Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Master's Thesis

Relationship between infrastructure and economic growth: The case of Indonesia

Stefanie Fera Tumbelaka

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Stefanie Fera Tumbelaka

Economics and Management
Economics and Management

Thesis title

Relationship between infrastructure and economic growth: The case of Indonesia

---

Objectives of thesis

The main aim of the thesis is to assess and analyze the relationship between digital infrastructure and economic development in Indonesia.
Partial aims will fulfil the main aim.

Methodology

The thesis will be divided into three parts.

The first part is a theoretical one and is based on a literature search. It defines the current state of knowledge in the field of infrastructure and economic growth. In this part, articles, books, research and different electronic resources will be used to provide information. Methodologically, this part of the thesis will be the analysis of documents.

The second part will rely on the theoretical part and it is the key component of the thesis. An econometric analysis will be created by using secondary data to create a one-model econometric analysis to show the relationship between infrastructure and economic growth.

The final part concludes the results of the previous parts and discusses them with another author.

The proposed extent of the thesis

60 – 80 pages

Keywords

Digital infrastructure, poverty, GDP, development,

Recommended information sources

Donou-Adonsou, Ficawoyi. 2018. "Technology, Education, and Economic Growth in Sub-Saharan Africa." Telecommunications Policy 43: 353–60. https://doi.org/10.1016/j.telpol.2018.08.005.

Holmgren, Johan, and Axel Merkel. 2017. "Much Ado about Nothing? E A Meta-Analysis of the Relationship between Infrastructure and Economic Growth." Research in Transportation Economics 63: 13–26. https://doi.org/10.1016/j.retrec.2017.05.001.

Owusu-Manu, D.-G.et al., 2019. The impact of infrastructure development on economic growth in sub-Saharan Africa with special focus on Ghana. Journal of Financial Management of Property and Construction, 24(2)

Pradhan, Rudra P, Mak B Arvin, Sahar Bahmani, and Neville R Norman. 2014. "Telecommunications Infrastructure and Economic Growth: Comparative Policy Analysis for the G-20 Developed and Developing Countries." Journal of Comparative Policy Analysis: Research and Practice 16 (5): 401–23. https://doi.org/10.1080/13876988.2014.960227.

Todaro, Michael P., and Stephen C. Smith. 2015. Economic Development. 12th Edition. Pearson . https://www.pearson.com/us/higher-education/program/Todaro-Economic-Development-12th-Edition/PGM142511.html.

Expected date of thesis defence

2021/22 SS – FEM

The Diploma Thesis Supervisor

doc. Ing. Irena Benešová, Ph.D.

Supervising department

Department of Economics

Electronic approval: 15. 2. 2022

prof. Ing. Miroslav Svatoš, CSc.

Head of department

Electronic approval: 21. 2. 2022

doc. Ing. Tomáš Šubrt, Ph.D.

Dean

Prague on 30. 03. 2022

Declaration

I declare that I have worked on my master's thesis titled "Relationship between infrastructure and economic growth: The case of Indonesia" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 31.03.2022 _____

Acknowledgement

I would like to thank doc. Ing. Irena Benešová, Ph.D. as my supervisor for the extrme support on the educational purpose, to my family (Mom and Dad) and friends (especially Nathalie, Diana and Jigar) for the mental support.

Relationship between infrastructure and economic growth: The case of Indonesia

Abstract

This Master's thesis examines Indonesia's economic growth and development through the economic impact of infrastructure.

For this study, the link between numerous sectors such as current health expenditure, direct investment in electricity, gas, and water, direct investment in construction, direct investment in transportation and communication, and Indonesian economic development was explored. Annual data from 2001 to 2020 were utilized for the analysis.

The data analysis was performed using the Ordinary Least Squares (OLS) method. According to the empirical findings, there is a positive significant relationship between current health expenditure and direct electricity investment and Indonesian economic development. Direct investment in construction, on the other hand, has a negative influence on economic growth, whereas direct investment in transportation and communication has doesn't show significance on the GDP.

Keywords: GDP, Direct Investment, Expenditure, Electricity, Gas, Water, Construction, Transportation, Communication.

Vztah mezi infrastrukturou a ekonomickým růstem: Případová studie Indonésie

Abstrakt

Předkládaná diplomová práce zkoumá vzah mezi ekonomickým růstem a rozvojem Indonésie prostřednictvím ekonomického dopadu infrastruktury.

V rámci diplomové práce byla zkoumána souvislost mezi mnoha proměnnými, jako jsou běžné výdaje na zdravotnictví, přímé investice do elektřiny, plynu a vody, přímé investice do stavebnictví, přímé investice do dopravy a komunikací a indonéský ekonomický rozvoj. Pro analýzu byla použita roční data od roku 2001 do roku 2020.

Analýza dat byla provedena pomocí metody nejmenších čtverců (OLS). Podle empirických zjištění existuje pozitivní významný vztah mezi současnými výdaji na zdravotnictví a přímými investicemi do elektřiny a indonéským ekonomickým rozvojem. Přímé investice do stavebnictví mají naopak negativní vliv na ekonomický růst, zatímco přímé investice do dopravy a spojů se na HDP neprojevují.

Klíčová slova: HDP, přímé investice, výdaje, elektřina, plyn, voda, stavebnictví, doprava, komunikace.

Table of content

List of pictures

List of tables

List of abbreviations

GDP	Growth Domestic Product
FDI	Foreign Direct Investment
DDI	Domestic Direct Investment
OLSM	Ordinary Least Square Method
ADF	Augmented Dickey–Fuller
DW	Durbin–Watson

1 Introduction

One of the most hotly debated themes in contemporary scientific literature and economic research is the relationship between infrastructure investments and development results. In the scientific literature, the influence of infrastructure on development is examined from both theoretical and empirical perspectives, and a range of concepts and models are used. Infrastructure is universally acknowledged as being critical to a country's success.

The goal of development is to increase public welfare. The government's position as a development mobilizer is critical in promoting people's well-being and the country's economic prosperity. Economic growth is one indication for observing the outcomes of previous progress and is also valuable for determining the future path of development. Positive economic growth shows that the economy is expanding, whereas negative economic growth suggests that the economy is contracting.

Indonesia is a developing country, which means it has a low level of material wellbeing and requires a lot of investment to maintain its economic progress. Sustainable and reasonably high economic growth is a definition of the success of economic development and represents the progress that has been made. The involvement of local and international parties, as well as government, cannot be isolated from the stability of economic progress. Developing countries require large amounts of money to sustain their national growth.

Economic growth is one sign of a country's development achievement. Various policy strategies have been attempted by policymakers in each nation in an effort to encourage high and equitable economic growth. In general, private capital influences the magnitude of economic growth, which is connected to the value of investment to enhance a country's capital stock, also known as productive investment (Arsyad, 2016). However, little is known about the economic role of public capital infrastructure. According to Fourie (2006), public infrastructure investment, also known as social overhead capital, is critical in order to encourage productive investment. This is reinforced by a World Bank report (2005) that emphasizes the need of the government's *"big push"* in public infrastructure investment in order to encourage productive investment as well as the country's economic activity.

From an academic standpoint, Aschauer (1989) proved that public infrastructure, in addition to its influence on the productivity of private inputs, may also drive economic growth through a variety of channels. Adequate infrastructure (electricity, road network, etc.) may, for example, reduce private sector expenditure on physical capital maintenance,

enhance the rate of capital creation, and eventually promote economic growth. Furthermore, infrastructure has a substantial influence on the health quality of human resources, which might affect economic growth on a microeconomic level. According to Barro (1990), economic growth is affected not just by private capital stock and human resources, but also by government engagement in supplying public capital infrastructure.

