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Determinants of Information and Communication Technology Development in Indonesia (2018-2021)

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ABSTRACT

This study aims to analyze the influence of average household consumption for telecommunications, households that own and control cell phones, Number of Villages or Regions Receiving Cell Phone Signals and the Covid-19 Pandemic on the Information and Communication Technology Development Index in Indonesia for 2018-2021. The data used in this study is secondary data, namely the Information and Communication Technology Development Index, Average Household Consumption for Telecommunications, Households Who Own and Control Cell Phones, Number of Villages/Regions That Receive Cell Phone Signals and the Covid-19 Pandemic as dummy variables, which have been published by the Indonesian Central Bureau of Statistics (BPS). The analytical method used in this study is panel data regression analysis using the Fixed Effect Model approach. The study results show that variables Average Household Consumption for Telecommunications, the variable Households Who Own and Control a Cellular Telephone have an influence, the variable Number of Villages/Regions Receiving Cellular Telephone Signals and Communication and the Covid-19 Pandemic variable have a positive and significant influence on the variable Information and Communication Technology Development Index in Indonesia 2018-2021.

Keywords: Cell Phones, Covid-19, Production, Signals, Telecommunications

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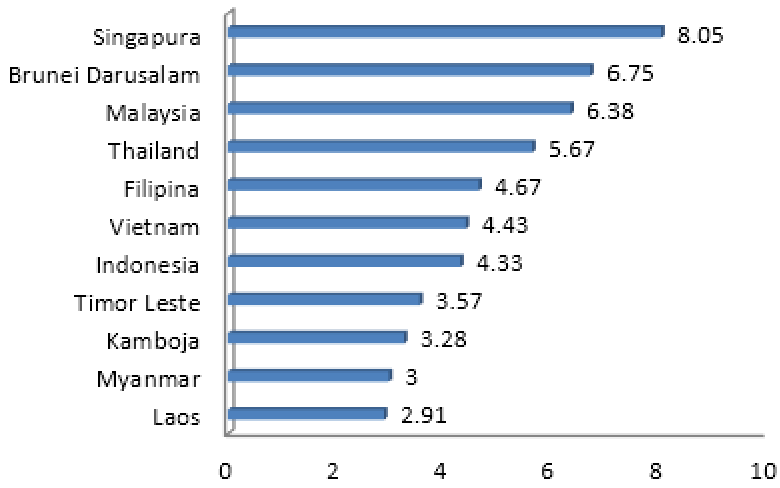
INTRODUCTION

Development is a multifaceted journey that entails profound transformations in the composition and mindsets of a society and its national establishments, all of which must be sustained over time. One of the main goals of the sustainable development agenda is to encourage economic growth. In this digital era or commonly known as the 4.0 era, economic and economic growth is greatly supported by advances in Information and Communication Technology (ICT) (Dharmawan & Marsisno, 2019). Information and communication technology (ICT) has a very important influence and role in productivity, growth and efficiency. ICT is a combination of software, hardware, telecommunications and information techniques used to store and change information (Daulay, 2021). Juliyanti (2022) defines Information and Communication Technology as the scope of computers, the internet, and all electronic delivery systems such as television, radio, projectors, and other similar things. ICT is also defined as an integrated combination that refers to all communication technologies (internet, mobile phones, computers, networks, software, middleware, video conferencing, social networks, applications and media services that allow them to be accessed in digital form. ICT is a growth tool which is important and plays a very important role in rapid economic growth (Farooqi, Yaseen, Anwar, & Makhdum, 2020).

Varieties of situations in the growth and availability of technology, information, and communication within a region form the basis for the development of ICT growth standards (Wiratmo, 2003). These standards are known as the ICT Development Index or commonly referred to as the Information and Communication Technology Development Index (ICT-DI) in Indonesian. The ICT-DI serves as a tool to measure the level of information and communication technology development across different regions by assessing the growth of ICT development, digital gaps or discrepancies in digital access, and the potential for ICT development in a specific area (Dixon, 1997). The ICT-DI consists of 11 indicators grouped into 3 sub-index components, they are infrastructure, usage, and skills (Devanty, Hamzah, & Sofilda, 2018). According to Kossaï, de Souza, Zaied, and Nguyen (2020), the rating scale ranges from 0 to 10, where 10 reflects a very high level of ICT development in a region, while 0 indicates a very low level of ICT development. The latest data regarding the Information and Communication Technology (ICT) Development Index in Southeast Asia in 2017 shows that Indonesia is ranked 5th lowest, with an index value of 4.33%. This figure indicates that in that year, ICT development in Indonesia was still relatively low compared to a number of other countries in the Southeast Asia region. On the other hand, Singapore dominates the highest ranking in ICT development in Southeast Asia by reaching an index value of 8.05% in the same year, as seen in figure 1.

