based on standardized regression coefficients (β) and p-values at the 0.05 significance level.

**5. Results**

**5.1 Descriptive Results of the Sample**

A total of 346 valid questionnaires were returned and analyzed in this study. As summarized in **Table 2**, the majority of respondents were male (69.2%). Most respondents were aged 31–40, followed by those aged 41–50, and in terms of work characteristics, masonry and plastering workers represented the most significant proportion of the sample. Moreover, most respondents had 1–10 years of construction experience, suggesting that the sample primarily comprised relatively experienced skilled workers.

**Table 2** Descriptive Characteristics of the Respondents (n = 346)

Variable	Category	Frequency	Percentage
Gender	Male	239	69.2 %
	Female	107	30.8 %
Age	< 21	14	4.0 %
	21-30	72	20.8 %
	31-40	156	45.1 %
	41-50	78	22.5 %
	51-60	26	7.5%
Type of Work	Masonry / Plastering	158	45.7 %
	Electrical work	42	12.1 %
	Carpentry	36	10.4 %
	Painting	32	9.2 %
	Steel work	30	8.7 %
	Concrete work	28	8.1 %
	Tiling	20	5.8 %
Work Experience	< 1	16	4.6 %
	1-5	132	38.2 %
	5-10	118	34.1 %
	10-15	46	13.3 %
	> 15	34	9.8 %

## 5.2 Results of Multiple Regression Analysis

A multiple regression analysis (MRA) was employed to investigate the factors influencing the labor productivity of skilled workers in the construction industry. In this analysis, labor productivity (Y) was designated as the dependent variable, while the independent variables comprised materials (X1), tools and equipment (X2), health and safety (X3), motivation (X4), construction site area (X5), and weather conditions (X6). The analytical results are summarized in **Table 3**.

As shown in **Table 3**, the multiple regression model explained 77.2% of the variance in labor productivity among skilled construction workers ( $R^2 = 0.772$ ). Among the independent variables, health and safety ( $\beta = 0.130$ ,  $p < 0.05$ ) and motivation ( $\beta = 0.786$ ,  $p < 0.05$ ) had a significant positive effect on labor productivity. In contrast, construction site area ( $\beta = -0.154$ ,  $p < 0.05$ ) exerted a substantial adverse effect. Meanwhile, materials, tools and equipment, and weather conditions did not show statistically significant effects when the other variables were held constant ( $p > 0.05$ ).

The assumptions of the regression model were also assessed. Tolerance values for all predictors were greater than 0.10, and Variance Inflation Factor (VIF)

values were below 10, indicating that multicollinearity was not a concern. These findings suggest that the model is appropriate and reliable for examining the factors affecting labor productivity in the construction industry.

After conducting the multiple regression analysis to identify the factors influencing labor productivity among skilled workers, three independent variables were found to have a statistically significant effect on the dependent variable: Health and Safety (X3), Motivation (X4), and Construction Site Area (X5). **Table 2** presents the summary of the regression analysis results, including the standardized coefficients and significance levels for each variable. Based on the analysis, the regression equation representing the relationship between the dependent and independent variables can be expressed as Eq. (1):

$$Y = 0.364 + 0.139X_3 + 0.812X_4 - 0.213X_5 \quad (1)$$

**Table 4** summarizes the results of the research hypotheses testing based on the multiple regression analysis. Hypotheses H2, H3, and H5 were supported at the 0.05 significance level, while H1, H2 and H6 were not supported.

**Table 3** Results of Multiple Regression Analysis

Independent Variables	b	S.E.	t	Sig.	Zero-order	Tolerance	VIF
Constant	0.364	0.097	3.760	0.001			
Materials (X1)	0.036	0.049	0.733	0.464	0.595	0.255	3.929
Tools/Equipment (X2)	0.067	0.054	1.239	0.216	0.651	0.200	4.988
Health/Safety (X3)	0.139	0.062	2.243	0.026	0.674	0.222	4.501
Motivation (X4)	0.812	0.044	18.575	0.001	0.681	0.418	2.394
Construction Site Area (X5)	-0.213	0.049	-4.755	0.001	0.218	0.712	1.405
Weather Conditions (X6)	0.023	0.026	0.863	0.389	0.469	0.530	1.887

**Table 4** Results of Research Hypotheses Testing

Hypothesis	Relationship	$\beta$	p-value	Result
H1	X1 → Labor Productivity	0.040	0.464	Not supported
H2	X2 → Labor Productivity	0.076	0.216	Not supported
H3	X3 → Labor Productivity	0.130	0.026	Supported
H4	X4 → Labor Productivity	0.786	0.001	Supported
H5	X5 → Labor Productivity	-0.154	0.001	Supported
H6	X6 → Labor Productivity	.0032	0.464	Not supported

## 6. Discussion

The research findings revealed that the multiple regression analysis identified three key factors influencing skilled workers' labor productivity in the construction industry: motivation (X4), health and safety (X3), and construction site area (X5). Each variable demonstrated distinct meanings and directions of influence, as described below.

