G-Tech : Jurnal Teknologi Terapan
Vol. 10, No. 2, April 2026, p. 856-865
E-ISSN: 2623-064X | P-ISSN: 2580-8737

Regression Analysis of Human Resource Factors on Construction Project Performance in Malang City

Rini Pebri Utari [1]✉, Wahyu Izza Ramadhan[2]

[1,2] Civil Engineering, Faculty of Engineering, Universitas Muhammadiyah Malang, Indonesia

✉ **Corresponding Author :** Rini Pebri Utari (e-mail: rinipebriutari@umm.ac.id)

Article Information

Article History

Received : April 06, 2026
Revised : April 13, 2026
Published : April 20, 2026

***Keywords*:**

Construction Project Performance;
Human Resource Factors;
Multiple Linear Regression;
Workforce Productivity.

ABSTRACT

The construction sector in Indonesia continues to grow rapidly, including in Malang City, where infrastructure and building projects are expanding significantly. Despite this growth, project success remains highly dependent on human resource performance. Previous studies have examined individual human resource factors; however, limited research has compared the dominant influence of multiple factors within a single model in regional contexts. This study aims to analyze the influence of competence, motivation, loyalty, and work discipline on construction worker performance in Malang City and to identify the most dominant factor. A quantitative approach was employed using primary data from 88 construction workers collected through structured questionnaires and analyzed using multiple linear regression. The results show that all variables have a significant and positive effect on worker performance, with a coefficient of determination (R^2) of 0.653, indicating that 65.3% of performance variation is explained by the model. Competence is the most dominant factor (β = 0.907), followed by work discipline (β = 0.653), motivation (β = 0.558), and loyalty (β = 0.511). These findings highlight the importance of technical skills in improving productivity and supporting sustainable construction practices. This study provides empirical evidence and practical insights for improving workforce management and project performance.

INTRODUCTION

The construction industry in Indonesia has grown rapidly in recent years, driven by continuous government-led infrastructure and building development programs. While growth is concentrated in major cities like Jakarta, regional cities such as Malang have also experienced a significant increase in construction activities, including residential buildings, apartments, hotels, and infrastructure projects (Prasetyo et al., 2022; Kurniawan et al., 2023). Despite this expansion, construction projects remain complex and resource-intensive, with human resources (HR) recognized as a critical determinant of project success. Workforce competence, motivation, loyalty, and discipline significantly influence project outcomes, productivity, and overall efficiency (Sari & Putra, 2021; Adebowale & Smallwood, 2021; Tam et al., 2021). Even with sufficient financial resources and advanced technologies, inadequate HR performance can lead to delays, inefficiencies, and project failure (Enshassi et al., 2021).

Recent trends highlight the increasing relationship between HR performance and sustainable construction practices. The adoption of green building methods, energy-efficient systems, and smart construction technologies requires workers with high technical competence,

adaptability, and technological literacy (Rahman et al., 2023; Darko et al., 2022). To capture this empirically, this study introduces the concept of Sustainable Construction Performance (SCP) as a measurable variable representing environmentally responsible construction outcomes, including energy efficiency, use of green materials, waste management, and adoption of sustainable technologies (Osei-Kyei & Chan, 2021; Li et al., 2022; Aghimien et al., 2022).

However, existing studies have predominantly examined individual HR factors or focused on large metropolitan areas, with limited attention to emerging cities such as Malang. In addition, only a few studies have quantitatively compared the relative influence of multiple HR factors within a single analytical model, particularly in regional construction contexts. Furthermore, the integration between human resource performance and sustainable construction outcomes remains insufficiently explored in empirical research (Willy & Sekarsari, 2020; Jarkas & Radosavljevic, 2021; Rahman et al., 2023; Darko et al., 2022).

These limitations indicate the need for a more comprehensive analysis that not only evaluates the combined influence of HR factors but also connects workforce performance with sustainable construction practices. Understanding these relationships is important not only at the project level but also for broader industry stakeholders and policymakers. Strengthening workforce competence and HR management strategies can support efforts to improve construction productivity and achieve sustainable development goals in the construction sector.

Therefore, this study aims to analyze the influence of competence, motivation, loyalty, and work discipline on construction worker performance in Malang City and to identify the most dominant factor affecting project performance. In addition, this study seeks to examine how these human resource factors contribute to supporting sustainable construction performance.