Experience in industrialized nations shows that the amount of infrastructure investments is the most significant element in economic success. According to the World Bank (1994), every 1% improvement in infrastructure results in a 1% gain in gross regional domestic product. According to Agénor and Moreno-Dodson (2006), infrastructure in low-income or developing nations remains in poor shape. Therefore, improving access to suitable infrastructure in developing nations must be prioritized at the national level.

As for the state of Indonesia's infrastructure, according to the World Economic Forum (2017), the country climbed 34 places in the Quality of overall infrastructure ranking from 2007 to 2017. Its most recent rating is 68 out of 137 nations for 2017, and it is still ranked lower than surrounding countries such as Singapore, Thailand, and China.

The government claims that the total number of homes in Indonesia that have access to electricity has reached 99.28 %. This data, however, was challenged for simply estimating the household's capacity to switch on the lights. According to government figures, at least 500,000 Indonesian homes are without electricity until May 2021. The vast majority of them reside in outlying or distant settlements (Utama, 2021). According to the Central Statistics Agency (BPS), the length of roads in Indonesia only reached 348.08 thousand kilo meters (km) in 2000. The length of the road has expanded by 57.54% in two decades, reaching 548.37 thousand kilometers (km) in 2020. In Indonesia, 93% of people have access to safe and adequate drinking water. Access to clean drinking water is 97.6% in urban areas and 87.1 percent in rural regions. This is partially offset by the accomplishment of safe drinking water, which is only 11.9 percent on average (Sumartiningtyas, 2021).

Infrastructure has long been one of Indonesia's development priorities, according to the Coordinating Minister for Economic Affairs. The government has developed 223 projects and 3 national strategic initiatives since 2016. So far, 62 projects totaling 320 trillion rupiah in investment have been developed and are completely functioning (Kominfo, 2019).

Infrastructure has a significant influence in economic, social, and political elements, both directly and indirectly. The purpose of this study is to examine the impact of infrastructure on Indonesia's economic growth. This study extends earlier theoretical and

empirical research on infrastructure and economic growth. Previously, research on the influence of infrastructure on cross-border economic expansion have been conducted. In general, the infrastructure employed is of a restricted variety. This study focuses on infrastructure investment and expenditure in several sectors, including health; energy, water, and gas; construction; transportation, and communication.

2 Objectives and Methodology

2.1 Objectives

Indonesia has been developing the infrastructure for a long time, and the investment has been substantial. The subjects addressed in this study include how current health expenditure; direct investment in electricity, gas, and water; direct investment in construction; and direct investment in transportation and communication have a significant influence on economic growth, as represented by the growth of domestic product (GDP) variable. The contribution of each form of infrastructure investment in the sectors outlined above to economic growth can therefore be observed, indicating that the type of infrastructure investment has a significant impact on growth in Indonesia. So that the direction of government policy in infrastructure development may be established based on conditions in Indonesia.

The following research questions are raised in this study:

1. What is the impact of current health expenditure on economic growth?
2. What is the impact of direct investment in electricity, gas and water on economic growth?
3. What is the impact of direct investment in construction on economic growth?
4. What is the impact of direct investment in transportation and communication on economic growth?

According to the research questions listed above, the following are the objectives of this study:

1. To assess the impact of current health expenditure on economic growth.
2. To assess the impact of direct investment in electricity, gas and water on economic growth.
3. To assess the impact of direct investment in construction on economic growth.

   To assess the impact of direct investment in transportation and communication on economic growth.

2.2 Methodology

The quantitative technique was employed for studies in this diploma thesis, particularly the linear regression analysis with time series data from 2001 to 2020. The variables utilized in this paper to determine the relationship between economic development

and infrastructure are current health expenditure; direct investment on gas, electricity and water; direct investment on construction; direct investment on transportation and communication.

The thesis will be divided into three parts. The first part is a theoretical one and is based on a literature search. It defines the current state of knowledge in the field of infrastructure and economic growth. In this part, articles, books, research and different electronic resources will be used to provide information. Methodologically, this part of the thesis will be the analysis of documents.

The second part will rely on the theoretical part and it is the key component of the thesis. An econometric analysis will be created by using secondary data to create a one-model econometric analysis to show the relationship between infrastructure and economic growth.

The final part concludes the results of the previous parts and discusses them with another author.

2.2.1 Sampling Method

The sample for this study was drawn from all of Indonesia's data. Purposive sampling was utilized, which is a sampling approach in which sample members are subjected to data gathering considerations depending on specified purposes and objectives. It has the following characteristics: the sample is appropriate for the purpose, the number of samples is not questioned, and the sample unit is adjusted to specific criteria depending on the study objectives.

2.2.2 Model Specification

One-equation model will be used in this research. The model that will be employed in this study is a version of the Cobb-Douglas function, which is a function with two or more variables, namely the dependent variable and the independent variable. The Cobb-Douglas function model is simpler to learn and use. As a result, the Cobb-Douglas function is expressed as follows:

$$Y_{it} = A_{it} X_{it}^{\gamma} L_{it}^{1-\alpha-\beta-\gamma} U_{it}$$

Where:

Y = GDP in year t

A = Constant

X = Infratructure in year t

U = Error term

Canning (1999) considers the production function to be a *constant return to scale*. The equation is then divided by labor (L) and linearized into logarithmic form. As a result, the equation is as follows:

$$Y_{it} = \alpha_{it} + \gamma X_{it} + U_{it}$$

Where:

Y = GDP in year t

X = Infrastructure in year t

U = Error term

2.2.3 Data Colletion Method

Data collecting procedures are critical for ensuring the scientific validity of a study, and research methodologies are also required to achieve results that are consistent with the research aims. In this study, data were gathered by utilizing secondary data, which is material that has been processed by others and is generally available in the form of articles. The data utilized is time series panel data with a 20-year observation period from 2002 to 2020. The primary data for this study came from the Central Statistics Agency (BPS) and the World Bank. The data includes:

1. Growth Domestic Product (GDP) Current

   GDP at current prices, which displays the added value of goods and services computed using prices prevailing in specific units as the base year, is used as a proxy for regional economic growth. The data is gathered from World Bank in the USD value, then transferred into million USD value from year 2001 to 2020, based on GDP current pricing. The reason GDP current is being employed in this study instead of GDP constant is that beacuse GDP constant failed the stationary test, however GDP current does when transformed using the first difference.

2. Current Health Expenditure
3. The World Bank provides data on current health expenditure as a percentage of GDP. The data from year 2001 to 2020 was translated into million USD value by multiplying the percentage value each year by GDP Current data.
4. Direct Investment In Gas, Electricity, And Water

Data was acquired from the Indonesian Central Statistics Agency (BPS). The raw data is divided into two categories: foreign direct investment and domestic direct investment. There's not needed to transform the data into million USD because data is orginally came in this form. The data was then merged by combining foreign direct investment and domestic direct investment together to become direct investment in gas, electricity and water.

5. Direct Investment In Construction

   Same as previous data. Direct investment on construction is a combination of foreign and domestic direct investment with million USD value.

6. Direct Investment In Transportation And Communication

   Data is combined form of foreign and domestic direct investment in million USD value.

