

How does ICT Drive Human Development in Indonesia? Evidence from Provincial Data

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Abstract. This study aims to explore ICT development on human resource development in Indonesia. This study uses the ICT index to represent ICT development and HDI to represent human resource development. In addition, this study also sets FDI and domestic investment as control variables. The data used is panel data from provinces in Indonesia during the 2017-2023 period. Through panel data regression, using the Least Square Dummy Variable (LSDV), this study shows that ICT and domestic investment positively and significantly impact human resource development, while FDI is negatively insignificant.

Keywords: ICT; Human Development; Investment.

1 Introduction

A lot of research on the impact of information and communication technology (ICT) on economic development has been undertaken. However, the results have been varied [1]-[4]. [5] revealed that the internet contributes 3.4 percent to GDP in developed countries, with the home consumption sector being the key contributor. Furthermore, this research also demonstrates that the internet provides more options for entrepreneurs. In contrast, there is poor and ambiguous empirical evidence about the contribution of information technology to economic growth for low-middle income countries [4].

[6] argued that ICT does not have a direct effect on economic growth, this is because ICT does not stand alone, there are more other exogenous variables that are more dominant in influencing growth. This opinion is increasingly relevant where the impact of ICT tends to be weak in driving growth in developing countries [4], but has a greater effect on developed countries [5]. Amid the fact that there is no consensus on the impact of ICT on economic growth, especially in developing countries, we cannot deny that the countries that are leading the industry today are countries based on the knowledge economy. Compared to traditional economic concepts such as capital and labor in creating wealth and prosperity, they lead the industry with knowledge, technology, and innovation. Proponents of the knowledge-based economy concept believe that a society with better knowledge will face challenges, optimize opportunities, and increase scalability and efficiency.

ICT has reduced the cost of electronic networks, boosted processing power, and improved the efficiency of disseminating existing knowledge. For example, researchers around the globe might collaborate to increase research productivity, which leads to greater research and development and the discovery of new technologies and knowledge. On the other hand, acquiring and disseminating new knowledge and technology can be done rapidly, efficiently, and at a low cost, which is a positive indicator for human resource development. Furthermore, this situation enables the formation of new business prospects, employment chances, and, as a result, increased growth. [7] claimed that the knowledge revolution and growing globalization create significant prospects for business, social, and economic development. Based on the narration, incentives provided by ICT accompanied by globalization are one of the essential capitals in building a knowledge-based economy [7].

The great opportunities brought by ICT and considering the concept of a knowledge economy that has an orientation to the quality of human resources strengthens the opinion of [6], which states that currently, it is not appropriate to use ICT as a proxy for economic growth in developing countries and more reliable to measure the impact of ICT on other welfare indicators such as access to health, education, and human resource development. This premise is also reinforced by several studies on the impact of ICT on growth which tend to be inconsistent. Returning to the issue of the role of ICT in economic growth, the concept of economic knowledge provides a theoretical view that can be relied upon in answering how information technology promotes growth by driving some of the exogenous variables, especially human development.

However, besides providing several benefits, ICT can exacerbate inequality if agents or communities cannot adapt to or keep up with quick changes. As a result, for an industry to grow sustainably, it must actively and profitably generate new value-added. As a result, high-value services and innovations, rather than production, are the most important elements in the value chain [7]. In short, the concept of the knowledge economy believes that innovation is an important factor in business continuity and business competition. Of course, this innovation is not born immediately but is driven by qualified human resources. One of the main factors for increasing human resources is the ease of access to information and knowledge. Industry and entrepreneurs can level up through innovation, and workers can improve their skills. Ease of access to information and knowledge is an incentive brought by ICT. ICT can provide information more quickly and precisely, reducing operational costs, time efficiency, and generating level up-skill and business opportunities [8]–[10].

Indonesia, through the Central Statistics Agency since 2017, has issued an official release on the information and communication technology development index (ICT Index) in each province in Indonesia. ICT Index is a standard measure that can describe the level of information and communication technology development in a region, the digital divide, and the potential for ICT development. The issuance of this index clearly shows that Indonesia views the important role of information technology in mediating or moderating the factors driving growth. The question now is, is ICT in Indonesia able to encourage the creation of a knowledge-based economy? There is still limited data to answer this issue, but seeing the foundation of a knowledge-based economy is human resources. The investigation of the impact of ICT on the Human development index (HDI) is one of the best approaches that can be taken for the case of Indonesia.