The underlying conceptual structure of this research is depicted in **Figure 1**, which illustrates the hypothesized relationships between human resource factors and worker performance, as well as their potential contribution to Sustainable Construction Performance (SCP).

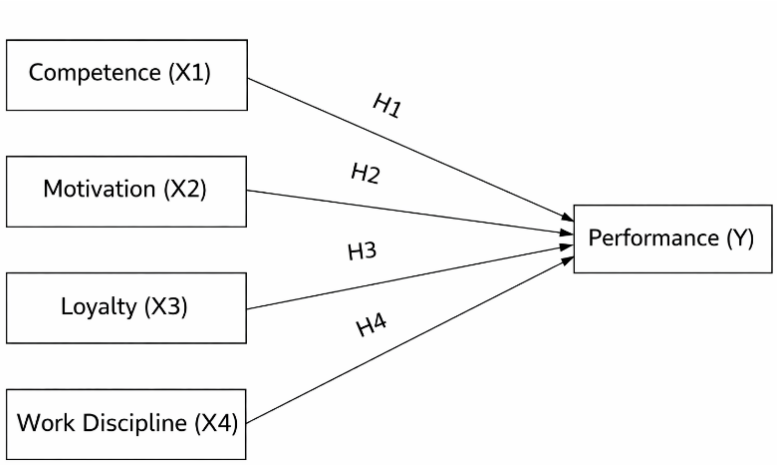

Figure 1 Conceptual Structure of the Study

RESEARCH METHODS

Research Design and Study Area

This investigation adopts a quantitatively oriented methodology to explore how human resource (HR) dimensions shape the performance of construction labor. Through the use of numerical measurement and inferential techniques, the study evaluates the interaction between predictor variables namely competence, motivation, loyalty, and work discipline and the outcome variable represented by worker performance levels. The empirical setting of the research is situated in Malang, Indonesia, an area characterized by a notable surge in construction development,

encompassing both public infrastructure and privately funded projects. Primary data were obtained from construction personnel actively engaged in ongoing projects throughout the year 2024.

Population and Sample

Population refers to the complete group of elements or individuals possessing specific attributes defined by the researcher as the focus of investigation, from which generalizations are ultimately derived (Sugiyono, 2015). In the context of this research, the population comprises construction workers participating in building projects within Malang in the year 2024.

The sampling technique used is probability sampling, guaranteeing that every element within the population possesses the same probability of being included in the sample. The number of respondents was established using the Slovin formula with an acceptable margin of error. This approach is considered appropriate for studies with relatively homogeneous populations and limited population size, ensuring representativeness while maintaining statistical efficiency. The final sample of 88 respondents is also deemed adequate for multiple linear regression analysis, as it exceeds the minimum requirement of 5–10 observations per independent variable, thereby supporting the robustness and reliability of the analysis.

Detailed information regarding the identified projects, including the workforce involved in each, is presented in **Table 1** below:

Table 1 Data on Building Construction Projects and Workforce in Malang City, 2024

No	Sub-Activity / Work	Service Provider	Number of Workers
	Maintenance and Upkeep of Regional Government Buildings in Malang City		
1	Continued Construction of Bunulrejo Subdistrict Office	CV. Sari Restu	21
2	Continued Construction of Kedungkandang Subdistrict Office	CV. Sari Restu	18
3	Continued Construction of Wonokoyo Subdistrict Office	CV. Prabu Jayatsu Buana	23
4	Addition of New Rooms at Merjosari Subdistrict Office	CV. Perkutut	15
5	Improvement and Expansion of Multipurpose Building RW 12, Merjosari Subdistrict	CV. NRZ Assahra	35

The sample size was determined using the Slovin formula as follows:

$$n = \frac{N}{1 + (N \times e^2)} \quad (1)$$

Research Variables

In this study, the explanatory variables (X) encompass competence (X1), represented by knowledge, skills, and behavioral aspects; motivation (X2), which involves incentives, working conditions, job attributes, and organizational regulations; loyalty (X3), indicated through compliance, accountability, commitment, and integrity; as well as work discipline (X4), characterized by adherence to rules, punctuality, and procedural conformity. Meanwhile, the outcome variable (Y) refers to worker performance, assessed based on work outcomes (quality, quantity, and efficiency), behavioral aspects (initiative, precision, and discipline), and individual characteristics (leadership, honesty, and creativity).