2.2.4 Data Analysis Method

When a model has the best linear unbiased qualities of any estimator, it is considered to be good as a predicting tool. A model is deemed to be good and capable of prediction if it has passed a set of tests for the fundamental assumptions that underpin it. The following tests will be utilized in this analysis:

a. Unit Root Test

   Each variable in this study will be subjected to an unit root (Augmented Dickey–Fuller) test to determine whether or not the data is stationary. The presence of stationary data is critical in this study. If the data is not stationary, the first difference and log difference methods will be used to convert it to stationary data.

b. Multicollinearity Test

   Multicollinearity develops when the independent variables are highly interdependent. This might lead to a quantitatively unstable estimate coefficient. This test is performed with many treatments, notably if the f-statistic is significant but the t-statistic is not. In general, multicollinearity may be detected by inspecting the correlation matrix of the independent variables. If the correlation coefficient between independent variables exceeds 0.8 or 0.9, there is a major problem with multicollinearity.

c. Normality Test

A normality test is a test that determines whether or not data on a variable or collection of data is normally distributed. If the data is regularly distributed, it is safe to believe that it was drawn at random from the normal population.

Data is considered to be normally distributed if there is no substantial or standard deviation from the standard normal. If a statistical test, such as the Kolmogorov-Smirnov test, is used, the variable is considered to be regularly distributed if the significance value is greater than or equal to 0.05. If the significance is less than 0.05, however, the variables or data are not regularly distributed.

d. Heteroscedasticity Test

Heteroscedasticity occurs when the variances of the random variables diverge. The characteristic of heteroscedasticity in OLS is that the coefficients no longer have the lowest and best variance, despite the fact that they are still biased and linear.

The impacts of heteroscedasticity on OLS are (Nachrowi & Usman, 2006):

1. One of the impacts of the non-constant variance is a bigger variance than the estimate.
2. The larger the estimated variance will affect the hypothesis test performed (t and F tests) because the test uses the estimated variance amount. As a result, both tests are less accurate. To detect the presence of Heteroscedasticity, the steps that must be taken are to carry out a Heteroscedasticity test where H_0 is Heteroscedasticity, and if the probability of the R-squared statistic is less than alpha (α=0.05), then we reject H_0 which means that there is a Heteroscedasticity problem.

e. Autocorrelation Test

This test was performed using the Durbin-Watson statistic. The DW d statistic measures the level of serial correlation in the regression equation error where the dw d statistic number less than two indicates a serial correlation, the implication of the serial correlation in the error is that the model becomes inconsistent for a larger number of samples, where the error will read larger . Durbin-Watson statistics can be defined as:

$$\mathrm{d}=\mathrm{E}\ \frac{\sum_{\mathrm{t}=2}^{\mathrm{t}=\mathrm{r}}(x_t - x_2^t - 1)2}{\sum_{t=2}^{t=r}\prod_t^2}$$

Simply put, the Durbin-Watson d statistic is the ratio of the sum of the squares of consecutive residual differences to Rss. The test approach is to transform the preceding equation into:

$$d = \frac{\sum ut2 + \sum u\_(t - 1\_ - 2\sum ut\ ut - 1}{\sum u_t^2}$$

because $\sum x_t^2$ and $\sum x_{t-1}^2$ differ only by one observation period, they are estimated to be the same. Then, by setting $\sum x_t^2 \sim \sum x_{t-1}^2$, the equation can be written as:

$$d = 2(1 - \frac{\sum u_t u_t - 1}{\sum u_t})$$

currently the sample's first degree autocorrelation coefficient, ρ an estimation of is defined as follows:

$$\rho = \frac{\sum u_t u_t - 1}{\sum u_t}$$

as a result of this the preceding equation may be represented as:

$$d = 2(1 - \rho)$$

As a result, there will be no connection when d is equal to or near to 2, because p is equal to zero.

Durbin-Watson d statistics can be known or defined in panel data processing as:

$$D_{panel} = \frac{\sum N = 1\ \sum T_t = 2(u_{it}u_{it} - 1)2}{\sum N_1 = 1\ \sum T_1 = 2u_{it}^2}$$

T = panel data time period.

N = number of individuals or cross-sections.

X_{it} = residual observation of individual panel data I in period t.

In general, autocorrelation is tough to overcome. Correlation may be reduced via logarithmic transformation. It's merely that occasionally the data being studied contains negative values, which cannot be translated into logarithmic form (Nachrowi & Usman, 2006).

2.2.5 Data Panel

Panel data is a data collection that provides sample data for a certain time period. Panel data, in other words, is a hybrid of time series and cross-sectional data. The observation time is represented by the symbol r, whereas the observed cross section unit is represented by it. Panel data is created by mixing time series units with cross sections to create a data collection. Panel data can be handled if the criterion r > 1 and n > 1 are met. A balanced

panel has the same amount of observation periods for each cross-section unit. An umbalanced panel, on the other hand, is one in which the number of observation periods for each cross-sectional unit is not the same.

2.2.6 Ordinary Least Square (OLS) Method

The OLS method is a multivariate regression analysis tool. By calculating a regression line, this approach is utilized to minimize the amount of squared errors. The OLS technique is an econometric method that uses two variables: the independent variable and the dependent variable. The OLS approach yields a population regression function that will be utilized for data estimation.

OLS is a regression approach that minimizes the square of the number of mistakes (errors). When doing interval estimation and population regression parameter testing, the linear regression model utilized with the OLS technique must fulfill the BLUE (Best Linear Unbiased Estimator) condition. BLUE Among the assumptions are:

- The regression model's parameters are linear.
- There is no exact linear relationship between two or more independent variables, and the independent variable is not stochastic (has a fixed value for each sample repeated) and has no-multicollinearity.
- The anticipated value of the error term or error is zero, $E(\varepsilon_i) = 0$.
- Error term or has a consistent variance across all observations (homoskedasticity), $E(\varepsilon^2) = \sigma^2$.
- Error terms or mistakes in the observation status are unrelated to errors in other observations (no-autocorrelation).
- Normally, error terms or errors are spread.

Using the OLS method, the total number of errors is as follows,

$$\sum_{i=1}^{n} \varepsilon_i^2$$

If the linear equation is as follows,

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_p X_{ip} + \varepsilon_i$$

As a result, the equation for the sum of squares of the total error is as follows:

$$\sum \varepsilon_i^2 = \sum (Y_i - \beta_0 - \beta_1 X_{i1} - \beta_2 X_{i2} - \ldots - \beta_k X_{ip})^2$$

The matrix notation for the number of squares of errors ($\sum \varepsilon i2$) is as follows,

$$\varepsilon_i'\varepsilon_i = [\varepsilon_1 \quad \varepsilon_2 \quad \dots \quad \varepsilon_n]\begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \vdots\\ \varepsilon_n\end{bmatrix} = \varepsilon_1^2 + \varepsilon_2^2 + \cdots + \varepsilon_n^2 = \sum\varepsilon_i^2$$

As we know, there are multiple observations in regression analysis, hence there are several (n) linear equations that rely on the number of observations performed.

$$Y_1 = \beta_0 + \beta_1 X_{11} + \beta_2 X_{12} + \cdots + \beta_k X_{1p} + \varepsilon_1$$

$$Y_2 = \beta_0 + \beta_1 X_{21} + \beta_2 X_{22} + \cdots + \beta_k X_{2p} + \varepsilon_2$$