Figure 1. ICT Development Index in Southeast Asia 2017

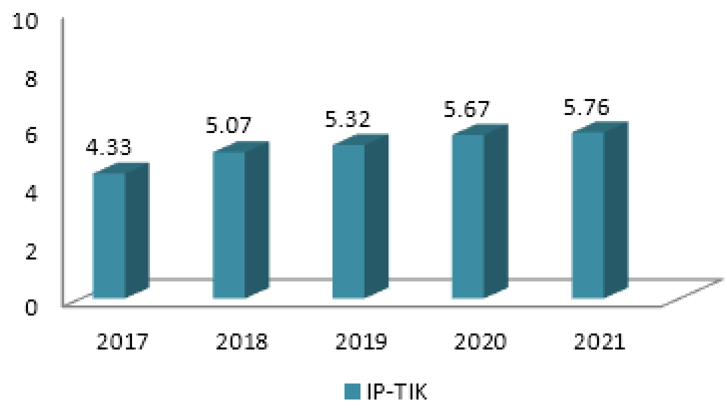


Source: Lokadata, 2017.

Factors that may be the cause of the low ICT development index in Indonesia compared to several other ASEAN countries are the geographical and demographic diversity in this country. Indonesia is an archipelagic country with an area of 1,905 million km^2, and has various population groups within it. This is a challenge in itself in efforts to build sophisticated and evenly distributed information and communication technology throughout Indonesia.

However, looking at overall national level, Indonesia has experienced significant growth, which can be proven by the continuous increase in the information and communication technology index value from year to year. The increase in the value of the Indonesian development index can be seen in figure 2.

Figure 2. Indonesian Information and Communication Technology Development Index 2017-2021



Source: BPS (n.d.), processed.

The Information and Communication Technology Development Index is used to compare ICT developments both between regions and over time. In 2021, in Figure 2 Indonesia's IP-ICT value will reach 5.76, which is the highest figure in the 2017-2021 period. Badan Pusat Statistik (BPS, n.d.) states that IP-ICT changes affect HDI, GRDP and digital competitiveness index. Furthermore, technological progress also has an impact on economic inequality between regions because the existence of technology is considered to increase productivity and will continuously increase overall output and output per capita (Dharmawan & Marsisno, 2019). Information and Communication (ICT) is one sector that continues to develop and plays an important role in driving economic growth, reducing economic disparities, and improving people's quality of life. In the digital era like now, access and use of ICT is greatly influenced by social, economic and educational factors. Hence, as a developing nation, Indonesia possesses significant opportunities for advancing the ICT sector as a leading industry. Continuous monitoring of the progress of ICT (Information and Communication Technology) developments is incredibly important and necessary for policymakers (Rusydi, 2017). Considering the potential impact of ICT usage on social and economic development, every country strives to ensure ICT accessibility for all segments of society. However, any policy should be grounded in real evidence and facts regarding what truly influences the development of Information and Communication Technology (ICT) in Indonesia.

LITERATURE REVIEW

The Information and Communication Technology Development Index is a quantitative measure used to measure a country's progress. Information and Communication Technology (ICT) development has become a key factor in economic growth, improving quality of life, and social inclusion in various countries. To understand the factors influencing ICT development, several previous studies have identified various relevant factors. The study carried out by Selan and Wahyuni in 2022 explore the elements that impact the growth of ICT in Indonesia during the period of 2015-2020. Their findings reveal that GDP per capita, household spending on telecommunications, and price indices related to transportation, communication, and financial services commodities are key factors influencing the advancement of ICT in Indonesia.

