International Journal of Economics, Business and Innovation Research
https://e-journal.citakonsultindo.or.id/index.php/IJEBIR
E-ISSN : 2964-0865
IJEBIR

Digitalization And Labor Productivity: Examining The Paradox In Indonesia's Digital Economy

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Abstract

Digital transformation has become one of the key drivers of modern economic change; however, its impact on labor productivity remains uneven across regions. This study aims to analyze the effect of digitalization, measured by the Indonesian Digital Society Index (IMDI) and the Human Development Index (HDI), on labor productivity across provinces in Indonesia. The analysis employs a panel data regression method using the Random Effect Model (REM), based on data from 34 provinces during the 2022–2024 period, sourced from the Ministry of Manpower, the Ministry of Communication and Informatics, and Statistics Indonesia (BPS). The results indicate that IMDI has no significant effect on labor productivity, while HDI has a positive and significant influence. These findings suggest that digitalization in Indonesia still faces a gap between infrastructure availability and its productive utilization, a phenomenon consistent with the Solow Paradox. In contrast, the quality of human capital emerges as a key determinant in enhancing labor productivity.

Keywords : Labor Productivity, Digitalization, Indonesian Digital Society Index, Solow Paradox

INTRODUCTION

The rapid advancement of digital technology has revolutionized the way people work and interact in the global society, redefining traditional economic paradigms. Digitalization, which encompasses the widespread adoption of Information and

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Communication Technologies (ICT), is widely recognized as a critical driver of production efficiency and innovation across various economic sectors (Lavrow et al., 2019). In Indonesia, digital transformation has been positioned as one of the key pillars of long-term economic development through the Digital Indonesia 2045 strategy. This initiative reflects the government's commitment to promoting the utilization of digital technologies across sectors to achieve inclusive and sustainable economic growth (Mottaeva et al., 2023).

One of the key instruments used to assess the digital readiness of Indonesian society is the Indonesia Digital Society Index (Indeks Masyarakat Digital Indonesia/IMDI), which consists of four main pillars: Infrastructure and Ecosystem, Digital Skills, Empowerment, and Employment. In 2022, the IMDI score reached 37.80 and increased to 43.18 in 2023, indicating a positive trend in the digital readiness of the population. However, despite improvements in digital infrastructure and skills, the Empowerment and Employment pillars continue to face significant challenges (Mou, 2023). This issue deserves particular attention, as the success of digital transformation depends not only on the availability of digital infrastructure but also on the ability of individuals to utilize technology productively, especially within the labor market and formal employment sectors.

Although Indonesia's labor productivity has shown an upward trend, with GDP per person employed (constant PPP) reaching approximately USD 8,939.2 in 2024, the country's labor productivity remains below the average of middle-income countries in the ASEAN region. Furthermore, a substantial productivity gap persists when compared to more advanced economies such as Malaysia. A comparison of labor productivity across five middle-income ASEAN countries is presented in Figure 1.

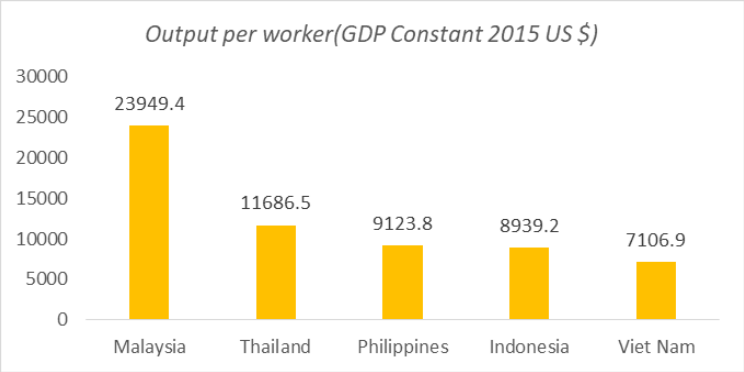


Figure 1. Labor Productivity in Middle-Income ASEAN Countries, 2024 ource: International Labour Organization, 2024

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Figure 1 illustrates that although Indonesia has made notable progress in digital readiness, as reflected by the increasing Indonesia Digital Society Index (IMDI), its labor productivity remains lower than that of several ASEAN countries, particularly Malaysia and Thailand. This situation raises a fundamental question: why has the advancement of digitalization, as indicated by the improvement in IMDI, not been accompanied by a substantial increase in labor productivity? This phenomenon suggests the existence of a digital–productivity paradox, whereby advances in digital technology have not yet translated into significant improvements in labor output.