$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$

$$Y_n = \beta_0 + \beta_1 X_{n1} + \beta_2 X_{n2} + \cdots + \beta_k X_{np} + \varepsilon_n$$

The above equation can be written in matrix form as follows,

$$\begin{bmatrix}Y_1\\ Y_2\\ \vdots\\ Y_n\end{bmatrix} = \begin{bmatrix}1 & X_{11} & X_{12} & \cdots & X_{1p}\\ 1 & X_{21} & X_{22} & \cdots & X_{2p}\\ \vdots & \vdots & \vdots & & \vdots\\ 1 & X_{n1} & X_{n2} & \dots & X_{np}\end{bmatrix}\begin{bmatrix}\beta_0\\ \beta_1\\ \vdots\\ \beta_p\end{bmatrix} + \begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \vdots\\ \varepsilon_n\end{bmatrix}$$

2.2.7 Model Verification

Economic Verification

The economic criteria consider the sign and magnitude of the estimator coefficient in relation to theory or common sense. According to this concept, all forms of infrastructure have a positive impact on economic growth. If there is a discrepancy in the results, say it is due to the sign of the magnitude of the coefficient, which in this case is negative, then an explanation in the form of reasons or justifications for the findings is required.

Statistical Verification

a. Goodness of Fit test

This test is often known as the F-statistic test, and it is a test of the model's accuracy, or what we typically refer to as the Goodness of fit in the H_0 hypothesis domain. All of the parameters we assume are zero (but do not include constants). The F-statistic value for the OLS technique is as follows:

$$F = \frac{R^2/(k-1)}{(1-R^2)/(T-K)}$$

The distribution of F with degree of fredoom (k-1) for the numerator and (T-k) for the denominator will be followed by the value of F. A high F-statistic value is preferable

than a low F-statistic value. While the prob-F value is the F-marginal statistic's significance threshold. If the prob-F value is less than the alpha value, we may reject the H_0 hypothesis. If the alpha confidence level is greater than the prob-F value, we can infer that all of the parameters we estimate (excluding constants) are different from zero or the model we apply is good.

b. R-Squared

R-squared (R^2) is a statistical measure of the regression model's success rate in predicting the value of the dependent variable. These are the percentages of variation that the model can explain. R^2 has a value between zero and one. The closer we get to one, the better the model becomes.

c. Adjusted R-Squared

One challenge with using the R2 metric to determine if a model is good or bad is that we will always receive a value that increases when the independent variable is added to the model. In general, adjusted R2 penalizes the addition of independent variables that do not improve a model's predictive ability. Adjusted R2 is defined as:

$$adj.R^2 = 1 - (1 - R^2)\frac{n-1}{n-p-1}$$

where n represents the sample size and p represents the number of regressors (excluding constants).

The value of adj R^2 will never surpass the value of R, even if it lowers due to the superfluous addition of the independent variable, and adj R^2 can even be negative for a model with a poor goodness of fit.

f. Significant test for each independent variable

This test is carried out with a t-statistical test at a degree of confidence (1-alpha()). This test is used to determine whether the resultant coefficient value is substantially different from zero. Typically, the rightmost column in the regression output displays the probability value of the regression parameter that we predict, assuming that the regression error is normally distributed. The p-value denotes this value. With this p-value, we may decide whether to accept or reject the H_0 hypothesis. If the p-value is less than the alpha value, we reject H_0. In this study, we use an alpha value of 0.05.

3 Literature Review

Infrastructure refers to the physical system that provides transportation, irrigation, drainage, buildings, and other public facilities needed to meet basic human needs in the social and economic sphere. The infrastructure system is the main support for the functions of the social and economic system in people's daily lives. The infrastructure system can be defined as the basic facilities or structures, equipment, and installations built and needed to function the social system and the community's economic system (Warsilan & Noor, 2015). According to Cambridge dictionary infrastructure is "the basic systems and services, such as transport and power supplies, that a country or organization uses in order to work effectively." (Cambridge, n.d.).

Another definition of infrastructure is the physical capital facilities and includes the organizational, knowledge, and technological frameworks essential for community organization and economic development. Infrastructure includes laws; public education and health systems; water distribution and treatment system; garbage and waste collection, processing and disposal; public safety systems such as fire and security; communication systems, transportation systems, and public utilities (Tatom, 1993).

Infrastructure can be divided into two groups, namely infrastructure based on its function and designation. Infrastructure is divided into economic and social infrastructure. Economic infrastructure plays a vital role in encouraging the performance of economic growth in various countries. Economic infrastructure includes public utilities, such as electricity, telecommunications, clean water supply, sanitation and sewerage, and gas. Then it also includes public works such as roads, canals, dams, irrigation, and public works projects such as railways, city transportation, waterways, and airports. In contrast, social infrastructure is the infrastructure of Education and Health (Familoni, 2004).

Infrastructure differentiation is also often based on the investment made in the infrastructure. The investment disaggregation is divided into two categories. The first category is extensive transportation and communication networks (roads, railways, roads, ports, and telephone systems). This difference relates to the different intensity of intervention at each level of government. The distinction of this category is related to the characteristics between regions (Herranz-Loncan, 2007).

Discussions on infrastructure tend to lead to discussions of public goods (Stiglitz, 2000). Some infrastructures such as toll roads are public goods provided by the government,

although this infrastructure is not pure public goods. Public goods have two main characteristics regarding their use, namely non-rivalry and non-excludable rivalry (Samuelson, 1954) . Non-rivalrous products do not run out as more people consume them, and non-excludability indicates that the item is available to all citizens.

By understanding the nature of infrastructure as a public good, based on the theory, infrastructure has an externality character. This is in accordance with its nature, namely, where the government provides the infrastructure. Each party who uses the infrastructure does not pay directly for its use. For the private sector, some infrastructure is an unpaid input, which is called an infrastructure externality (Charlot & Schmitt, 1999).

Externalities are circumstances in which the effect of producing or consuming products and services imposes costs or advantages on others that are not represented in the prices charged for such goods and services (OECD, 2002). A clear example of a negative externality, also known as an external diseconomy, is pollution. Chemicals thrown into a lake by an industrial company may harm fish and plants, affecting the livelihoods of fishermen and farmers in the area. A positive externality or external economy, on the other hand, may result from the construction of a road that opens up more land for housing, commercial development, tourist etc. The transistor's discovery resulted in a slew of positive externalities in the production of contemporary telecommunications, stereo, and computer technology. When property rights cannot be adequately allocated, externalities occur.

In theory, there are two forms of externalities, namely positive externalities and negative externalities. Positive externalities tend to be undersupplied, and negative externalities tend to be overproduction (Stiglitz, 2000).

Undersupply is a condition of demand for an item that is described by a demand curve that does not reflect the social value of the item. The social value curve is above the demand curve because the social value of the good is greater than its private value. Socially, the optimum quantity to be supplied is when the social value curve intersects the supply curve. This implies that the socially optimum quantity is greater than the optimum quantity determined by its private value. While overproduction is the opposite condition, namely when social costs are not included in the calculation of the production costs of an item so that privately available production is smaller. The implication is that more goods are produced where there should be less optimally produced goods because social costs should be included (Mankiw, 2011).

Infrastructure has the nature of externalities. Various infrastructures such as roads, education, and health have positive externalities (Pedroni & Canning, 2004). Provide support that the facilities provided by various infrastructures are positive externalities that can increase the productivity of all production process inputs. Positive externalities on infrastructure are in the form of spillover effects in the form of increasing the production of companies and the agricultural sector without increasing capital and labor inputs and increasing the level of technology. With the construction of infrastructure, the level of productivity of companies and the agricultural sector will increase. One of the most visible is road construction (Wylie, 1996).

