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Original Article

Productivity Model of Labour on Construction Projects in Indonesia

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Abstract *- Productivity and construction are two concepts that are connected. Construction is a labor-intensive sector of the economy, and employers value employees as a resource. This study aims to assess labor productivity on Indonesian construction projects, examine the variables that affect labor productivity on Indonesian construction projects, and create a model for predicting labor productivity on Indonesian construction projects. A questionnaire survey and information on road preservation projects obtained from the Indonesian Ministry of PUPR's Directorate General of Highways for the 2018–2022 fiscal year comprise the quantitative methodology employed in this study. Ratio Output/Input, Partial Least Square (smartPLS), Autoregressive Integrated Moving Average (ARIMA), and Structural Equation Modeling (SEM) were employed in the data analysis. The findings indicated that from 2018 to 2022, labor productivity decreased. As measured in kilometers per day per person, Region I's labor productivity was 2.4652, 2.2094, 1.7079, 1.8826, and 1.8879. In region II, the corresponding labor productivity values were 3.1724, 2.3126, 1.9292, 2.2208, and 2.2045 (km/day/person) and 1.7141, 1.9103, 1.6525, 1.8632, and 1.6302 (km/day/person) were the respective labor productivity figures for Region III. Internal labor, field circumstances, time, and finances significantly affect labor productivity in Regions I, II, and III. The projection results for 2023 to 2027 were obtained based on the outcomes of the processing of the three labor productivity statistics in each region (I, II, and III). 1.8157, 1.8017, 1.8295, 1.8400, and 1,8301 (km/day/person) where the corresponding values for areas I. The corresponding values for region II were 2.0287, 2.2569, 2.2689, 2.2602 and 2.2477 (km/day/person). The corresponding values for area III were 1.7980, 1.6771, 1.7641, 1.7015, and 1.7466 (km/day/person). Therefore, the output amount of the job and the length and number of contracted labor inputs make up the conceptual model of labor productivity on construction projects in Indonesia that has been used in this study.*

Keywords *- Productivity, Labor, Construction project, SmartPLS, ARIMA.*

1. Introduction

A vast sector of the economy that consistently creates jobs for a large number of people and has a significant impact on the national economy is the construction industry [1-3]. This contribution can be seen in the construction industry's capacity to supply a nation with capital, fixed assets, and essential infrastructure facilities [4,5].

The expansion of regional development, which is continuing to pick up steam, requires the assistance of suitable facilities and amenities from every sector. In order to spur development in a region, the transportation sector is crucial. As a result, every road construction aspect must be carefully considered, from design to maintenance [6-8].

The road structure's deterioration and the road's functioning prior to the plan's design life are common issues with roads in Indonesia. By implementing a road maintenance program, a road is intended to serve its customers in line with the specified plan age [9-12].

Until the stated design life, the road maintenance and repair program is anticipated to continue offering the highest level of service. Due to the high expenditures associated with road maintenance and repairs, a new road preservation strategy requires. The preservation method is an action conducted to maintain the road's functionality that can ensure an increase in the life of the road [13–16].

Construction projects depend on highly correlated management inputs like capital, materials, and labor to be completed successfully. Construction is a labor-intensive sector of the economy, and employers value employees as a resource. It is crucial to comprehend the notion of labor productivity since it significantly impacts construction management, where timely measurement and monitoring of productivity is the best management practice. Productivity concerns are mostly connected to labor performance and are problems linked with subpar project completion [17–19].

In industrial operations, the phrase "productivity" refers to the comparison of input and output. A productivity metric shows how effectively resources are used and managed to provide the best results. A measure of an industry's ability to produce goods or services is its productivity [20].

The practical completion of a project that creates significant revenues for the construction sector and impacts the national economy depends heavily on labor productivity. Labor is seen as a key productivity resource [26].

Cost, quality, timeliness, job security, and goal attainment are used to gauge a project's success. Productivity significantly impacts how long a construction project will take to complete. The likelihood of job delays increases as productivity declines. On the other hand, the likelihood of delays decreases as production increases [22].