The latest research on the impact of ICT on human resource growth in Indonesia was conducted by Mursyid, through panel data, this study shows that ICT has a positive and

significant impact on human resource development [11], but the sample in this study is limited to the provinces in East Indonesia so that it cannot be generalized. Therefore, in general, this study contributes to expanding the empirical literature on the impact of ICT on human resource development in developing countries, especially Indonesia. Through panel data regression with a fixed-effect model, this study also strengthens the perspective of convergence technology; although the impact of ICT on development is positive, many other exogenous factors also influence its effect.

2 Literature Review

2.1 ICT and Human Development Index

The theoretical perspective that underlies the relationship between ICT and inclusive development is in line with the neoclassical framework that believes ICT is fundamental in the prosperity of the nation and the redistribution of wealth associated with economic prosperity [9], [10], [12]. This theoretical view of ICT has been used to motivate a strand of contemporary literature on the importance of information technology in the socio-economic progress of developing countries. However, although several studies have been conducted to understand the existing empirical facts, the impact of ICT on economic growth is still far away from robust consensus [2]–[4], [13]–[15].

Based on research by [12], we have a perspective that the same level of technology does not necessarily have the same impact; many factors ranging from human resources, and local challenges, such as geography, education level, etc., will significantly determine the convergence of the effects. A study estimates the convergence equation derived from the Romer model for 31 OECD countries for 1980-2008 by applying the GMM system approach. The empirical findings of the model support the conditional convergence hypothesis but show a lower rate of convergence than predicted by the existing literature [16]. Therefore, not surprisingly, [6] argued that since the effects of ICTs are not always automatic but depend on implementation in various sectors, it is better to study the impact of ICTs on education, health systems, human development, or company profitability. Therefore, scholars have begun to relate ICT implementation to different variables that reflect one or more facets of human development, such as health, education, job creation, and overall quality of life.

[17] investigated the influence of information technology on job creation in small enterprises. Their findings demonstrate that technological innovation positively impacts job creation and functions as a driver of economic development. [18] supported these findings, claiming that governments and institutions provide a favorable technological environment that encourages the growth of SMEs and the creation of jobs in developing countries. Meanwhile, [19] investigated the impact of ICT investment on human development (through the lenses of education and health), and their findings revealed a positive relationship between ICT and human development, implying that joint investments in ICT, health, and education can significantly improve development, according to the authors. [6] employed the Human Development Index (HDI) as a measure of human development to study the relationship between ICT and human development. Their findings reveal that ICTs have a much greater positive impact on human development in developing countries than in developed countries.

[20] studied how ICT advancements improve human development in underdeveloped nations in Sub-Saharan Africa. Their findings demonstrate that policies promoting ICT (mobile,

internet, and telephone) adoption improve inclusive human development. [8] examined how the use of information and communication technology (ICT) by individuals, businesses, and governments influences human development as assessed by two indicators: the HDI and the Social Progress Index (SPI). Their findings reveal that, regardless of a country's level of development, an individual's usage of ICT has a considerable positive impact on human development, particularly as assessed by the HDI. Furthermore, when it comes to the use of ICT in businesses, its impact on human development is large and good worldwide, but not so much in developed countries. On the other side, the government's use of ICT has a significant impact. In addition, ICT is also able to increase financial inclusion [21], [22]; mitigate the development gap between urban and rural areas [23]; increase business opportunities, especially for small and medium-sized enterprises [20]; and facilitate business operations [24], [25].

In line with the accompanying theoretical conception, socio-economic and human progress through information technology can be seen from three main factors: 1) the possibility of limiting the physical relocation of users and hence, more efficient use of available resources; 2) ICTs increase the boundaries of possibilities and increase the timely availability of information which is important in reducing asymmetric information, a constraint in business processes, entrepreneurship, and overall well-being; 3) ICT has a better acceleration impact for disadvantaged countries; this makes ICT the main choice for poor and developing countries for level up and scaling [7], [9], [24], [25].

Meanwhile, the concept of the knowledge economy is based on the view that information and knowledge are the main factors of economic development, so the ability to produce and use information (human resources) effectively is a vital skill resource for many individuals [26], [27]. Technological change and innovation encourage the development of a knowledge-based economy through their influence on production methods, consumption patterns, and economic structure. The two are closely linked in recent growth performance. Some changes in the innovation process cannot occur without ICTs and conversely, some impacts of ICTs may not be felt without changes in the innovation system. These changes have also affected the way organizations interact in the economy, with networks.

Referring to the concept of the knowledge economy, it can be concluded that human resources are the essential factor of growth. This is because humans manage through replication, modification, and adaptation so that agents or communities can improve skills and create or take advantage of existing business opportunities. On the other hand, because ICT offers efficient use of resources starting from the production process, and supply chain to marketing and also the potential for the creation of a new business model that is no longer centered on natural resources, capital, and labor, it can be understood that ICT is an important factor in the ecosystem—knowledge-based economy.