3.1 Infrastructure and Economic Development

According to Todaro and Smith, **development** is a physical reality and community determination to try as hard as possible through a series of combinations of social processes, economic and institutional, to achieve a better life. Process Development has three objectives, namely: increased availability and expansion distribution of various kinds of goods basic living, increasing of the standard of living, and expanding economic options and social for each individual and nation as a whole (Todaro & Smith, 2003). **Economic growth** is a process of increasing production capacity in an economy continuously over time to produce higher levels of national income and output (Todaro & Smith, 2003).

Economic growth can be interpreted as an increase in per capita income (O'Sullivan, 2006). Economic growth is usually measured by gross domestic product (GDP), or the total value-added created in one country. To see the welfare of person , economic growth is measured by GDP per capita.

Several things are the source of economic growth. The primary source of economic growth is the **availability of capital and labor factors**. An increase in capital and labor will increase aggregate output in the economy. Capital includes public and private sector investment in the economy; for example, the private sector builds factories, purchases production machines, etc. In contrast, the public sector by building infrastructure such as roads, bridges, telecommunications networks, and electricity networks is also known as public capital (Mankiw, 2011). Other sources of economic growth include capital deepening, human capital, and technological advances (O'Sullivan, 2006). **Capital deepening** is an increase in the amount of capital for each worker, meaning that workers have more

opportunities to increase their productivity due to the many accesses to utilize existing capital.

In many countries, the growth of capital for each worker plays a vital role in driving the economy. Countries such as the United States and Japan have proven that access that is increasingly accessible to every worker makes it easier for workers to carry out their activities in the economy. They are increasingly able to increase their productivity so that capital accumulation occurs, encouraging their economy.

Next is the increase in **human capital**. Human capital relates to a person's level of knowledge/education that contributes to productivity and income. Improving the education and skills of workers also allows spillover effects to other workers, namely with various experiences, knowledge, and skills. In theory, more competent workers will be more productive and will have higher income levels by taking advantage of the spillover effect; in aggregate, there can be an increase in productivity and income levels for other workers. An increase in human capital will increase work productivity and income to increase economic growth (O'Sullivan, 2006). The last source is **technological progress**. This source of growth has an indirect effect on economic growth. Technological advances affect the way workers work. Advances in technology provide convenience in the production process. A society with the same level of knowledge will be more productive when the community can take advantage of technological advances in the production process. Increased productivity will increase the level of income of workers, and this will encourage the economy.

3.1.1 Economic Development Theory

Development must be viewed as a multidimensional process that includes various fundamental changes to social structures, attitudes of society, and national institutions, while continuing to pursue economic growth, addressing income inequality, and alleviating poverty (Todaro & Smith, 2003). Economic development can be interpreted as a series of efforts in the economy to develop its economic activities so that infrastructure development will continue to develop, education levels will be higher, and technology will increase. The implication of the development of economic activity is expected to be able to expand employment opportunities which will reduce the unemployment rate. In addition, the prosperity of the community is getting higher due to an increase in people's income.

An increase in the output produced characterizes economic growth. The percentage increase in output must be more significant than the percentage increase in

population. Economic growth is a quantitative measure that describes the economic development of a country from time to time. This development is expressed in terms of the percentage change in national income in a given year compared to the previous year (Sukirno, 2016).

Economic growth is a process of increasing production capacity in an economy continuously or continuously over time to produce higher levels of national income and output. There are three main factors or components in determining the economic growth of each nation, which (Todaro & Smith, 2003):

Capital accumulation includes all new forms of investment, such as land, physical equipment and human resources through improvements in health, education and skills. When a percentage of current revenue is saved and invested in order to boost future production and income, this is referred to as **capital accumulation**. New factories, machinery, equipment, and materials boost a country's physical capital stock (the total net real worth of all physically productive capital goods) and allow for increased output. These immediately productive expenditures are supported by investments in what is known as social and economic infrastructure, which includes roads, power, water and sanitation, communications, and other infrastructure that facilitates and integrates economic activity. A farmer's investment in a new tractor, for example, may enhance the total output of the crops he can produce. Without appropriate transportation infrastructure to deliver this extra goods to local commercial markets, his investment may have no impact on national food production.

Population growth is one of the factors that leads to a growth in the labor force. Population expansion and the resulting increase in the labor forcehave long been thought to be a beneficial element in boosting economic growth. A larger labor force equals more productive employees, and a larger total population expands domestic market potential.

Technological progress, which is defined as a way to get work done. New and better means of completing conventional activities, such as producing crops, creating clothing, or building a house, lead to technical advancement. Technological development is divided into three categories: neutral, labor-saving, and capital-saving.

Neoclassical Growth Theory

The most well-known economic development model is the **Solow neoclassical growth model**, for which Robert Solow of the Massachusetts Institute of Technology won the Nobel Prize (Solow, 1956). Although Solow's model better reflects a mature economy than a

developing economy in certain ways, it remains a fundamental reference point for growth and development literature. **If economies have the same rates of savings, depreciation, labor force expansion, and productivity growth, they will conditionally converge to the same income level**. As a result, the Solow model serves as the foundation for examining **cross-national convergence**.

The neoclassical growth theory's production function is used to calculate an economy's growth and equilibrium. The function is $Y=AF(K,L)$.

Y The gross domestic product (GDP) of a country is represented by the letter.

K Denotes the capital stake of the company.

L The amount of unskilled labor in a given economy

A Denotes a significant technological level.

An economy's production function is frequently rewritten as $Y = F$ because of the connection between labor and technology (K, AL).

Increasing any of the inputs has an influence on GDP and, as a result, on an economy's equilibrium. However, if the three components of neoclassical growth theory are not all equal, both unskilled labor and capital returns on an economy are reduced. These lower returns suggest that increasing these two inputs has exponentially lower returns, but technology's contribution to growth and the output it can create is limitless.

Endogenous Growth Theory

Endogenous growth theory explained that economic growth is driven by variables in the production process (for example, rising returns or induced technical development) that are analyzed in a growth model (Todaro & Smith, 2003). The new growth theory provides a theoretical framework for analyzing endogenous growth, which is gross national income (GNI) growth that is driven by the system that governs the production process rather than external influences. GNI growth is a natural result of long-run equilibrium in these models, contrary to standard neoclassical theory. **The main goals of the new growth theory are to explain both growth rate differences between nations and a larger share of observed growth**.

Governments may enhance resource allocation efficiency when complementary initiatives provide both social and private advantages. They can do so by providing public goods (infrastructure) or promoting private investment in knowledge-intensive sectors, where human capital can be amassed and growing returns to scale created as a result. Unlike

the Solow model, new growth theory models describe technological progress as an **organic result of public and private investment in human capital and knowledge-intensive sectors** (Todaro & Smith, 2003). In contrast to neoclassical theory, endogenous growth models suggest that public policy can play a more active role in promoting economic development. This can be by investing directly and indirectly in human capital formation and encouraging foreign private investment in knowledge-intensive industries like computer software and telecommunications.