This study aims to evaluate labor productivity on construction projects in Indonesia, analyze the factors that affect labor productivity on construction projects in Indonesia, and develop a projected model of labor productivity on construction projects in Indonesia.

2. Research Method

In this study, quantitative data analysis was employed. The respondents are workers involved in road building since the respondent's criteria are construction employees working on road projects in Indonesia. The minimal number of samples needed to process a study using the Partial Least Square (PLS) model is 30, or large samples over 200 [23,24]. As a result, it is anticipated that each of the three regions, I, II, and III, will have a minimum of 30 respondents for the data used in this study. The operational research model is depicted in Figure 1.

Two different types of variables, the independent and the dependent, were employed in this study; the independent variable was known as the X variable, and the dependent variable was the Y variable. Table 1 lists the variables that were used.

The project's physical contract data, which includes the project name, work volume, duration, and the number of contracted workers, as well as the results of distributing questionnaires via Google Form, is the source of the data used in modeling labor productivity on road construction projects in Indonesia.

Table 1. Research variable

No.	Code	Variables/Indicators/Sub Indicators	Source
Dependent Variable			
I	**X1**	**Field Conditions (on-site factor)**	
1	X1.1	Lack of materials and equipment	W. S. Alaloul et al., 2021.
2	X1.2	Delays in the delivery of materials and equipment	A. B Muzamil, B. Khursid, 2014.
3	X1.3	Project locations that are difficult for workers to reach	W. S. Alaloul et al., 2021
4	X1.4	Project site security	W. S. Alaloul et al., 2021
5	X1.5	Control/supervision of working hours	Altuncan dan Tanyer, 2018.
II	**X2**	**Time Factor**	
1	X2.1	Work 7 days a week	W. S. Alaloul et al., 2021
2	X2.2	High working hours	W. S. Alaloul et al., 2021
3	X2.3	Project size/project duration	M. Nizar, 2016
4	X2.4	Increasing the number of workers to speed up work	W. S. Alaloul et al., 2021
5	X2.5	No schedule (less regular schedule)	A. B Muzamil, B. Khursid, 2014.
III	**X3**	**Financial Factor**	
1	X3.1	Bad salary	A. B Muzamil, B. Khursid, 2014.
2	X3.2	Late payment for labor	W. S. Alaloul et al., 2021
IV	**X4**	**Labor Internal Factors**	
1	X4.1	Total manpower	A. B Muzamil, B. Khursid, 2014.
2	X4.2	Poor worker health	W. S. Alaloul et al., 2021
3	X4.3	Skill level of workers	Johari dan Jha, 2021.
4	X4.4	Worker motivation	W. S. Alaloul et al., 2021
5	X4.5	The skill level and training	W. S. Alaloul et al., 2021
6	X4.6	Work experience	Altuncan dan Tanyer, 2018.
Independent Variable			
	Y	**Labor Productivity**	
1	Y1	Productivity factors that affect the success of a project in managing and utilizing Human Resources to achieve optimal results	Harris, dkk., 2017

Fig. 1 Research operational model

3. Results and Discussion

3.1. Labor Productivity in Construction Projects in Indonesia

Table 2 displays the worker productivity on Indonesian construction projects. For instance, in Region I of 2018, labor productivity is calculated. This is likewise done in Region II and Region III, namely:

$$\text{Average of productivity} = \frac{Total\ Productivity\ Value}{Number\ of\ Projects}$$
$$= \frac{441.2708}{179}$$
$$= 2{,}4652\ \text{(km/days/person)}$$

A map of Indonesia's productivity values is depicted in Figure 2. Based on information obtained from the Ministry of PUPR for the Directorate General of Highways and the amount of data obtained in 2029 road preservation project data, along with the average value of labor productivity in each region, it is possible to see the number of projects from each region I, II, and III in the years 2018 through 2022. It clearly shows that the productivity value in region I will decline until 2022, while the values in regions II and III will fluctuate between 2018 and 2022. This could result from working conditions not supported by materials, labor equipment, or effective implementation techniques when a project is being implemented.