Currently, no data can be used as a reference to measure the impact of ICT on the knowledge economy in Indonesia. Still, because the knowledge economy is centered on human resources, it is very rational if ICT becomes a proxy for human resource development as represented by the Human Development Index (HDI). Although, HDI does not reflect the subjective side of human existence, such as life satisfaction and self-esteem, which also reflect the quality of life. However, the three metrics of lifespan, knowledge, and a reasonable standard of living may still be used to assess the influence of ICT on development, particularly in the framework of a knowledge economy that relies on knowledge and human resources [28].

2.2 Investment and Human Development Index

Generally, investment in a country can be divided into two groups: foreign direct investment (FDI) and Domestic direct investment (domestic investment); we also apply this anatomical classification to the variable investment in this study. [29] argued that FDI, which is generally long-term participation by one country in another, will impact the transfer of knowledge, expertise, and technology. [30] also argued that FDI is essential because FDI provides the primary source of capital that brings the latest technology and contributes to economic growth. In addition to technology transfer, the impact of various externalities and the mix of foreign and domestic investment can also change a country's financial volume and trade patterns, which tends to be positive for the socio-economic development of the host country [31].

Meanwhile, the use of domestic investment as a control variable in this study refers to the research of [32]. Through panel data regression from provinces in Indonesia, this study shows that domestic investment and FDI simultaneously have a positive and significant impact on human resource development in Indonesia. In addition, determining domestic investment as one of the control variables other than FDI for the Indonesian case is because Indonesia's geographical location, which is an archipelagic country, still experiences development inequality, including HDI and the information technology index. Therefore, the realization of domestic investment in certain areas could theoretically have almost the same impact as the realization of FDI.

Based on theoretical views and some empirical facts regarding the role of FDI in human resource development, and referring to the fact that domestic investment is an essential factor in human resource development in Indonesia, to obtain robust conclusions, this study sets FDI and domestic investment as control variables.

3 Method

3.1 Data

The ICT Development Index is a standard measure that can describe the level of information and communication technology development in a region, the digital divide, and the potential for ICT development. The ICT development index is composed of 11 indicators which are combined into three sub-indices, namely the access and infrastructure sub-index, the usage sub-index, and the expertise sub-index. This index has a scale of 0–10; the higher the index value indicates the development of ICT in a region is overgrowing, and vice versa, the lower the index value indicates the development of ICT in an area is still relatively slow. The ICT development index in Indonesia was officially released in 2017 by the Indonesian Statistical Center Agency.

In this study, the value of the ICT development index will be used as a proxy for human resource development, which is represented by the Human Development Index (HDI). This study also uses the investment variable as a control variable; the investment variable is divided into two variables, namely FDI and domestic investment. HDI, FDI, and domestic investment data are obtained from the official release of the Indonesian Central Statistics Agency. Considering data availability, this study uses 2017-2023 annual data from 34 provinces in Indonesia.

3.2 Empirical Model

Considering the availability of cross-sectional data and the limitations of time series data from provinces in Indonesia, this study uses panel data regression. In addition, due to the geographical condition of Indonesia, which is an archipelagic country and there are still gaps in various aspects of socio-economic development, the impact of ICT in each region will likely be different even though the influence of ICT in each area is the same; this is because many variables may not be observed or are commonly known as endogeneity problems. Therefore, this study uses the Least Square Dummy Variable (LSDV) model, the Fix Effect model [33]. This model assumes that the slope of the regression is constant both between individuals and over time. Still, the intercept for each observation is different but the same over time. The model in this study follows equation (1); where HDI is the human development index; ICT is an index of information and communication technology; FDI is foreign direct investment, DI is a domestic investment; e is an error; β_0 is the intercept and $\beta_1, \beta_2, \beta_3$ is the coefficient for each exogenous variable; α_i is the personal effect for each province; i represent the individual of i and t represent time.

$$HDI_{i,t} = \beta_0 + \alpha_i + \beta_1 ICT_{i,t} + \log \beta_2 \log FDI_{i,t} + \log \beta_3 \log DI_{i,t} + e_{i,t} \quad (1)$$

4 Result and Discussion

The result of panel regression with the fixed effect model shows that ICT and domestic investment significantly positively impact HDI. In contrast, the negative effect of FDI is insignificant (See Table 1). Furthermore, Table 2 indicates that the model is free from multicollinearity, but the model has heteroscedasticity issues, as shown in Table 3. This conclusion is based on the probability value of the ICT and FDI variables, which have a p-value is less than 0.05. To avoid making biased conclusions, this study uses the Robust Least Squares method. However, using the Least Squares method will make the model no longer the fixed effect model. Still, this method can be used at least when the coefficients' direction and the independent variables' significance do not change. Based on Table 4, the correction using the Robust least square method does not affect the direction of the coefficient and the level of significance so it can be concluded that the Fix effect model is still feasible.