Methods of Data Acquisition

Data were obtained through carefully designed survey instruments administered to construction workers, based on operational indicators and measured using a five-point attitudinal scale. The measurement indicators were developed based on established theories and prior empirical studies related to human resource performance and construction productivity (Sari & Putra, 2021; Adebowale & Smallwood, 2021; Tam et al., 2021). Each variable was operationalized into measurable items to ensure content validity. Furthermore, instrument validity was assessed using correlation analysis, while reliability was confirmed through Cronbach's Alpha, ensuring that the questionnaire consistently measures the intended constructs.

A multiple regression framework was applied to simultaneously evaluate the influence of several explanatory variables on a single outcome, enabling the identification of both the strength and direction of the relationships between competence, motivation, loyalty, work discipline, and project performance. Multiple linear regression was selected as the analytical method because it allows for the simultaneous examination of the effects of multiple independent variables on a dependent variable, as well as the identification of the most dominant factor based on regression coefficients. This method is widely used in construction management research and is appropriate for achieving the research objectives.

Data Analysis Techniques

1. Descriptive Analysis

   Descriptive analysis was applied to interpret respondent profiles and the spread of observed variables. The percentage index was calculated to interpret responses:

   $$\%\ Index = \frac{n}{N} \times \quad (2)$$

   The results were categorized into five levels ranging from "very poor" to "very good."

2. Classical Assumption Tests

   To verify the appropriateness of the regression model, a series of classical diagnostic tests were performed, including a normality assessment using the Kolmogorov–Smirnov method (significance value > 0.05 indicating normal distribution), a multicollinearity check through the Variance Inflation Factor (VIF < 10 suggesting absence of multicollinearity), and a heteroscedasticity examination employing the Glejser approach (significance value > 0.05 indicating homoscedastic conditions).

3. Multiple Linear Regression Analysis

   Multiple linear regression was applied to investigate the association between the predictor variables and the response variable:

   $$Yi = \boldsymbol{\beta}0 + \boldsymbol{\beta}1X1 + \boldsymbol{\beta}2X2 + \boldsymbol{\beta}3X3 + \boldsymbol{\beta}4X4 + e \quad (3)$$

4. Hypothesis Testing

   Hypothesis evaluation was carried out through several statistical procedures, including the t-test to assess the individual contribution of each predictor to performance, the F-test (ANOVA) to evaluate the collective influence of all predictors, and the coefficient of determination (R^2) to estimate the proportion of variance in the outcome variable accounted for by the explanatory variables.

The research stages are illustrated in **Figure 2.** The research process begins with problem identification and literature review to establish the theoretical framework and research variables. This is followed by the development of research instruments and data collection through questionnaires distributed to construction workers. The collected data are then tested for validity and reliability before proceeding to classical assumption tests. Subsequently, multiple linear regression analysis is conducted to examine the relationships between variables and test the research hypotheses. Finally, the results are interpreted to draw conclusions and provide practical recommendations for improving construction project performance.