Research by Agustina and Pramana (2018) highlights the importance of independent variables such as per capita income, productive age, and average years of schooling in influencing the ICT Development Index. The results of this research show that around 96.92% of the variation in IP-ICT can be explained by the independent variables in their model, with a positive influence of per capita income, productive age, and average years of schooling on IP-ICT. Meanwhile, research conducted by Suharni (2021) groups provinces in Indonesia based on the ICT Development Index, which is formed by sub-indices of use, skills, and infrastructure. The results show three provincial clusters with high, medium, and low ICT Development Index. Research conducted by Farooqi, Yaseen, Anwar, and Makhdum (2020) focuses on the determinants of ICT adoption in developing countries. The results of this research highlight the variables of electricity access, imports of ICT goods, government effectiveness, and GRDP per capita as significant factors in the ICT Development Index.

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RESEARCH METHOD

This research uses secondary data obtained from the Indonesian Central Statistics Agency (BPS, n.d.). The data used covers 34 Provinces in the period 2018 to 2021. This research uses a type of research analysis of the influence of independent variables on the dependent variable, where the independent variables include Average Household Consumption for Telecommunications, Households that Own and Control Cell Phones, Number of Villages that receive cell phone signals and the Covid-19 pandemic (dummy) in Indonesia in 2018-2021, while the dependent variable is the Information and Communication Technology Development Index. The variables analyzed in this research include: (a) Average Household Consumption for Telecommunications; (b) Households that Own and Control Cell Phones; (c) Number of Villages That Receive Cell Phone Signals; and (d) Covid-19 pandemic (dummy).

The research employs a method of analysis that utilizes panel data regression, which combines time-series and cross-sectional data through the incorporation of dummy variables. The equation for the panel data regression employed in this study is as follows.

$$IPTIKit = \beta_0 + \beta_1 LN(RKT)_{it} + \beta_2 PMTS_{it} + \beta_3 STS_{it} + \beta_4 DUMMYit + eit$$

Information:
IPTIKt : Information and Communication Technology Development Index
β_0 : Constant
$\beta 1$ ***, $\beta 4$: Regression coefficient
LNRKTit : Average Household Consumption for Telecommunications (Rupiah)
RMTSit : Households that Own and Control Cell Phones (Percent)
STSit : Number of Villages That Receive Cell Phone Signals (Number of Villages)
DUMMYit : Covid-19 Pandemic (0 = Before the Pandemic, 1 = During the Pandemic)
eit : Error term

RESULTS

In panel data regression, there are three regression model approaches, namely the Common Effect model, Fixed Effect model and Random Effect model. To determine the regression model that best suits the research data, the Chow Test, Hausman Test, and LM Test must be carried out.

Model Selection

Test Chow

Test chow used to compare the Common Effect Model and Fixed Effect M model by comparing the probability results with the α value (0.05). The hypothesis is as follows.

H0: Common Effect Model is accepted
Ha: Fixed Effect M odel accepted

Table 1. Chow Test

Effects Test	Statistics	df	Prob.
Cross-section Test	39.659441	(33.98)	0,0000
Chi-square cross-section	362.34622	33	0,0000

Source: Data processing results.

According to the findings from the Chow test, it is evident that the probability value of the F-statistic is 0.0000, which is less than the significance level α (0.05). Consequently, the researchers reject the null hypothesis (H0) or accept the alternative hypothesis (Ha). These results indicate that, currently, the Fixed Effect model is the most appropriate model.

Hausman Test

The Hausman test is conducted when the Fixed Effect model is chosen in the Chow test because the purpose of the Hausman test is to compare the optimal model between the Fixed Effect model and the Random Effect model. The hypothesis utilized in the Hausman test is as follows.

H0: Random Effect model is accepted
Ha: Fixed Effect model is accepted

Table 2. Hausman Test

Test Summary	Chi-Sq.Statistics	Chi-Sq.df	Prob.
Random cross-section	18.218021	4	0,0011

Source: Data processing results.

Based on the Hausman test results, it shows that the random cross section probability value is 0.0000 < α (0.05) then reject H0 or accept Ha so the best model that can be used is the Fixed Effect model.

Estimated Results

The selection of the estimation model is determined by the outcomes of the model selection tests, which include both the Chow test and the Hausman test. In this study, the chosen model is the Fixed Effect Model, identified as the most suitable model.