This issue is both practically and academically important. If digitalization fails to contribute meaningfully to labor productivity, a comprehensive evaluation of digital transformation policies and programs becomes necessary. Such policies should place greater emphasis on the productive use of technology within the formal sector. Digitalization strategies should therefore focus not only on expanding digital access and literacy but also on enhancing workforce competencies that align with the demands of the modern labor market (Barykin et al., 2022).

Furthermore, the effectiveness of digitalization is influenced by several supporting factors, including infrastructure readiness, educational attainment, and technology-based training programs tailored to industrial needs. These factors are essential to ensure that digital transformation generates tangible benefits not only in terms of digital access and literacy but also in improving the global competitiveness of Indonesia's workforce (Aliyev & Shahverdiyeva, 2017).

A comprehensive investigation of the relationship between digitalization and labor productivity across regions is therefore necessary to understand the mechanisms underlying this phenomenon and to formulate more effective strategies for addressing the challenges of the digital economy. The economic efficiency gains generated by digitalization are expected not only to increase output but also to contribute to more inclusive and sustainable development. In this regard, collaboration among government institutions, the private sector, and educational organizations must be strengthened to build an optimal digital ecosystem that enables all segments of society to participate in and benefit from digital transformation.

Based on the foregoing discussion, this study aims to examine the relationship between the level of digitalization, measured by the Indonesia Digital Society Index (IMDI), and labor productivity across provinces in Indonesia. Specifically, the study seeks to provide empirical evidence on the extent to which digital progress contributes to regional labor productivity and to identify factors that hinder the optimization of digital

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transformation in provinces with relatively low productivity levels. The findings are expected to serve as a foundation for designing more responsive, inclusive, and equitable digital economic development policies, while simultaneously enhancing the competitiveness of Indonesia's workforce in the global economy.

Objectives

This study employs a quantitative approach using panel data regression analysis to examine the effect of digitalization on labor productivity in Indonesia. The dataset consists of observations from 34 provinces over the period 2022–2024. Panel data regression is selected because it enables the simultaneous analysis of cross-sectional differences among provinces and temporal dynamics over time, thereby producing more efficient and reliable estimates.

Labor productivity serves as the dependent variable, representing the efficiency of labor in generating economic output. The primary independent variable is the Indonesia Digital Society Index (IMDI), which reflects the level of digitalization and society's capacity to adapt to digital technologies. In addition, the Human Development Index (HDI) is included as a control variable to account for the quality of human capital in terms of education, health, and living standards.

All data were obtained from official government institutions. Labor productivity data were sourced from the Ministry of Manpower, IMDI data from the Ministry of Communication and Digital Affairs, and HDI data from Statistics Indonesia (BPS). The appropriate panel data regression model was determined through a series of specification tests, including the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test.

The empirical panel data regression model is specified as follows :

$$PTKit = \beta 0 + \beta 1\ IMDIit + \beta 2IPMit + eit$$

Where:

PTK = Labor Productivity
IMDI = Indonesia Digital Society Index
HDI = Human Development Index
i = Cross-sectional units representing 34 provinces in Indonesia
t = Time-series dimension covering the period 2022–2024
β_0 = Intercept constant, representing the value of the dependent variable when all independent variables are equal to zero
$\beta_1, \beta_2, \beta_3$ = Regression coefficients indicating the magnitude and direction of the effect of each independent variable on the dependent variable

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ε_{it} = Error term representing unobserved factors and random disturbances affecting the dependent variable

DISCUSSION

To determine the most appropriate panel data regression model, several specification tests were performed. The first step involved the Chow Test, which was used to compare the Common Effects Model (CEM) and the Fixed Effects Model (FEM). The results of the Chow Test are reported in Table 1.

Table 1. Chow Test Results

Effects Test	Statistic	d.f.	Probabilitas
Cross-section F	372.080671	(33,66)	0.0000
Cross-section Chi-square	533.595078	33	0.0000

Source: Processed Data, 2025.

The results of the Chow Test indicate that the probability value of the Cross-section F statistic is 0.0000, which is lower than the 5 percent significance level (0.05). Therefore, the null hypothesis (H_0) is rejected, while the alternative hypothesis (H_1) is accepted. This finding suggests that the Fixed Effects Model (FEM) is more appropriate than the Common Effects Model (CEM) for estimating the relationship between digitalization and labor productivity across provinces in Indonesia.

The selection of the Fixed Effects Model implies the presence of significant heterogeneity across provinces that cannot be adequately captured by a pooled regression model. By accounting for province-specific characteristics that remain constant over time, the FEM provides more reliable and consistent estimates of the effects of the explanatory variables on labor productivity.