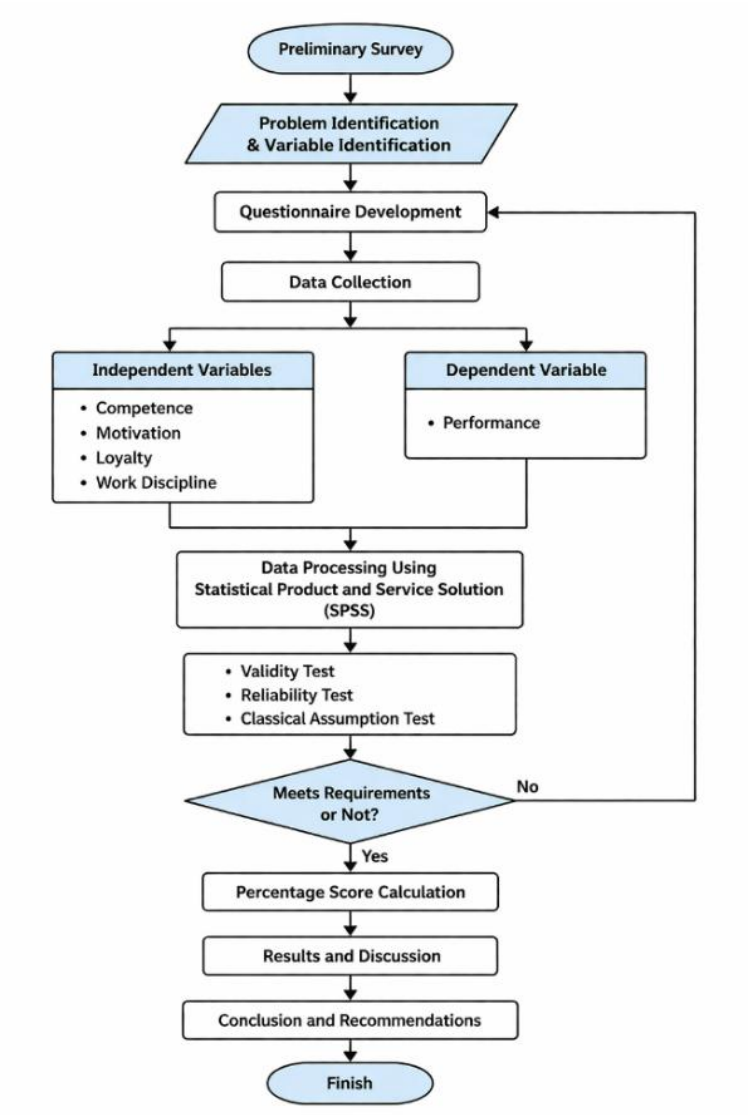

Figure 2 Research Flowchart

RESULTS AND DISCUSSION

Respondent Characteristics

The sample quantity was derived through the Slovin formula:

$$n = \frac{112}{1 + (112 \times 0{,}05^2)} = 87{,}5 = 88$$

A total of 88 respondents were included in this study, comprising individuals directly engaged in the construction project, such as laborers, skilled workers, foremen, and contractors. This number of respondents is deemed sufficient for conducting multiple linear regression analysis, as it meets commonly accepted standards in social science research. Generally, regression analysis requires a minimum sample size of approximately 5–10 times the number of variables being analyzed. Given that this study involves four independent variables, the minimum required sample would range between 20 and 40 respondents. Consequently, the inclusion of 88 respondents exceeds this threshold, thereby supporting the reliability and robustness of the statistical findings.

Instrument Testing Results

Validity Test

The validity test results shown in **Table 2** indicate that every item in the questionnaire has a correlation coefficient (r-count) exceeding the critical r-table value of 0.201, confirming that all items are Appropriate.

Table 2 Validity Test Results

Attribute	Number of Items	r-count Range	r-table	Result
Competence (X1)	5	0.624 – 0.860	0.201	Appropriate
Motivation (X2)	5	0.643 – 0.837	0.201	Appropriate
Loyalty (X3)	5	0.733 – 0.815	0.201	Appropriate
Work Discipline (X4)	5	0.657 – 0.793	0.201	Appropriate
Performance (Y)	15	0.574 – 0.782	0.201	Appropriate

As shown in **Table 2**, all indicators are declared Appropriate and suitable for further analysis.

Reliability Test

The reliability test results in **Table 3** reveal that all variables have Cronbach's Alpha values above 0.7, indicating that the questionnaire is consistently reliable.

Table 3 Reliability Test Results

Attribute	Cronbach's Alpha	Standard	Result
Competence (X1)	0.770	0.7	Appropriate
Motivation (X2)	0.792	0.7	Appropriate
Loyalty (X3)	0.839	0.7	Appropriate
Work Discipline (X4)	0.767	0.7	Appropriate
Performance (Y)	0.896	0.7	Appropriate

Based on **Table 3**, all research instruments are reliable and consistent. The results indicate that the instruments are statistically robust, ensuring that the regression analysis reflects reliable relationships between variables.

Classical Assumption Testing

Normality Test

Table 4 displays the results of the normality test conducted using the Kolmogorov-Smirnov method.

Table 4 Normality Test

N	Sig. Value	Threshold	Conclusion
88	0.147	0.05	Normal

As presented in **Table 4**, the significance value (0.147 > 0.05) indicate that the data follow a normal distribution.

Multicollinearity Test

Table 5 presents the results of the multicollinearity test.