Table 2. Labor productivity

No.	Region	Year	Number of projects	Average productivity value (km/day/person)
1	I	2018	179	2.4652
2	II		250	3.1724
3	III		124	1.7141
4	I	2019	151	2.2094
5	II		94	2.3126
6	III		133	1.9103
7	I	2020	226	1.7079
8	II		123	1.9292
9	III		129	1.6525
10	I	2021	122	1.8826
11	II		98	2.2208

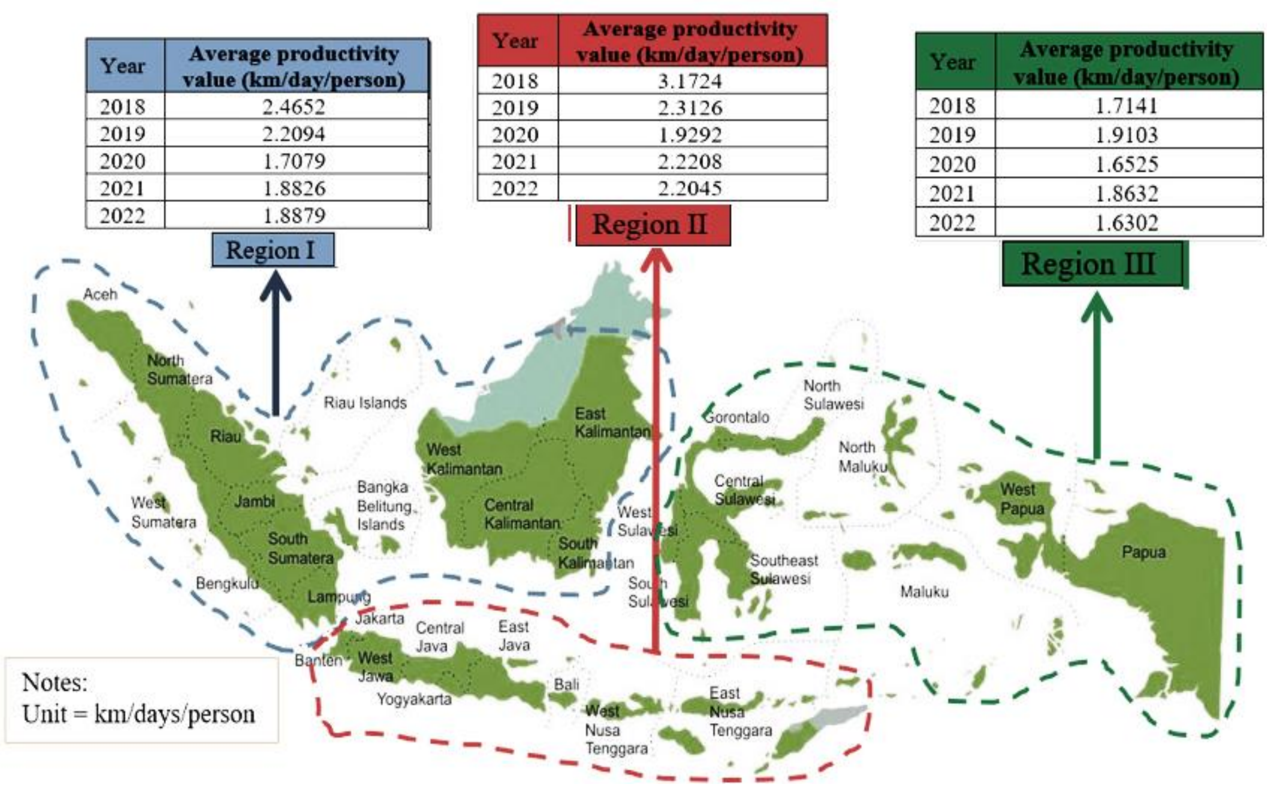

Fig. 2 Productivity value sharing map in Indonesia

3.2. Factors Affecting Labor Productivity in Construction Projects in Indonesia

An evaluation model that measures the relationship between variables is used in calculating the outer model. Figures 3, 4, and 5 all describe the outer model for each region.