Table 2. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Probabilitas
Cross-section random	3.455257	2	0.1777

Source: Processed Data, 2025.

The results of the Hausman Test indicate that the probability value of the Cross-section Random statistic is 0.1777, which is greater than the 5 percent significance level

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(0.05). Therefore, the null hypothesis (H_0) cannot be rejected, while the alternative hypothesis (H_1) is rejected. This result suggests that the Random Effects Model (REM) is more appropriate than the Fixed Effects Model (FEM) for estimating the relationship between digitalization and labor productivity across provinces in Indonesia. The preference for the Random Effects Model indicates that the unobserved provincial-specific effects are not systematically correlated with the explanatory variables included in the model. Consequently, the REM provides more efficient parameter estimates while still accounting for variations across provinces and over time. Based on these findings, the Random Effects Model was selected for subsequent analysis and interpretation.

Table 3. Lagrange Multiplier (LM) Test Results

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	99.72052	1.405256	101.1258
	(0.0000)	(0.2358)	(0.0000)

Source: Processed Data, 2025.

Based on the results of the Breusch–Pagan Lagrange Multiplier (LM) Test, the probability value of the Cross-section Breusch–Pagan statistic is 0.0000, which is lower than the 5 percent significance level (0.05). Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This finding indicates that the Random Effects Model (REM) is more appropriate than the Common Effects Model (CEM) for analyzing the panel data.

Based on the overall model selection procedure, including the Chow Test, Hausman Test, and Lagrange Multiplier (LM) Test, the Random Effects Model (REM) was identified as the most suitable model for this study. The Chow Test indicated that the Fixed Effects Model (FEM) was preferable to the Common Effects Model (CEM). However, the Hausman Test suggested that the Random Effects Model (REM) was more appropriate than the Fixed Effects Model (FEM). Furthermore, the LM Test confirmed that the REM outperformed the CEM. Taken together, these results support the use of the Random Effects Model as the final estimation model.

The selection of the REM implies that unobserved provincial-specific effects are random and uncorrelated with the explanatory variables included in the model. Consequently, the REM is considered the most appropriate approach for capturing

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unobserved heterogeneity across provinces while providing efficient and consistent parameter estimates of the determinants of labor productivity in Indonesia.

Table 4. Random Effects Model Estimation Results

Variabel	Koefisien	Std. Error	t-Statistik	Probabilitas
C	-392.7759	96.0420	-4.0896	0.0001
IMDI	-0.1350	0.2243	-0.6020	0.5485
IPM	6.8136	1.3943	4.8868	0.0000
R-squared	0.2793	Adjusted R-squared	0.2648	
Prob (F-statistik)	0.0000	Durbin-Watson stat	1.4014	

Source: Processed Data, 2025.

The estimation results indicate that the coefficient of the Indonesia Digital Society Index (IMDI) is –0.1350, with a probability value of 0.5485 (> 0.05). This finding suggests that digitalization, as measured by the Indonesia Digital Society Index, does not have a statistically significant effect on labor productivity across provinces in Indonesia. In other words, improvements in digital readiness have not yet translated into measurable gains in labor productivity at the regional level.

In contrast, the Human Development Index (HDI) exhibits a positive coefficient of 6.8136 and is statistically significant at the 1 percent level (p = 0.0000). This result indicates that improvements in human capital quality play a crucial role in enhancing labor productivity. Provinces characterized by higher levels of education, better health conditions, and improved living standards tend to have a more productive workforce. The finding highlights the importance of human capital development as a key determinant of labor productivity and regional economic performance.

Furthermore, the model yields a Prob(F-statistic) value of 0.0000, indicating that the Indonesia Digital Society Index (IMDI) and Human Development Index (HDI) jointly have a statistically significant effect on labor productivity across provinces. The R-squared value of 0.2793 suggests that approximately 27.9 percent of the variation in labor productivity can be explained by the variables included in the model, while the remaining 72.1 percent is attributable to other factors not captured in this study.

The insignificant effect of digitalization may reflect the existence of a digital–productivity paradox in Indonesia. Although digital infrastructure and digital readiness have improved considerably in recent years, the benefits of digitalization may not yet have

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been fully transformed into productivity gains. This condition may arise due to disparities in digital skills, limited adoption of advanced technologies in productive sectors, uneven digital infrastructure quality across regions, and the relatively slow adaptation of the labor force to technology-driven work environments. Consequently, digital transformation alone may be insufficient to improve labor productivity without complementary investments in human capital development and workforce capacity enhancement.