Table 5 Multicollinearity Test Results

Attribute	Tolerance	VIF	Conclusion
Competence (X1)	0.582	1.720	No multicollinearity
Motivation (X2)	0.614	1.628	No multicollinearity
Loyalty (X3)	0.386	2.588	No multicollinearity
Work Discipline (X4)	0.569	1.757	No multicollinearity

Based on **Table 5,** all tolerance scores are higher than 0.1, while VIF scores stay below 10, suggesting that the data are free from multicollinearity.

Heteroscedasticity Test

The heteroscedasticity test using a scatterplot is presented in **Figure 3**.

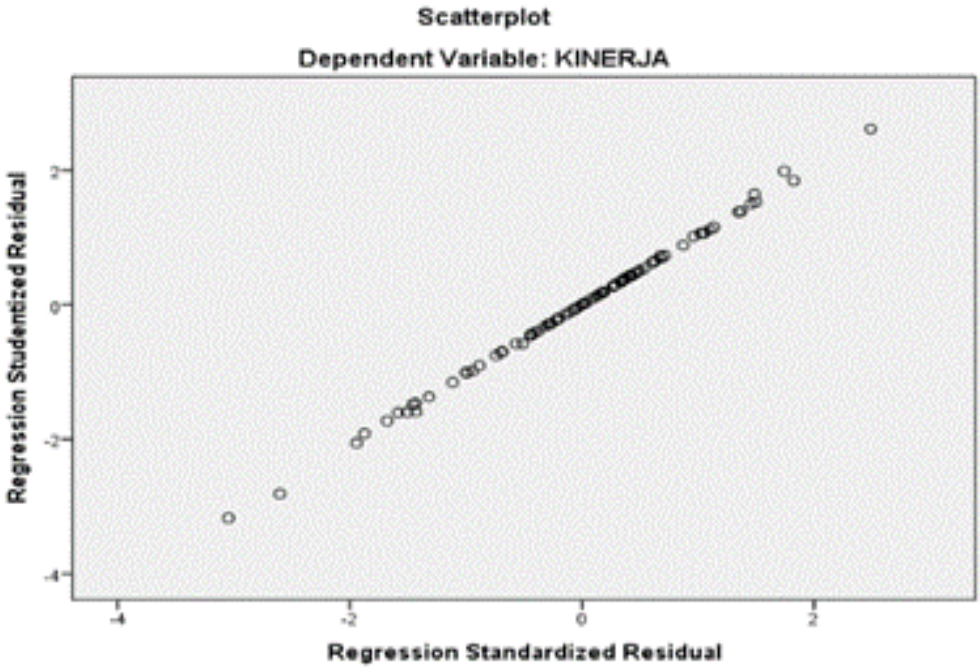

Figure 3 Scatterplot of Heteroscedasticity Test

As shown in **Figure 3,** The data are spread randomly without any discernible pattern, indicating the absence of heteroscedasticity.

Since all classical assumptions are satisfied, the regression coefficients can be interpreted as reliable estimators of the relationships between variables.

Analysis Using Multiple Linear Regression

Table 6 presents the findings from the multiple linear regression analysis.

Table 6 Regression Analysis Results

Attribute	Coefficient (B)	t-value	Sig.
Constant	8.531	1.672	0.098
Competence (X1)	0.907	3.190	0.002
Motivation (X2)	0.558	2.924	0.004
Loyalty (X3)	0.511	2.217	0.029
Work Discipline (X4)	0.653	2.996	0.004

From the results in Table 6, the regression equation can be expressed as follows:

$$Y=8.531 + 0.907X_1 + 0.558X_2 + 0.511X_3 + 0.653X_4$$

As indicated in **Table 6**, all independent variables have positive coefficients, confirming their positive influence on worker performance. Competence has the highest coefficient (β = 0.907), followed by work discipline (β = 0.653), motivation (β = 0.558), and loyalty (β = 0.511), indicating its stronger relative influence compared to other variables.

The coefficient of determination (R^2) of 0.653 indicates that 65.3% of the variation in worker performance is explained by the model, while the remaining variance is influenced by other factors not included in this study.

Hypothesis Testing

Partial Test (t-test)

Table 7 displays the results of the t-test analysis.