Modern theories of endogenous growth recognize that the adoption of new technologies (i.e., digital technologies) improves the economy's inventive capacity by promoting growth through knowledge spillover, the development of new goods and processes, and business models. As a result, the rapid growth of digital technologies has facilitated information searching, matching, and sharing, as well as increased organizational and collaborative efforts among economic agents, influencing how businesses operate, people seek opportunities, and citizens interact with their governments (Benhabib & Spiegel, 2005).

3.1.2 The Roles of Infrastructure

Infrastructure is vital to a society because it provides a physical foundation for the effective operation of organizations that supply necessary structures and related commodities and services in an economy (Gramlich, 1994). Roads, telephones, water supply, and railroads are examples of **hard infrastructure**, whereas governance, health, and education systems are examples of **soft infrastructure** that may sustain, create, and maintain socioeconomic standards (O'Brien & Pike, 2015).

In general, infrastructure investment benefits local economies by increasing the efficiency of companies' input-output flows as well as household goods and service flows (Underhill & Ebray, 2010).

Kessides (1993) investigated the relationship between infrastructure and economic development, concluding that it is critical for increasing industrial productivity and improving public welfare. As a result, infrastructure was shown to support economic development by increasing firm productivity and providing services that improve the public's quality of life. Infrastructure boosted firm productivity by making intermediate inputs more accessible, lowering production and distribution costs, and increasing the productivity of other production factors.

3.1.3 Infrastructure and Economic Growth

Several new growth theory literature try to explain the importance of infrastructure in driving the economy. This theory includes infrastructure as an input in influencing aggregate output and is also a possible source of increasing the limits of technological progress derived from the emergence of externalities in infrastructure development. Referring to the previous discussion, briefly the hypothesis of public capital which in this case is the stock of public capital increases output in the private sector directly and indirectly. The direct effect is based on the hypothesis because public capital provides intermediate services to the private sector in the production process/in other words, the marginal product of public capital services is positive. The indirect impact is caused by the notion that public and private capital are complimentary in the manufacturing process. As previously stated, infrastructure has spillover effects or externalities, particularly those observable in industrial activities. Infrastructure externalities have an impact on production activities because they provide accessibility, convenience, and the possibility of more productive production activities. These externalities are called positive externalities. Therefore, there is a simplification of the problem of the positive externalities caused by infrastructure to the production function. The public sector has an essential role in production activities. The public sector can be included in the production function because of the important role of the public sector as an input in production. The role of the productive public sector will create the potential for positive linkages between government and growth (Barro, 1990).

In his literature study on public spending, Barro (1990) began to include several assumptions to explain the relationship between government and economic growth. It is assumed that the government here is a public service that is provided without any usage fees and is not hindered by congestion effects. This model is a simplification of externalities related to the use of public services. Then consider the role of public services as an input (G) in addition to private capital (K) in private production. This productive role will create the potential for positive linkages between government and growth. Production shows assumed constant returns to scale on K and G together but diminishing returns on capital (K) separately.

Infrastructure for information and communication technology (ICT) plays a significant role in accelerating economic growth, particularly in today's era of the internet and mobile telecommunications. Digital telephone networks, mobile phones, internet capabilities,

internet servers, fixed broadband, and other technologies are now part of the information and communication technology infrastructure.

A research done by Prahdan, Malik, Bagchi (2018) looks at specific long-run correlations between per capita real GDP, information and communication technology (ICT) infrastructure, consumer price index, labor force participation rate, and gross fixed capital creation in G-20 nations between 2001 and 2012. The study reveals that the variables are cointegrated and do not drift apart over time using panel cointegration. This analysis indicates that improving ICT infrastructure - a seemingly indisputable requirement in an economy's information technology (IT) policy design for both fixed broadband and internet users – increases per capita GDP.

3.2 Previous Studies

Economists have carried out various studies regarding the role of infrastructure in economic growth. The contribution of these studies shows the important role of infrastructure in economic growth in various regions and countries in the world.

An autoregressive distributed lag (ARDL) framework is used to determine the **long- and short-run impact of the selected infrastructure stock and quality indices on Ghana's economic growth.** The research was using data from the World Bank's World Development Indicators, the United States' (US) International Energy Statistics, and the Central Intelligence Agency's (CIA) Factbooks from 1980 to 2016. The findings show that infrastructure development and economic growth have a statistically significant link. Furthermore, the infrastructure stock index that has the most beneficial influence on Ghana's economic growth is recognized as electricity-generating capacity. According to the study, electricity distribution loss has a substantial detrimental influence across both long and short time periods (Owusu-Manu, et al., 2019).

Wylie (1996) conducted a study that focused on **the role of infrastructure in economic growth in Canada**. This research was motivated by the poor performance of the Canadian economy in 1947-1972 and 1973-1991. The poor economic growth is suspected as a result of the decline in productivity per worker, from 5.84 percent to 2.63 percent per year. Meanwhile, total infrastructure capital per worker also fell 6.09 percent to 3.05 percent during the same period. On this basis, Wylie tried to examine the effect of infrastructure on economic growth and productivity in Canada. Wylie considers that infrastructure has an

influence on worker productivity so that the level of productivity will have a positive impact on economic growth (Wylie, 1996).

This is based on the meaning of capital deepening as a source of economic growth. The definition of infrastructure in this study is quite extensive, consisting of transportation services, telephone systems, electricity, trade, finance, insurance, real estate, schools, universities, and hospitals. The data used for economic performance is real output (real GDP), while infrastructure is measured by infrastructure stock in Canada. The results of this study indicate a link between infrastructure and economic growth and worker productivity. Infrastructure has a significant positive effect on the economy and in increasing worker productivity, especially public infrastructure such as roads, hospitals, and schools. According to the results of the study, roads are the most important economic infrastructure in driving the Canadian economy. Road is one of the important sectors in economic activity. The role of roads in encouraging the economy can be seen if when the scarcity of road infrastructure limits an economy, the absence of sufficient access makes various production factors experience a decrease in their level of mobility. On the other hand, by looking at the effect of the absence of roads, road construction leads to an efficient distribution of factors of production (Queiroz & Gautam, 1992).

Analysis of cross-sectional data from 98 countries shows a **consistent and significant relationship between economic development (in terms of each country's GNP) and road infrastructure** (as measured by the length of the asphalt network). The data show that road infrastructure per capita in high-income economies is dramatically greater than in middle and low-income economies in a nutshell, the average density of asphalt roads is 170 middle-31 and low-income economies 1,660 km/million population. and around 10,110 km/million inhabitants in high-income economies. The data also shows that the level of road damage is also related to the level of the economy (Queiroz & Gautam, 1992). At a high level of the economy, the level of road damage is smaller than the level of road damage at the medium/low level (Familoni, 2004). Quality and quantity are important in building the economy.

Canning (1999) conducted a study on the **contribution of infrastructure to aggregate output**. This research aims to find out how significant the role of infrastructure is to economic aggregate output in various economies in various countries in the world. The data used in this study is panel data from 1960-1990 data. Infrastructure is assumed to be an input in the production function and other production factors, namely labor, physical capital,

and human capital (education). Canning uses the definition of infrastructure, which telephone connections, electricity capacity, and land transportation (paved roads and railways) (Canning, 1999).