The empirical findings indicate that digital transformation, as measured by the Indonesia Digital Society Index (IMDI), has not yet exerted a statistically significant effect on labor productivity across provinces in Indonesia. This result suggests that advances in digitalization have not been fully translated into productive capacity within the labor market. In other words, a gap remains between the availability of digital infrastructure and its effective utilization for value-added economic activities.

Although the increasing IMDI score reflects progress in internet accessibility, digital literacy, and the adoption of information and communication technologies, digitalization in Indonesia appears to be concentrated primarily on technology availability and adoption rather than on the integration of technology into production processes and workforce skill enhancement. This observation is consistent with Statistics Indonesia (BPS, 2024), which reported that the proportion of workers possessing intermediate-to-advanced digital skills remains below 20 percent. Furthermore, the use of digital technologies in many economic sectors continues to be predominantly administrative rather than productivity-enhancing.

This phenomenon can be explained through the concept of the **Solow Productivity Paradox** (Solow, 1987), famously summarized by the statement, “You can see the computer age everywhere but in the productivity statistics.” The paradox suggests that increased investment in information technology does not necessarily lead to proportional gains in productivity. In the Indonesian context, despite substantial improvements in digital connectivity and technological penetration, the expected productivity gains have yet to materialize. The digital adoption process in many regions has not been accompanied by sufficient improvements in workforce competencies, organizational restructuring, or process innovation that would enable technology to be utilized efficiently and productively.

The Solow Paradox remains highly relevant to the Indonesian experience. While investment in digital technologies continues to grow, not all productivity gains are immediately observable in economic indicators. The rapid expansion of internet access and digital platforms has not automatically translated into higher labor productivity (Widjaja & Wijayadne, 2022). Moreover, substantial regional disparities in digital

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development indicate that provinces with higher levels of digitalization do not necessarily achieve greater labor efficiency than provinces that rely on more conventional production methods. This finding highlights the importance of complementary factors, including educational attainment, social readiness, and economic infrastructure, in determining the success of digital transformation initiatives (Harimurti, 2023).

In contrast, the Human Development Index (HDI) demonstrates a positive and statistically significant effect on labor productivity. This result confirms that human capital quality, particularly in terms of education, health, and living standards, serves as a fundamental driver of productivity growth (Purnomowati & Prasetiowati, 2023). The finding is consistent with Lucas's endogenous growth theory, which emphasizes that investments in human capital enhance individuals' capacity to adapt to technological change and generate productivity improvements. Consequently, the effectiveness of digitalization largely depends on the quality of human resources available to utilize and maximize technological advancements.

Furthermore, Brynjolfsson and Hitt (2000) argue that the productivity benefits of information technology can only be realized when technology adoption is complemented by adequate skills, organizational capabilities, and managerial practices. Therefore, policies aimed at accelerating digital transformation in Indonesia should not focus solely on expanding digital infrastructure and internet access. Equal emphasis should be placed on strengthening productive digital literacy, vocational education, workforce reskilling, and the integration of digital technologies into production systems and business operations.

Looking ahead, Indonesia's ability to leverage digitalization for productivity enhancement will depend on the synergy between digital policies, human capital development, and inclusive economic development strategies. Without strong human and institutional foundations, digitalization risks becoming merely a statistical achievement rather than a genuine source of sustainable economic value creation (Koswara, 2024). Therefore, future digital transformation policies should adopt a more holistic approach that simultaneously promotes technological advancement, workforce capability development, and institutional readiness to maximize the productivity benefits of the digital economy.

CONCLUSION

The findings of this study reveal that the Indonesia Digital Society Index (IMDI) does not have a statistically significant effect on labor productivity across provinces in

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Indonesia. This result suggests that digitalization in Indonesia remains largely focused on expanding digital access and infrastructure, rather than being effectively utilized to enhance productive economic activities. The finding is consistent with the **Solow Productivity Paradox**, which argues that technological advancement is not always reflected in measurable productivity gains. In contrast, the Human Development Index (HDI) exhibits a positive and statistically significant effect on labor productivity, indicating that human capital quality remains a key determinant in maximizing the benefits of digitalization. Higher levels of education, better health conditions, and improved living standards contribute substantially to workforce productivity. Therefore, the success of digital transformation depends not only on technological development but also on the readiness of human capital and the capacity of workers to adapt to technological change at the provincial level. These findings imply that policymakers should complement investments in digital infrastructure with strategies aimed at strengthening human capital development, enhancing productive digital skills, and promoting the integration of digital technologies into economic and production activities. Such an approach is essential for ensuring that digital transformation contributes effectively to sustainable productivity growth and regional economic development in Indonesia.

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