Table 3. Fixed Effect Model Estimation Results

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	-16.99063	3.110592	- 5.462184	0,0000
LN(CTR)	1.640710	0 .278307	5,895314	0,0000
RMTS	0,047794	0,011173	4,277537	0,0000
STS	0,000429	0,000159	2,702262	0,0081
DUMMY	0,298064	0,042917	6,945124	0,0000

Source: Data processing results.

From the results of the Fixed Effect Model estimation, the regression can be written as follows.

IPTIKit = -16.99063 + 1.640710(LN(CTR)it) + 0.047794(RMTSit) + 0,000429(STSit) + 0,298064(DUMMYit) + εit

Partial Test (T-Test)

The T test or what is usually called a partial test, is carried out to determine the effect of the independent variable on the dependent variable partially.

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Table 4. Partial Statistical Test Results (T)

Variables	Coefficient	Std. Error	t-Statistics	t-table	Prob.
C	-16.99063	3.110592	- 5.462184	-1.97810	0,0000
LN(CTR)	1.640710	0 278307	5,895314	1,97810	0,0000
RMTS	0,047794	0,011173	4,277537	1,97810	0,0000
STS	0,000429	0,000159	2,702262	1,97810	0,0081
DUMMY	0,298064	0,042917	6.945124	1.97810	0,0000

Source: Data processing results.

Based on table 4 which shows the T-statistic table, it can be seen as follows. Firstly, the variable Average Household Consumption for Telecommunications (RKT) demonstrates a t-statistic value of 5.895314, which is greater than the critical t-table value of 1.97810. Additionally, the associated probability value is 0.0000, which is less than the significance level of 0.05. This indicates that the variable Average Household Consumption for Telecommunications has a positive and statistically significant impact on the ICT Development Index (IP-TIK) in Indonesia from 2018-2021. Secondly, the variable Households Who Own and Control a Cellular Telephone (RMTS) exhibits a t-statistic value of 4.277537, surpassing the critical T-table value of 1.97810. Furthermore, the associated probability value is 0.0000, which falls below the 0.05 significance level. This suggests that the variable Households Who Own and Control a Cellular Telephone has a positive and statistically significant impact on the ICT Development Index (IP-TIK) in Indonesia from 2018-2021. Thirdly, the variable representing the number of villages/regions receiving cellular telephone signals (STS) records a t-statistic value of 2.702262, surpassing the critical t-table value of 1.97810. Additionally, the associated probability value is 0.0081, which is lower than the 0.05 significance level. This indicates that the variable denoting the number of villages/regions with access to cellular phone signals has a positive and statistically significant influence on the ICT Development Index (IP-TIK) in Indonesia from 2018-2021. Lastly, the variable associated with the Covid-19 Pandemic (DUMMY) demonstrates a t-statistic value of 6.945124, exceeding the critical t-table value of 1.97810. Moreover, the associated probability value is 0.0000, which is less than the 0.05 significance level. This implies that the Covid-19 Pandemic variable has a noteworthy impact on the ICT Development Index (IP-TIK) in Indonesia from 2018-2021.

Simultaneous Test (F Test)

Simultaneous Testing is carried out to analyze how much the independent variable is able to explain the dependent variable and test the feasibility of the model in research (A'yuni, 2015). Based on hypothesis F, the following results are obtained.

Table 5. Simultaneous Test Results

F-statistic	103,1997
Prob(F-statistic)	0,000000

Source: Data processing results.

Based on table 5, it is known that the independent variables (RKT, RMTS, STS and DUMMY) together have an influence on the dependent variable IPTIK (Information and Communication Technology Development Index). This is indicated by the probability that the F-statistic is lower than the alpha degree that has been chosen (0.0000 < 0.05).

Goodness of Fit
Goodness of Fit is used to explain the amount of variation that occurs in the independent variable so that it can explain the variation that occurs in the dependent variable (Devanty, Hamzah, & Sofilda, 2018). In this study, a Goodness of Fit test was carried out to explain the magnitude of variation in the variables Average Household Consumption for Telecommunications, Percentage of Households Who Own and Control a Cellular Telephone, Number of Villages Receiving Cellular Telephone Signals, and the Covid-19 Pandemic (Dummy) is able to explain the variations that occur in the Information and Communication Technology Development Index in Indonesia for 2018-2021.

Table 6. Goodness of Fit

Adjusted R-squared	0,965529

Source: Data processing results.