### 6.1 Motivation

The results indicate that motivation exerts the most substantial positive influence on labor productivity among skilled construction workers ( $\beta = 0.786$ ,  $t = 18.575$ ,  $p < 0.01$ ), exceeding the effects of all other

examined factors. This suggests that when workers perceive adequate motivational support, such as fair compensation, recognition of performance, and a supportive working environment, they are more likely to demonstrate sustained effort, commitment to project objectives, and consistent work quality. Higher motivation is also associated with reduced absenteeism and a greater willingness to address on-site challenges, thereby contributing to smoother project execution and reduced rework.

From a theoretical perspective, this finding reinforces Herzberg's Motivation-Hygiene Theory [22], which emphasizes the central role of intrinsic motivators, including achievement, recognition,

responsibility, and opportunities for advancement, in shaping performance outcomes. The magnitude of the standardized coefficient provides strong empirical evidence that motivation plays a dominant role in labor productivity within high-rise construction contexts, where individual effort and engagement directly affect overall project performance.

The strong positive effect of motivation identified in this study is consistent with previous research conducted in various construction settings. Prior studies by Enshassi et al. [3], Jarkas and Bitar [4], and Gunduz and Abu-Hijleh [5] similarly reported motivation as one of the most influential drivers of construction labor productivity, highlighting the importance of incentives, job satisfaction, and recognition in enhancing workers' performance. However, the magnitude of the effect observed in this study is notably higher than that reported in many earlier studies, suggesting that motivation plays a particularly dominant role in high-rise construction projects located in dense urban environments such as Bangkok. This difference may be attributed to the physically demanding nature of high-rise work, spatial constraints, and heightened coordination requirements, which amplify the importance of psychological and behavioral factors among skilled workers.

Beyond theoretical confirmation, this study offers novel empirical insight by quantifying the relative dominance of motivation over traditional resource-based productivity drivers, such as materials and equipment. A key advantage of this finding is that motivation-based interventions such as performance-based recognition, transparent reward systems, participatory supervision, and supportive leadership practices can be implemented with relatively low financial investment compared to capital-intensive solutions. Nevertheless, a potential limitation is that motivational strategies may yield diminishing returns if they are not supported by equitable compensation structures and consistent managerial practices, indicating that motivation should be integrated with broader organizational and human resource management policies.

## 6.2 Health and Safety

The results indicate that health and safety have a positive and statistically significant effect on labor productivity ( $\beta = 0.130$ ,  $t = 2.243$ ,  $p < 0.05$ ). This finding suggests that effective implementation of safety measures such as the provision of personal protective equipment (PPE), enforcement of accident prevention protocols, regular safety training, and proper site housekeeping contributes to reducing injuries, work disruptions, and unplanned downtime. A safer working environment enhances workers' confidence and concentration, enabling more stable and consistent task performance.

From a theoretical perspective, this result aligns with Occupational Safety and Health (OSH) principles [35], which emphasize that productivity is enhanced when workplace risks are effectively managed and

worker well-being is protected. Beyond confirming established theory, this study extends existing knowledge by empirically demonstrating the productivity relevance of safety practices from skilled workers' perspectives in high-rise construction projects, where work complexity and exposure to hazards are particularly pronounced.

This finding is consistent with previous studies that identified health and safety as a significant contributor to labor productivity in construction projects. For example, Soekiman et al. [11] and Hallowell and Gambatese [36] reported that improved safety management reduces work interruptions and enhances workers' confidence, ultimately leading to higher productivity levels. However, compared to earlier studies conducted in low-rise building or infrastructure projects, the present study highlights the heightened importance of safety in high-rise construction environments, where workers are exposed to elevated risks associated with working at heights, congested workspaces, and complex vertical logistics.