The inner model or structural model is tested to determine the relationship between the research model's concept, significant value, and R-square. The significance of the coefficients of the structural path parameters and R-square for the dependent construct of the t-test was used to assess the structural model. The R-square for each latent dependent variable is the first to consider when evaluating the model with PLS. To determine how much an exogenous construct may explain an endogenous construct, use the coefficient of determination (R-square). The coefficient of determination (R-square) is anticipated to fall between 0 and 1. The R-square estimation using SmartPLS yielded the following findings, which are presented in Table 3.

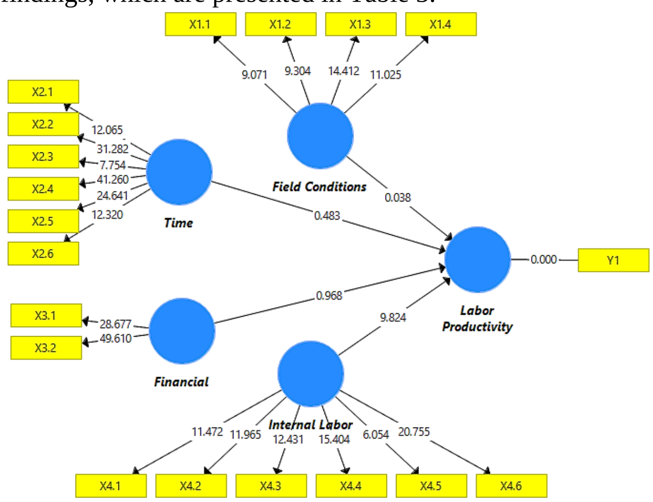

Fig. 3 Measurement of the outer model region I

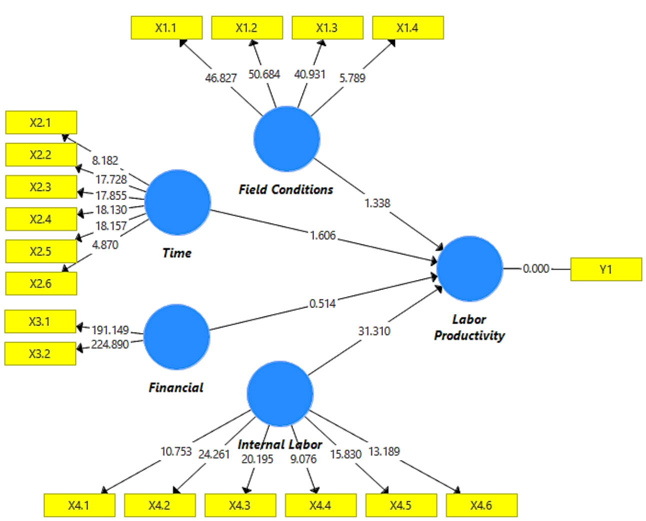

Fig. 4 Measurement of the outer model region II

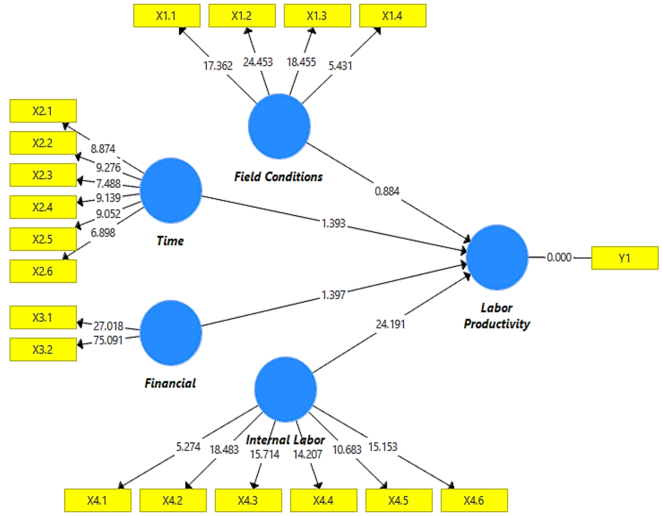

Fig. 5 Measurement of the outer model region III

Table 3. R-Square values in regions I, II and III

Labor productivity	Region		
	I	II	III
R Square	0.697	0.743	0.728
R Square Adjusted	0.585	0.644	0.716