Based on the results of panel data regression using the Fixed Effect Model , the value of R^2 is 0.965529. This means that variations occur in the Information and Communication Technology Development Index variable can be explained by the variations that occur in the variables Average Household Consumption for Telecommunications, Percentage of Households Who Own and Control a Cellular Telephone, Number of Villages That Receive Cellular Telephone Signals, and the Covid-19 Pandemic (Dummy) of 96.5529% and the remaining 3.4471% is explained by other variables outside the model.

Classic Assumption Test
As per Gujarati and Porter’s findings (2013), the only equations that conform to classical assumptions are those employing the Generalized Least Square (GLS) method. The GLS method is exclusively applied in the estimation model known as the Random Effect Model, whereas the Fixed Effect and Common Effect models utilize Ordinary Least Square (OLS). Consequently, the necessity to test classical assumptions in research with panel data hinges on the choice of the estimation model. If the most suitable regression model is the Random Effect Model, there is no imperative need to assess classical assumptions. Conversely, if the regression equation is better suited to Common Effects or Fixed Effects, it becomes essential to scrutinize classical assumptions. It is important to note that not all classical assumption tests are applicable in panel data regression. Linear tests are omitted, as it is assumed that the model follows a linear framework. A normality test is unnecessary, as it is not a prerequisite in panel data analysis. Furthermore, autocorrelation is relevant only in time series data, whereas cross-sectional or panel data does not demand this test. The multicollinearity test is only necessary when the panel data regression involves multiple independent variables. A heteroscedasticity test must be carried out because heteroscedasticity occurs more often in cross section blood. So, it can be concluded that in panel data regression not all classical assumption tests are carried out, only multicollinearity and heteroscedasticity tests need to be carried out.

Multicollinearity Test
Multicollinearity refers to a scenario in which one or more independent variables can be represented as a linear combination of other independent variables (Suratini, 2017). Ideally, a sound regression model should exhibit no correlations among its independent variables. When significant correlations exist among independent variables, it can disrupt the relationship between an independent variable and the dependent variable.

Table 7. Multicollinearity Test

	LNRKT	PMTS	STS	DUMMY
LN(CTR)	1	0.354545	0.171988	0.005314
RMTS	0.354545	1	0.071615	0.194657
STS	0.171988	0.071615	1	0.033141
DUMMY	0.005314	0.194657	0.033141	1

Source: Data processing results.

Based on table 7, it is known that RKT (LNRKT), RMS, STS and DUMMY are free from multicollinearity, because in the regression model the correlation value between the independent variables each has a value of less than 0.85.

Heteroscedasticity Test

Heteroscedasticity occurs when the residual values of a model exhibit varying levels of variance, implying that each observation's reliability differs due to unaccounted-for changes in underlying conditions within the model. This phenomenon is commonly observed in cross-sectional data, making it quite possible for heteroscedasticity to manifest in panel data as well, as discussed by Gujarati and Porter (2013). In the context of panel data, the purpose of the heteroscedasticity test is to assess whether the variability of residual errors in the panel data model remains consistent across all individual units or over time. If heteroscedasticity is present, it suggests that the variability of residual errors may not be uniform across specific individual units or particular time periods.

Table 8. Heteroscedasticity Test Results

Variables	T-statistic	Prob.
C	-0.034287	0.9727
LN(CTR)	-0.340399	0.7343
RMTS	1.033949	0.3037
STS	0.912539	0.3637
DUMMY	-0.128376	0.8981

Source: Data processing results.

Based on table 8, the results of the heteroscedasticity test show that the absolute residual probability value of the RKT (LNRKT), PMTS, STS and Dummy (D) variables is greater than the 5% alpha level. The absolute residual probability of CTR (LNRKT) is greater than the selected alpha degree (0.7343 > 5%). The absolute residual probability of RMTS is greater than the selected alpha degree (0.3037 > 5%). The absolute residual probability of STS is greater than the selected alpha degree (0.3637 > 5%). And the probability of DUMMY greater than the selected alpha degree (0.8981 > 5%). So, it can be concluded that H0 is accepted, which means that heteroscedasticity does not occur.