While the positive effect of health and safety on productivity is well established, the relatively minor standardized coefficient compared to that for motivation suggests that safety primarily functions as a productivity enabler rather than a direct performance accelerator. Its main advantage lies in preventing productivity losses caused by accidents, fatigue, and work stoppages, thereby stabilizing production processes. Nevertheless, a key limitation is that safety improvements alone may not yield substantial productivity gains unless motivational, organizational, and managerial measures complement them. This underscores the need to integrate safety management within a broader productivity enhancement framework rather than treating it as a standalone intervention.

## 6.3 Construction Site Area

The analysis reveals that construction site area has a statistically significant adverse effect on labor productivity ( $\beta = -0.154$ ,  $t = -4.755$ ,  $p < 0.01$ ), indicating that spatial constraints and inefficient site layouts can substantially hinder skilled workers' performance. In high-rise construction projects, where workspaces are inherently limited and construction activities are highly interdependent, poorly planned site areas may disrupt workflow, restrict worker mobility, and intensify interference among multiple trades. Consequently, workers may experience increased idle time, excessive movement across the site, and frequent interruptions, all of which contribute to productivity losses and physical fatigue.

In addition to operational inefficiencies, inadequate site space may elevate safety risks due to congestion, thereby increasing the likelihood of accidents and unplanned work stoppages. Conversely, well-organized spatial arrangements facilitate efficient material handling, smoother task sequencing, and improved coordination between labor and equipment, which is consistent with prior research [37].

The negative impact of construction site area on labor productivity identified in this study is consistent with earlier research emphasizing the importance of site layout and spatial organization. Olomolaiye et al. [24] and Salah et al. [25] similarly reported that congested workspaces and inefficient site layouts lead to workflow disruption, increased travel time, and reduced task efficiency among construction workers. These findings reinforce the critical role of spatial planning in minimizing non-value-adding activities and enhancing overall labor performance.

Compared to previous studies conducted in low-rise building or infrastructure projects, the present research provides quantitative evidence from high-rise construction projects, where spatial constraints are more severe due to vertical construction, limited ground-level staging areas, and complex material logistics. This finding supports the argument that construction site area should not be viewed merely as a logistical concern, but rather as a direct productivity determinant in vertical construction environments.

A key advantage of this result is that it highlights site planning as an actionable managerial intervention that can mitigate productivity losses without altering workforce size or labor composition. Strategic measures such as optimized material storage zoning, clearly defined access routes, vertical logistics planning, and coordinated activity sequencing can substantially improve workflow efficiency. However, a notable limitation is that spatial constraints are often partially unavoidable in dense urban settings, where land availability, regulatory requirements, and surrounding infrastructure impose physical restrictions. As a result, site planning decisions frequently involve trade-offs between spatial efficiency and external constraints, underscoring the importance of integrating site layout planning early in the pre-construction phase to minimize productivity losses during project execution.

#### **6.4 Variables without statistically significant influence**

Materials, tools and equipment, and weather conditions did not exhibit statistically significant effects on labor productivity in this study ( $p > 0.05$ ), despite showing positive zero-order correlations. This finding contrasts with several previous studies that identified these factors as critical drivers of construction labor productivity [6],[7],[14]. Such discrepancies highlight the contextual dependency of productivity determinants rather than methodological inconsistency.

One plausible explanation is that the high-rise construction projects examined in this study featured relatively standardized material supply systems and well-established equipment management practices. In large-scale urban projects in Bangkok, materials procurement, storage, and equipment allocation are typically planned and managed systematically, reducing their potential to act as productivity constraints. As a result, these factors may be perceived by skilled workers as baseline operational conditions rather than as performance-limiting variables [38].

Similarly, the non-significant effect of weather conditions may be attributed to effective project planning and worker adaptability. Unlike studies conducted in regions with extreme climatic variability or frequent weather disruptions, the projects included in this study may have benefited from scheduling flexibility, protective measures, and experience-based coping strategies that mitigated the direct impact of weather on daily productivity [39].

The advantage of this finding is that it emphasizes that productivity drivers are highly context-specific and that not all commonly cited factors exert equal influence across different project types and environments. This insight cautions against the uncritical generalization of productivity frameworks across construction contexts. However, a notable limitation is that materials, equipment, and weather conditions may become significant productivity constraints under different circumstances, such as projects in remote areas, regions with unstable supply chains, or environments exposed to severe weather. Therefore, future research should further investigate these variables across diverse project types and geographical settings to better understand the conditions under which they emerge as dominant productivity factors.