Table 7 t-Test Results

Attribute	t-value	Sig.	Conclusion
Competence (X1)	3.190	0.002	Notable
Motivation (X2)	2.924	0.004	Notable
Loyalty (X3)	2.217	0.029	Notable
Work Discipline (X4)	2.996	0.004	Notable

As shown in **Table 7**, all variables have sig values below 0.05, indicating that each variable has a notable effect on worker performance.

Simultaneous Test (F-test)

Table 8 presents the results of the F-test analysis.

Table 8 F-Test Results

F-value	Sig.	Conclusion
39.008	0.004	Notable

Based on **Table 8**, All independent variables together exert a notable impact on performance.

Statistical significance aligns with practical expectations: each HR factor **contributes to performance**, but their **relative effect differs**. Partial vs. simultaneous effects suggest **competence drives baseline productivity**, while other factors fine-tune output.

Coefficient of Determination

Table 9 shows the coefficient of determination (R^2) results.

Table 9 Model Summary

R	R Square	Adjusted R Square
0.808	0.653	0.636

As shown in **Table 9**, the model explains 65.3% of the variation in worker performance. The remaining 34.7% of variance could arise due to influences not incorporated in the model, such as workers' prior experience, project scale, environmental conditions, supervision quality, or other organizational and contextual influences. This emphasizes the central role of HR factors, particularly competence, while acknowledging that additional variables may also significantly affect performance outcomes.

Dominant Factor Analysis

Table 10 presents the summary of the dominant factor analysis, which is also depicted in **Figure 4**.

Table 10 Dominant Factors

Attribute	Percentage	Rank
Competence	86.75%	1
Loyalty	85.75%	2
Work Discipline	84.25%	3
Motivation	83.75%	4

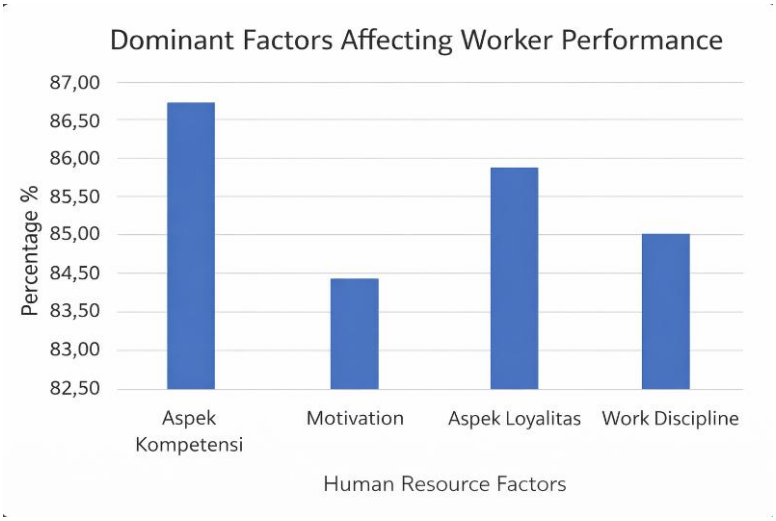

Figure 4 Dominant Factors Affecting Performance

As presented in **Table 10** and **Figure 4**, competence is identified as the most dominant factor influencing worker performance. This dominance indicates that performance variation is primarily driven by differences in technical capability rather than behavioral factors. In the context of Malang City, where the workforce is largely semi-skilled, skill gaps amplify the impact of competence, making it a more decisive determinant compared to motivation or discipline.

This finding aligns with Adebowale & Smallwood (2021) and Tam et al. (2021), which emphasize the critical role of competence in construction productivity, but contrasts with Willy and Sekarsari (2020), who identified discipline as dominant. These differences suggest that the relative importance of HR factors is context-dependent, particularly influenced by workforce characteristics and skill distribution. While motivation and loyalty remain significant, their lower impact indicates that they function as reinforcing factors, especially when integrated into competency-based development strategies (Jarkas & Radosavljevic, 2021).

From a sustainability standpoint, competence also acts as a key driver for implementing environmentally responsible practices, as it shapes the workforce's capacity to adopt green technologies and resource-efficient methods (Rahman et al., 2023; Darko et al., 2022). However, the model's reliance on survey data and a regional sample limits the generalizability of the findings, indicating the need for broader empirical validation.