Previously Hardy (1980) conducted a **study to determine the potential impact of telecommunications on economic growth** using data from 15 developed countries and 45 developing countries in the period 1965-1973. Hardy estimated that telephone and radio networks on GDP found that telephone has a significant effect on GDP while the radio variable does not show a significant effect (Hardy, 1980). The significant influence of telecommunications infrastructure is in accordance with the research results by Roller and Waverman (1996), who conducted a study on telecommunications infrastructure in 21 OECD member countries. An important finding in this study is that the **marginal productivity of telecommunication (MPT) in OECD countries is greater than in non-OECD** (Less-Developed Countries) countries. This is an implication of using a broader definition of telecommunication infrastructure (Röller & Waverman, 1996). Using the definition of IT (Information Technology) globally to define telecommunications so that it includes the internet, email, etc. This clearly has a much different impact when we look at telecommunications infrastructure that is limited to telephones. The condition of people's knowledge levels in various regions is different so that when IT enters a higher level of knowledge, MPT will be greater and vice versa.

Then Belaid (2004) tried to look at the simpler telecommunications infrastructure (telephone, mobile phone, and radio) and saw its considerable impact on economic growth in 37 Less Developed Countries (LDC) in the world. The findings are that **infrastructure has a significant influence** and briefly explain that the **possible impact of the internet will be insignificant on economic growth in the Least Developed Countries** due to the slow rate of internet adoption.

Telecommunications infrastructure contributes to aggregate output by lowering transaction costs (Norton, 1992). Two things explain the relationship between transaction costs and telecommunications. First, in many underdeveloped economies (LDCs) there is a lack of readily available information, which is a cost. Decisions to be taken or made will proceed slowly because economic actors do not know what to do in finding alternatives. Second, telecommunications is very important in the market for goods and factors of production. Telecommunications reduce transaction costs in the market mechanism and lead to higher aggregate output (Norton, 1992). In real terms, telecommunications also reduces

geographical distances and boundaries. Telecommunications reduce long distances by providing information flow from one area to another.

Furthermore, Herranz-Loncan (2007) conducted a study on the role of infrastructure in Spain's economic growth using data from 1850-1935. The results showed that infrastructure with a local scope, namely urban transportation, electricity distribution, and water infrastructure had a significant influence on the economic growth of Spain. The real availability of electricity is not only needed by power plants for their operations but is also used as an input in the production process, especially the large demand for electricity by manufacturing companies (Wang, 2002).

Agenor and Moreno-Dodson prove that the **link between public infrastructure and economic growth can be explained**, among other things, **through the role of infrastructure in increasing workers' productivity**, 34 where these workers were used as inputs in the production process (Agénor & Moreno-Dodson, 2006). Thus, it can be said that infrastructure has a positive effect on economic growth. In particular, the fulfillment of the need for water, electricity, and roads will provide facilities in transforming non-tradable goods into tradable goods and/or from the agricultural sector into services and manufacturing. Then other findings show that various infrastructures, including gas, water, electricity, transportation, and communication, contribute to GDP between 5-11 percent in various countries (Kessides, 1993).

Empirical studies conducted in **China** say that the **link between infrastructure development and economic growth is positive**. Using panel data from 24 provinces in China between 1985-1998, the estimated growth model shows that ownership of infrastructure (infrastructure endowment) can significantly explain economic growth performance in various provinces. The results show that transportation is the key factor that distinguishes the gap between one province and another, and the role of telecommunications is significant in reducing various obstacles to distance and isolation (Démurger, 2001).

Another study was conducted by Fan and Zhang (Fan & Zhang, 2004), both of whom wanted to see the **effect of infrastructure on productivity in the agricultural and non-agricultural sectors in rural areas** in each province in China. Then distinguish rural areas (rural) in China between the West China, Central China, and East China. The results of this study are that statistically, public capital and human capital (education) significantly affect productivity in the non-agricultural sector because the non-agricultural sector contributes greatly to rural income. This research also proves the **importance of public capital**, where

the productivity of the western region is higher than other regions. This is due to the availability of better infrastructure in the west than in the other two regions (Fan & Zhang, 2004).

In **Indonesia** itself, several studies have been done to find the relation between infrastructure and economic growth. Harry and Kasyful examined the **effect of increasing infrastructure on economic growth in the city of Sibolga** (Atmaja & Mahalli, 2013). This study aimed to find out how big the role of infrastructure in economic aggregate output in various economies in the city of Sibolga. The data used in this study is panel data from 1989-2013 data. The results obtained from this study are that **road and water infrastructure have a significant effect, while electricity and telephone infrastructure do not**.

Wulandari examined the analysis of the **influence of public infrastructure on economic growth in Aceh** (Wulandari, 2015). The purpose of this study was to find out how big the role of infrastructure is to economic aggregate output in various economies in the city of Aceh. The data used in this study is panel data from 2008-2012 data. The results obtained from this study are that **road infrastructure has a significant influence on economic growth while electricity and clean water infrastructure does not**.

Warsilan and Noor examined the role of infrastructure on economic growth and the implications of development policies in Samarinda City (Warsilan & Noor, 2015). The purpose of this study is to describe the relationship between economic growth and infrastructure and to analyze the implications of road development policies in Samarinda City. Community Health Center infrastructure, clean water and roads have a positive and significant impact on economic growth. The results with the AHP method show that the first priority target is to increase labor absorption with the priority target being to increase the length of the road, the second priority to increase economic growth by adding road facilities and the third priority to reduce poverty by increasing the length of the road. The results obtained from this study are that health infrastructure, clean water services, and water significantly influence economic growth.

In 2014, Iskarno, Kuncara, and Irianto did the research on the **effect of education and infrastructure on the economic growth of Indonesia** (Iskarno, et al., 2014). The goal of the research was to figure out and assess the impact of education and infrastructure on economic growth. The number of workers according to the highest educational level attained at the SMTA level as data objects of variable levels of education, length of road per area of the province as a data object of infrastructure variables, and GDP as data objects of variable

economic growth obtained from the Central Bureau of Statistics are the subjects of this study. By incorporating data from the Riau Islands province of Riau Province in the data, the scope of this study covers data from 32 provinces in Indonesia from 2008 to 2012. According to the findings, there is a **substantial positive relationship between educational attainment and economic growth**. Road infrastructure has a strong beneficial impact on economic growth, and there is a significant positive relationship between education and infrastructure and economic growth.

Prasetyo and Firdaus examined the influence of infrastructure on regional economic growth in Indonesia (Prasetyo & Firdaus, 2009). The Cobb-Douglas production function is used to construct the model. The results produced utilizing infrastructure data from 26 provinces and the fixed effects technique of panel data demonstrate that infrastructure, such as the supply of power, paved roads, and clean water, has an impact on economic growth. Furthermore, Indonesian industrial activities are still classified as labor-intensive, as evidenced by labor elasticity being larger than capital elasticity. The most significant influence on economic growth is electricity, which is followed by paved roads and clean water.

A research has been done in 2020 by Ailen and Abraham Camba on the relationship between internet subcribtion and broadband subscribtion on the impact of economic growth (Camba, 2020). Data has been gathered for the period 2000-2016 to examines the cointegration connection and causal link between internet penetration and broadband subscription and economic development in the ten ASEAN nations. GDP growth as a function of internet penetration and broadband subscription was produced using a pooled multiple regression model. The results of the cointegration test show that internet penetration, broadband subscription, and economic growth have a long-run equilibrium connection. Long-run causation exists between internet penetration and broadband subscription and economic development, according to the causality test. Broadband subscriptions boost economic growth in ASEAN countries in the near term. However, throughout the years 2000-2016, internet penetration has no direct relationship with economic development. The findings back up the argument that internet adoption and broadband connections are the engines of economic growth, changing ASEAN economies at a rapid pace. Based on these findings, the research suggests that ASEAN governments adopt policies that encourage improved internet and broadband infrastructure in order to achieve short and long-term economic growth.