Overall, the findings suggest that labor productivity in high-rise construction projects in Bangkok is driven more strongly by human-centered and spatial factors than by conventional resource availability. By empirically quantifying the relative effects of motivation, health and safety, and construction site area from skilled workers' perspectives, this study advances productivity research beyond descriptive factor identification toward strategy-oriented insights. The results underscore the need for a paradigm shift in productivity management from equipment- and material-focused interventions toward motivation-driven leadership, safety-integrated operations, and proactive spatial planning in vertically constrained urban construction environments.

## **7. Conclusion**

This study was based on data collected from 346 skilled construction workers employed in high-rise construction projects in Bangkok and its metropolitan areas. The majority of respondents were male, predominantly aged 31–40, and mainly engaged in masonry and plastering work, with most having 1–10 years of construction experience. This respondent profile provides a relevant basis for interpreting labor productivity factors within the context of urban high-rise construction in Thailand.

Based on the results of the study on the Perception of Factors Influencing Labor Productivity of Skilled Workers in the Construction Industry, using Multiple Regression Analysis (MRA), it was found that the factors influencing labor productivity among skilled workers include Motivation, Health and Safety, and Construction Site Area. Among these, motivation has

the most substantial positive influence on labor productivity, followed by health and safety, while the construction site area shows a negative impact. The findings indicate that enhancing worker motivation through rewards, recognition, and the creation of a supportive work environment plays a vital role in improving labor productivity. In addition, systematic management of occupational health and safety at construction sites can reduce risks and enhance work efficiency. Conversely, inappropriate site layout or limited working space may negatively affect task performance and decrease overall productivity.

This study contributes to the construction productivity literature in three ways. First, it advances theoretical understanding by providing worker-centric empirical evidence on productivity drivers. Second, it offers practical, real-time strategies for site managers focusing on motivation, safety, and spatial planning. Third, the findings inform policymakers in developing labor policies that prioritize human-centered productivity enhancement. This contextual information provides a clear basis for interpreting the study findings and reinforces the relevance of the results to skilled workers in high-rise construction projects.

#### 7.1 Limitations of the Study

Despite its contributions, this study has several limitations that should be acknowledged. First, the data were collected solely from skilled workers involved in high-rise construction projects in Bangkok and its metropolitan areas; therefore, the findings may not be fully generalizable to other construction sectors, regions, or rural project environments. Second, the study relied on self-reported questionnaire data, which may be subject to individual perception bias and may not fully capture actual on-site productivity performance. Third, the cross-sectional research design reflects workers' perceptions at a single point in time and does not account for potential changes in productivity factors across different project phases or economic conditions.

#### 7.2 Implications and Future Research

Despite these limitations, the findings provide essential practical and theoretical implications. From a practical perspective, the results suggest that construction managers should prioritize motivation-driven management practices, integrate occupational health and safety into productivity strategies, and emphasize effective construction site planning to mitigate spatial constraints in high-rise projects. These measures can be implemented with relatively low financial investment while yielding significant productivity benefits. From a theoretical perspective, this study extends existing labor productivity research by highlighting the contextual importance of human-centered and spatial factors over traditional resource-based variables in high-rise construction environments. Future research is recommended to validate these findings across different project types and regions, and to employ longitudinal research designs to capture dynamic changes in productivity drivers over time.

## 8. Future Research Directions

### 8.1 Longitudinal Studies

Future research could employ longitudinal study designs to track changes in labor productivity and its influencing factors over extended periods. This would provide insights into the dynamic nature of these relationships, allowing for the observation of how interventions or changes in project conditions impact productivity over time, rather than relying solely on cross-sectional data.

### 8.2 Qualitative Approaches

Integrating qualitative research methods, such as in-depth interviews, focus groups, or ethnographic studies with skilled workers, could offer a richer, more nuanced understanding of their perceptions and experiences. This would complement quantitative findings by exploring the 'why' behind observed correlations and uncovering factors that structured questionnaires might not capture.

### 8.3 Diverse Projects and Labor Groups

Future studies should explore a broader range of construction project types and more diverse worker demographics, including differences in age, experience, education, and migrant status. Such expansion would help determine whether the factors influencing labor productivity vary across project contexts and workforce groups, thereby supporting the development of more targeted and effective improvement strategies.

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