Furthermore, because the fixed effect model is feasible to use, this study also provides individual effects for each province, as shown in Table A.1. From the individual effects obtained, at least we can divide each province into two clusters, the first provinces with negative intercept and the other with positive intercept value. Consequently, in provinces with negative intercept values, the impact of ICT and domestic investment will have a lower impact than in other provinces with positive intercepts. This individual effect can be evidence that socio-economic development in Indonesia has not been evenly distributed and strengthens the assumption of the conditional convergence impact of technology [16], [34].

Table 1. Result of Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICT	1.432763	0.140550	10.19394	0.0000
LOG(FDI)	-0.048006	0.071732	-0.669235	0.5049
LOG(DDI)	0.173271	0.057431	3.017040	0.0032
C	60.67300	2.058248	29.47798	0.0000
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.992174	Mean dependent var	70.56485	
Adjusted R-squared	0.989328	S.D. dependent var	3.964795	
S.E. of regression	0.409588	Akaike info criterion	1.279255	
Sum squared resid	16.60851	Schwarz criterion	2.071668	
Log likelihood	-49.98933	Hannan-Quinn criter.	1.601272	
F-statistic	348.6302	Durbin-Watson stat	2.233495	
Prob(F-statistic)	0.000000			

Table 2. Correlation matrix of each independent variable

	ICT	FDI	DDI
ICT	1.000000		
FDI	0.348117	1.000000	
DDI	0.468565	0.758805	1.000000

Table 3. Glejser Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ICT	-0.125611	0.026199	-4.794442	0.0000
LOG(FDI)	0.034716	0.013154	2.639244	0.0093
LOG(DDI)	0.011408	0.014918	0.764728	0.4458

Table 4. Result of Robust Least Squares

Variable	Coefficient	Std. Error	z-Statistic	Prob.
ICT	4.193085	0.187418	22.37290	0.0000
LOG(FDI)	-0.101457	0.103999	-0.975554	0.3293
LOG(DDI)	0.265902	0.118513	2.243663	0.0249
C	45.66953	1.993101	22.91381	0.0000
Robust Statistics				
R-squared	0.694016	Adjusted R-squared	0.687062	
Rw-squared	0.848894	Adjust Rw-squared	0.848894	
Akaike info criterion	146.9872	Schwarz criterion	159.9413	
Deviance	339.0886	Scale	1.554684	
Rn-squared statistic	666.1640	Prob(Rn-squared stat.)	0.000000	

4.1 Impact of ICT on HDI

The results of this study indicate that ICT has a significant positive effect on HDI in Indonesia. This result is in line with Mursyid [11] which more or less has the same orientation; ICT is one of the critical factors in developing human resources. In addition, other research also shows that ICT has an enormous marginal contribution in emerging markets [7], [24]. Therefore, in the case of Indonesia, the national authorities need to pay more attention to the acceleration of ICT development. Of course, the geographical location of Indonesia, which is an archipelagic country, is a challenge. Still, this study shows that the development of ICT that has been carried out so far has encouraged the development of human resources.

How did this happen? As mentioned in the introduction and literature study, ICT development will provide easy access to information and knowledge distribution, cut or even eliminate physical barriers, inclusiveness of financial services, and various other facilities that impact effectiveness, efficiency, and equality of opportunity. A straightforward example is that farmers in remote areas of Indonesia can now cultivate certain plants without going out to the city center. Moreover, it is possible that some of this knowledge and skills can be obtained for free; this is a clear example of how ICT can enhance human resource development.

Furthermore, this ease of access to information and knowledge will create a knowledge-based economic climate that is not only based on capital and labor but focuses on efficiency and optimization, including in non-high-tech economic sectors, for example, such as the agricultural cultivation techniques previously mentioned, or modern farming methods that do not require much space so that more people can earn additional income or even become their primary source of income. Marketing that used to be limited due to location factors and financial services is now open thanks to internet connections and the presence of a marketplace, and many more advantages brought by ICT. However, we also remind that Indonesia may be trapped in the exclusive development of human resources when there is a widening gap. Therefore, the equitable distribution of ICT development, especially facilities and infrastructure, needs serious attention by both national and local authorities.