Table 4. Hypothesis test results

Hypothesis	Construct/variable	Information
1	Financial	Hypothesis Accepted
2	Internal Labor	Hypothesis Accepted
3	Field Condition	Hypothesis Accepted
4	Time	Hypothesis Accepted

According to the specification table, the research model used in each region is included in a strong model specification because it has good goodness of fit and is specified between 50 and 75 percent of the time. To determine if exogenous variables impact endogenous variables, hypothesis testing is utilized. According to the test criteria, if Tstatistics. Exogenous variables have a significant positive or negative impact on endogenous variables, according to the T-table (1.96). In PLS (Partial Least Square), simulation tests each postulated association statistically. The sample, in this instance, is subjected to the bootstrap procedure. The goal of bootstrap testing is to reduce the issue of anomalous research data. In PLS (Partial Least Square), simulation tests each postulated association statistically. The sample, in this instance, is subjected to the bootstrap procedure. The goal of bootstrap testing is to reduce the issue of anomalous research data. Table 4 displays the outcomes of the bootstrapping test from the PLS analysis for each region I, II, and III.

By completing all instrument tests that are processed using SmartPLS, it is possible to see from Table 4 that all the variables used in the study are hypotheses that can be accepted or are consistent with the research objectives, which include the identification of factors that affect labor productivity on construction projects in Indonesia, particularly on road projects—based on the final score that was determined by the quantity and average of the disseminated questionnaires. Table 5 lists the primary factors that affect labor productivity in each location, from most important to least important (I, II, and III), in descending order. A map of Indonesia's level division is shown in Fig. 6.

3.3. Labor Productivity Projection Model for Construction Projects in Indonesia

The Autoregressive Integrated Moving Average (ARIMA) approach calculates the projection model for labor productivity on road construction projects in Indonesia. The data used in this projection are the labor productivity values from 2018 to 2022 in regions I, II, and III, which are examined in target number 1. To go on to statistical analysis, data processing is done with RStudio. Since the productivity data does not follow a seasonal pattern, this study's data are non-seasonal.

ARIMA is the projection technique used for non-seasonal data. The AR (Autoregressive), MA (Moving Average), and ARIMA (Autoregressive and Moving Average) models were combined to create the ARIIMA approach, which is an auto-regressive integrated moving average model. The Box-Jenkins time series method is another name for this approach. There are four steps in the ARIMA modeling process. Data preparation and stationary model identification are the first steps. Estimating the model is the second step. 3. Run diagnostic tests and choose the best model. Applying the best model to future projections is the final stage. In order to run ARIMA modeling three times, this study is split into three sections. Table 6 displays the outcomes of projection analysis using ARIMA and RStudio software in areas I, II, and III.