DISCUSSION

The Influence of Average Household Consumption for Telecommunications

The regression analysis pertaining to the variable 'Average Household Consumption for Telecommunications' reveals a significant and positively impactful association with the ICT Development Index. This is evident through the coefficient value of 1.640710, coupled with a probability of 0.0000. Essentially, for every 1% upsurge in Average Household Consumption for Telecommunications, there's an anticipated augmentation of 0.01640 in the Information and Communication Technology Development Index. These findings consistently align with the initially posited research hypothesis. A substantial household consumption in telecommunications signifies a broader embrace and utilization of ICT among households. The prevalence of ICT usage among individuals and households directly correlates with the potential for enhancing the ICT development index. Consequently, the outcomes of this study offer robust support for the premise that increased average household consumption significantly contributes to the elevation of the ICT development index. This underlines the pivotal role that household-level engagement with telecommunications plays in fostering ICT adoption and, subsequently, contributes to the overall advancement of the ICT development index.

The Influence of Households Who Own and Control Cell Phones
Based on the results of the regression of the variable Households that Own and Control Cell Phones, it can be seen that it has a positive and significant influence on the ICT Development Index which can be seen from the coefficient value of 0.047794 with a probability of 0.0000. This means that every 1% increase in households owning and controlling cell phones will increase the Information and Communication Technology Development Index by 0.047794. These results are in accordance with the proposed research hypothesis. Apart from being a communication tool, cell phones are also used as a means to access distance education platforms, online courses, online shopping, access information and digital educational resources. The use of mobile phones not only increases access to technology, but also has a broad impact on various aspects of information and communication technology development. This contributes to improving the ICT of a country or region, which in turn can support economic growth, improved quality of life and social inclusion.

The Influence of the Number of Villages Receiving Cell Phone Signals
Based on the results derived from the regression analysis concerning the variable ‘Number of Villages Receiving Cell Phone Signals’, a noteworthy observation arises. It indicates a notably positive and substantial impact on the ICT Development Index, evident from the coefficient value of 0.000429, accompanied by a probability of 0.0081. Essentially, this signifies that for every incremental addition of 1 village receiving cell phone signals, there’s an anticipated increase of 0.000429 in the Information and Communication Technology Development Index. These findings consistently support the initially proposed research hypothesis. Enhanced accessibility to information appears to correspond with an elevation in digital literacy and technological acumen within society. Consequently, this contributes directly to the augmentation of the ICT development index. Hence, the outcomes of this analysis reinforce the premise that an expansion in the number of villages equipped with cell phone signals directly correlates with the elevation of the ICT development index.

The Influence of the Covid-19 Pandemic
Based on the regression results, it is known that the Dummy variable (Covid-19 Pandemic) has a positive and significant influence on the ICT Development Index which can be seen from the coefficient value of 0.298064 with a probability of 0.0000. This means that the presence of the Covid-19 pandemic during 2020 to 2021 increased the Information and Communication Technology Development Index by 0.298064 from the years before the 2018-2019 pandemic. These results are in accordance with the proposed research hypothesis. This is based on because The Covid pandemic has changed the pattern of life in all aspects due to social restrictions which are usually done in person, shifting to doing it online or relying on it.

During the pandemic, travel and social restrictions have driven major shifts in how work, education and digital services are accessed. The pandemic has also forced many businesses and organizations to accelerate their digital transformation, including digitization of business processes, use of cloud technology, e-commerce, and remote work solutions. By increasing access to technology, even villages can make a positive contribution to improving ICT, which ultimately supports sustainable social, economic, and technological development.

CONCLUSION

Conclusions that can be given based on the results and discussions explained in the previous chapter are as follows. Firstly, average household consumption for telecommunications has a positive and significant effect on the information and communication technology development index in Indonesia in 2018-2021. Secondly, households that own and control cell phones have a positive and significant effect on the information and communication technology development index in Indonesia in 2018-2021. Thirdly, the number of villages that receive cell phone signals has a positive and significant effect on the information and communication technology development index in Indonesia in 2018-2021. Lastly, pandemic-19 has a positive and significant effect on the information and communication technology development index in Indonesia in 2018-2021.

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DECLARATION OF CONFLICTING INTERESTS
We are committed to maintaining research integrity and presenting findings accurately and objectively in accordance with scientific research ethics. We believe that there are no conflicts of interest that could influence the results or conclusions we present in this paper.

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