Although the statistical impact of ICT on economic growth in developing countries is debatable, the results of this study and the positive role of ICT in developed countries indicate that ICT development in Indonesia is on the right track. In addition, the average Indonesian ICT index, which is still 5.7, is also an opportunity, meaning that there is still a lot of room to optimize ICT in human resource development and ultimately create a knowledge-based economic ecosystem. We think that a knowledge-based financial ecosystem supported by Indonesia's natural mineral and biological wealth will become the country's main economic strength in the future.

4.2 Impact of FDI on HDI

The regression results show that FDI does not significantly impact human development even though, in aggregate, FDI in the research period has a greater dominance than domestic investment. Theoretically, of course, this is contrary to the goals and benefits that should be obtained by the host country receiving FDI. However, this effect has been happening recently. In Thailand, the impact of FDI on the level of transfer of technical knowledge and managerial practice and training is generally relatively low. This is because most of the FDI inflows come from common to medium technology industries that do not require a lot of talent. This

condition implies that multinational companies investing in Thailand do not contribute much to human resource development.

As an alternative view, a World Bank study of sixty developing countries from 1965 to 1987 shows that economic growth strongly correlates with education levels, macroeconomic stability, and openness. Thus, there is a possibility that, apart from foreign investment entering the host country, and non-high-tech investments, another cause of the minimal contribution of FDI to human resource development is the inadequate readiness of the host's human resources. For example, as happened in Thailand two decades ago, there was a high skill gap between local and foreign workers, so local human resources could not compete for strategic positions [35].

Meanwhile, Malaysia's decision to attract FDI to build its economy is an example of success; one of the essential components of Malaysia's success is the government's role in preparing human resources. Therefore, we can get a perspective that foreign investment in the form of a high technology-based industry will come to the host country due to the readiness of its human resources. However, there is still no conclusion on how the multinational company develops the skills of workers further. However, studies also show that global companies pay more attention to the career development of their employees. Usually, they provide more competitive salaries even though the workforce is generally not more significant than domestic companies [35].

Learning from the cases of Thailand and Malaysia, we think that the host government needs to be selective in attracting foreign investment. Especially for Indonesia, the government needs to prioritize the middle-high technology industry. FDI based on middle-high technology will help Indonesia accelerate human resources development and provide added economic value without sacrificing employment opportunities under foreign investment. For example, the government's efforts to downstream mining products and export them in semi-finished form is an essential breakthrough for Indonesia. Besides that, with the development and equity of ICT, which is proven to improve human resource development, the skill gap as expressed by Michie[35] is getting narrower so that local workers can adapt more quickly and get qualified knowledge transfer. Regardless of whether they will stay in multinational companies, move, or start their own business, a better ability to adapt knowledge technology is an asset in developing a knowledge-based economy.

4.3 Impact of Domestic investment on HDI

This study shows that domestic investment has a significant positive effect in encouraging human resource development. This finding is in line with the research of [32]. Interestingly, in the period 2006-2013, the amount of domestic investment was indeed more significant than FDI, but even though in the period 2017-2023 total domestic investment was not always dominant compared to FDI, domestic investment was still proven to have a significant impact. Therefore, domestic investment has proven to have a strong consensus as a driver of human resource development in Indonesia.

Based on the regression results in this study and [32], we assume that increasing and equitable distribution of domestic investment is something that the authorities can continue to strive for to improve inclusive and sustainable human resource development. Given Indonesia's vast geographical location and the shape of an archipelago, it is very likely that the impact of

domestic investment in an area will also have an effect that is theoretically almost the same as the impact of FDI. For example, technology and knowledge of agriculture or plantations brought by investors from a more developed area are very likely to help local farmers in the host area. In addition, domestic investment generally opens wider job opportunities to help reduce unemployment and extreme poverty.

5 Conclusion

In general, we conclude that optimizing human development in Indonesia can do this by accelerating and equitably developing ICT facilities and infrastructure. However, we also argue that ICT infrastructure development is accompanied by other infrastructures like roads, schools, and health. Meanwhile, for FDI, we believe that Indonesia should be selective in accepting foreign investment and focus on middle-high technology. Furthermore, seeing the significant contribution of domestic investment to human resource development, the government needs to encourage and provide incentives, especially for local investors who want to invest in less developed areas such as Eastern Indonesia. This policy aims to increase the quality of human resources and pay attention to their distribution. Thus, the concept of the knowledge economy can be achieved more quickly and inclusively.

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