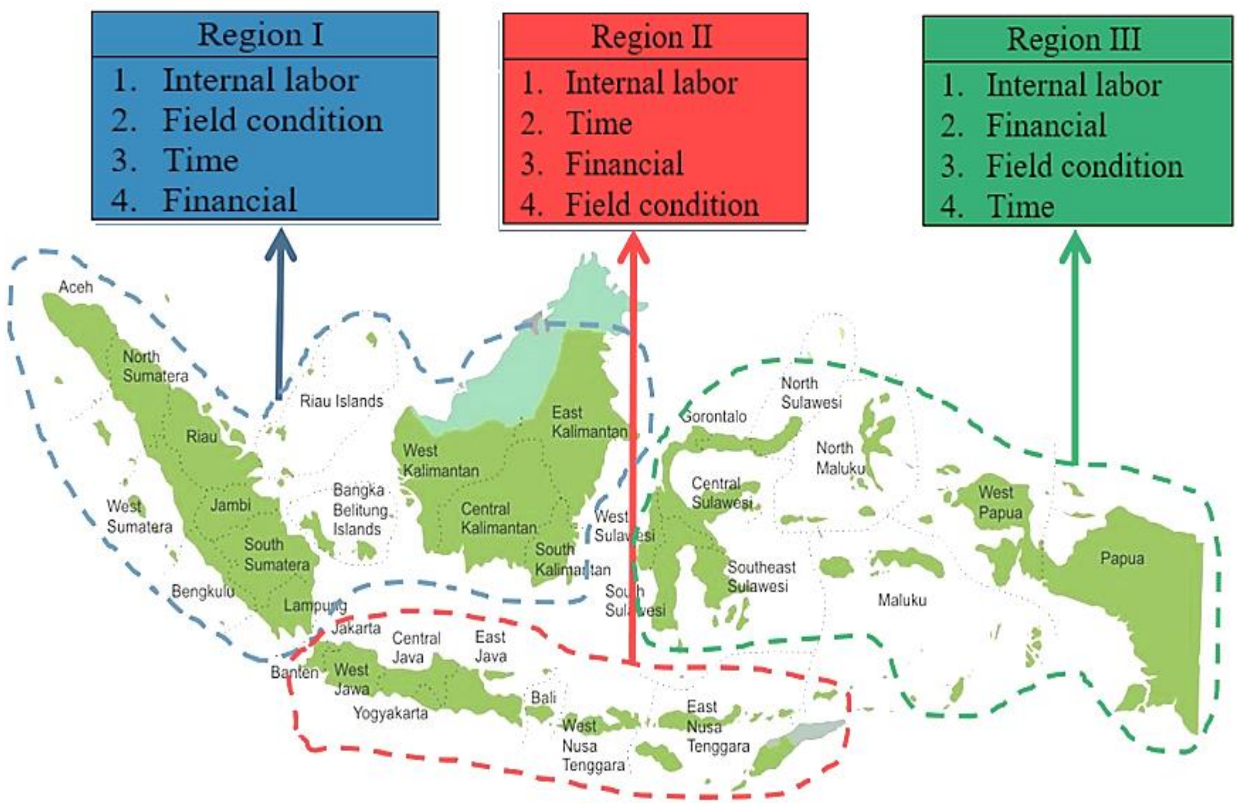

Fig. 6 Map of the division of the level of significance in Indonesia

Table 5. The level of significance of regional variables

Factor Variable	Value Analysis/Region		
	I	II	III
Internal Labor	0.9870	0.9160	0.9120
Field Condition	0.4620	0.6370	0.6430
Time	0.4500	0.5810	0.6260
Financial	0.4400	0.4990	0.5340

Table 6. Projected results of labor productivity in Indonesia in 2023-27

Year	Productivity Projection		
	Region I	Region II	Region III
2023	1.8157	2.0287	1.7980
2024	1.8017	2.2569	1.6771
2025	1.8295	2.2689	1.7641
2026	1.8400	2.2602	1.7015
2027	1.8301	2.2477	1.7466

4. Conclusion

1. Between 2018 and 2022, there was a difference in labor productivity for road construction projects in Indonesia, particularly for work on road preservation that is classified into regions I, II, and III. From 2018 to 2022, the labor productivity in Region I is 2,4652, 2,2094, 1,7079, 1,8826, and 1,8879 km/day/person. From 2018 through 2022, region II's labor productivity will be 3.1724, 2.3126, 1.9292, 2.2208, and 2.2045 km/day/person. From 2018 to 2022, Region III's labor productivity is 1.7141, 1.9103, 1.6525, 1.8632, and 1.6302 km/day/person. The data analysis concludes that area II has higher labor productivity than regions I and III.

2. Field circumstances, time, finances, and internal labor are elements that affect worker productivity on construction projects in Indonesia, particularly on road preservation work that is classified into regions I, II, and III. These aspects are more or less critical in each of the three regions—I, II, and III. In area I, these factors are (1) internal workforce; (2) field circumstances; (3) time; and (4) money. The following elements apply to area II: (1) internal labor; (2) time; (3) finances; and (4) field conditions. Precisely, factors (1) internal labor; (2) finance; (3) field conditions; and (4) time while in area III. Conclusion: There are considerable regional disparities in the parameters that influence labor productivity on Indonesian construction projects.

3. For Region I, the values for 2023–2027 are 1.8157, 1.8017, 1.8295, 1.8400, and 1.8301 (km/day/person). Specifically, while in region II, 2.0287; 2.2569; 2.2689; 2.2602; and 2.2477 (km/day/person). Specifically, 1.7980; 1.6771; 1.7641; 1.7015; and 1.746659 (km/day/person) in area III.

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