CONCLUSION

This study analyzes the influence of competence, motivation, loyalty, and work discipline on construction worker performance in Malang City and identifies the most dominant factor. The results show that all variables have a significant and positive effect, with a coefficient of determination (R^2) of 0.653, indicating that 65.3% of performance variation is explained by the model. Competence is identified as the most dominant factor, emphasizing the importance of technical skills in improving performance, particularly in a workforce dominated by semi-skilled labor. Within the framework of sustainable construction, workforce competence plays a central role in enabling environmentally responsible practices, including efficient resource use and the adoption of green technologies. Therefore, construction companies should prioritize competency development through training, certification, and continuous upskilling, supported by motivation and loyalty to enhance engagement and consistency. Future research is recommended to include additional variables such as experience, leadership, and project characteristics, as well as to explore different contexts to improve the generalizability of the findings.

ACKNOWLEDGEMENTS

The authors acknowledge with gratitude the contributions of everyone who helped make this research possible, especially the construction workers and project stakeholders in Malang City for their valuable data and participation. Appreciation is also extended to colleagues and family for their support and encouragement.

REFERENCES

Adebowale, O. J., & Smallwood, J. (2021). Workforce competence and project success. *Construction Economics and Building, 21*(3), 45–60.

Aghimien, D., Aigbavboa, C., & Oke, A. (2022). Drivers of sustainable construction practices in developing countries. *Sustainability, 14*(9), 5302.

Alaghbari, W., Razali, A., & Kadir, M. R. A. (2020). The impact of human resource practices on construction project success. *International Journal of Project Management, 38*(2), 134–145.

Darko, A., Chan, A. P. C., & Yang, Y. (2022). Drivers for green building adoption. *Building and Environment, 207*, 108450.

Enshassi, A., Mohamed, S., & Abushaban, S. (2021). Factors affecting labor productivity in construction projects. *International Journal of Productivity and Performance Management, 70*(1), 1–20.

Gann, D. M., & Salter, A. J. (2020). Innovation in construction and the role of human capital. *Construction Management and Economics, 38*(7), 610–626.

Hernandi, A., & Tamtana, J. (2020). Productivity analysis in construction projects and cost performance. *International Journal of Engineering Research, 9*(7), 112–118.

Hwang, B. G., Shan, M., & Looi, K. Y. (2022). Key constraints and solutions for productivity improvement in construction. *Journal of Cleaner Production, 338*, 130543.

Jarkas, A. M., & Radosavljevic, M. (2021). Motivational factors impacting labor productivity. *Journal of Construction Engineering and Management, 147*(6), 04021046.

Kurniawan, D., Hidayat, A., & Prabowo, H. (2023). Urban construction growth and regional development in Indonesia. *Sustainability, 15*(6), 5123.

Li, X., Wu, P., & Wang, X. (2022). Skill development for sustainable construction workforce. *Automation in Construction, 139*, 104300.

Loosemore, M., & Malouf, N. (2019). Safety training and workforce competence in construction projects. *Engineering, Construction and Architectural Management, 26*(3), 460–476.

Nguyen, T. T., Nguyen, L. D., & Le-Hoai, L. (2021). Critical factors affecting labor productivity in construction. *Engineering, Construction and Architectural Management, 28*(2), 589–604.

Osei-Kyei, R., & Chan, A. P. C. (2021). Review of sustainable construction practices. *Journal of Cleaner Production, 298*, 126704.

Prasetyo, Y., Nugroho, A., & Santoso, B. (2022). Construction industry development in Indonesia: Trends and challenges. *Journal of Construction Engineering and Management, 148*(3), 04021190.

Rahman, M. A., Karim, S., & Hasan, M. (2023). Human resource capabilities in sustainable construction projects. *Sustainability, 15*(4), 3256.

Sari, D. P., & Putra, R. A. (2021). Human resource management in construction project performance. *International Journal of Construction Management, 21*(5), 487–495.

Tam, V. W. Y., Shen, L. Y., & Kong, J. S. Y. (2021). Impacts of construction workforce skill on project performance. *Journal of Cleaner Production, 279*, 123726.

Willy, A., & Sekarsari, J. (2020). Human resource factors affecting construction worker performance. *Journal of Civil Engineering Research, 10*(2), 45–52.

Zuluaga, C. M., Sosa, M., & Castañeda, D. I. (2022). Human factors in construction productivity. *Heliyon, 8*(5), e09345.