The Internet is thought to contribute to the knowledge spillover effect across countries. As a result, a rise in Internet usage in a nation is thought to have a favorable influence on economic growth. The study showed evidence that the Internet has a positive and substantial effect in economic growth after controlling for investment ratio, government consumption ratio, and inflation in the growth equation using panel data from 207 nations from 1991 to 2000 (Choi & Yi, 2009).

The impacts of human capital creation and Internet penetration on economic growth are investigated in a research by Hazwan Haini (2019). By delivering creative applications and possibilities through a new medium of information transmission, the Internet promotes economic growth. The Internet's development potential, on the other hand, is contingent on an economy's human capital formation in order to fully absorb the Internet's prospective possibilities. This research uses a panel dataset of ten economies from the Association of Southeast Asian Nations (ASEAN) from 1999 to 2014 to analyze the link using a translog production function model. Human capital formation and Internet penetration are both good and substantial contributors to economic growth, according to the projected results. Furthermore, human capital creation and the Internet interact constructively and are important to economic progress, supporting human capital's ability to absorb information. To improve affordability and accessibility to the Internet across the region, ASEAN economies should continue to embrace policies that foster human capital generation and support the growth of the communication technology industry.

Between 1980 and 2015, a research used investment to evaluate the changes in private and state health spending in Turkey in relation to the effects of production levels. The goal of this study is to use ARDL to look at the relationship between healthcare spending as a percentage of GDP and GDP per capita. The results of the boundary test for co-integration indicate that the variables are co-integrated and have a long-term meaningful connection (Erçelik, 2018).

In emerging nations, one research discovered a direct association between health spending and economic development. The E7 nations are assessed using the Pedroni panel cointegration approach and the Dumitrescu Hurlin panel causality analysis in this context. Annual data for the years 1996 to 2016 is used for this purpose. According to the Pedroni panel cointegration test, there is a long-run link between economic growth and total and public health spending (DİNÇER & YUKSEL, 2019).

Dumrul, Dogan, Nadide (2016) looked into the link between health spending and economic development using panel data from low- and high-income nations. They look at twenty-five high-income economies and nineteen low-income economies over the years 1995–2012 and 1997–2009, respectively, using dynamic panel data technique. In the short term, they discover a reciprocal link between health spending and economic growth, as well as one-way causation from economic growth to public health spending in the long run.

4 Practical Part

4.1 Descriptive Analysis

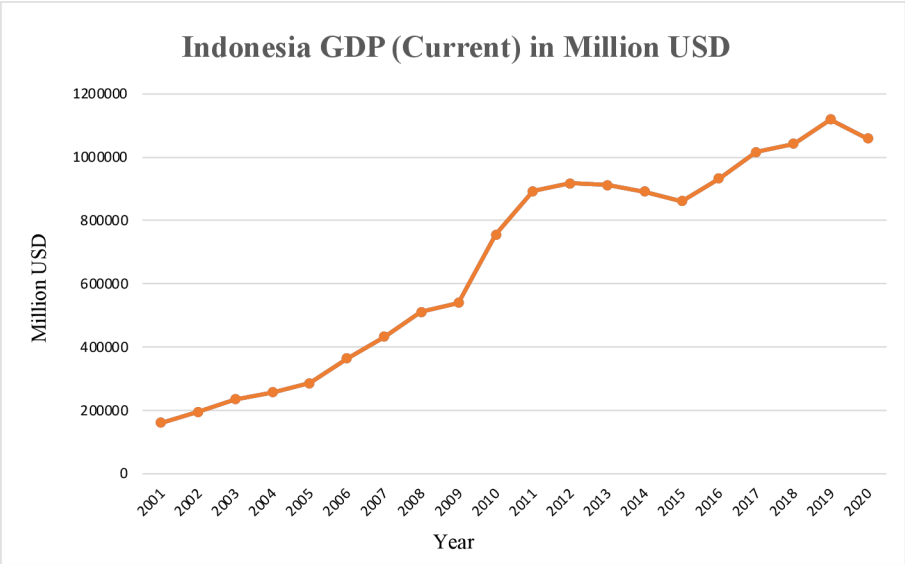
4.1.1 GDP Analysis of Indonesia

High economic growth is an important aspect of development and one of the aims of national development. Growth domestic product (GDP) is employed as a gauge of the health of the country's economy in this context. The GDP growth rate is frequently used as a measure of the overall health of the economy. In general, a growth in GDP is viewed as evidence that the economy is functioning well.

GDP indicates a region's or country's ability to produce additional value at a given point in time. GDP may be seen from three perspectives: production, usage, and income. All three show the breakdown of value-added data by economic sector, component of use, and source of revenue.

GDP from the production side is the total of all gross added value that the economic sectors may generate via their varied production activities. Meanwhile, in terms of application, it describes how to make advantage of the additional value. Furthermore, in terms of income, value added is the total of operational surplus salaries, depreciation, and net indirect taxes. GDP is valued in two ways: "at current prices," which utilizes prices for the current year, and "at constant prices," which uses pricing data for a certain year (base year). In this study GDP at current price is utilized.

Figure 1. Total GDP of Indonesia (current million USD, 2001-2020)



Source: World Bank (2020)

The figure 1 above shows that Indonesia's GDP is growing throughout the year. According to the Ministry of Finance's Fiscal Policy Agency (BKF), Indonesian economic growth has never been lower than world economic growth over the previous 20 years. In terms of G20 membership, Indonesia has the world's 16th biggest GDP. This has become Indonesia's major capital in order to be seen by the rest of the world, particularly to participate in global decision-making (Kompas, 2021).

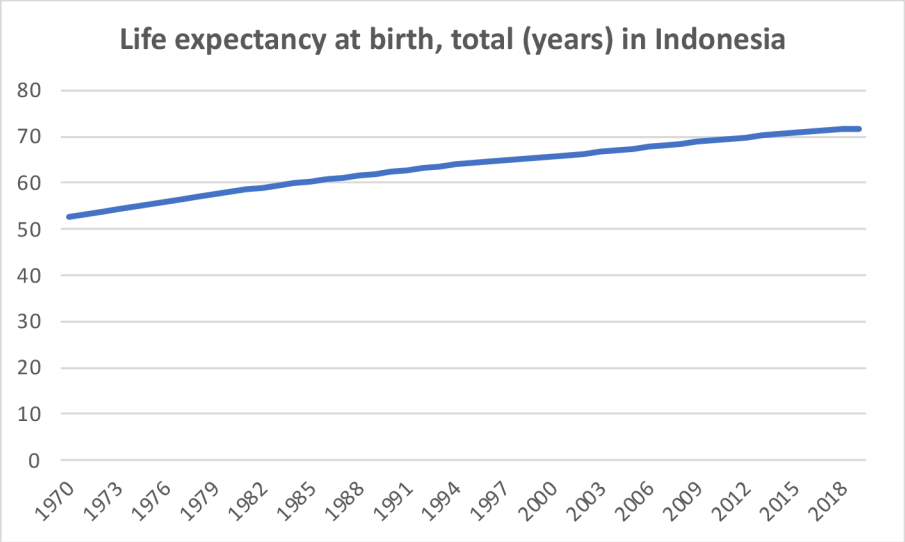
4.1.2 Health Infrastructure Analysis

One of the national development initiatives that is held in all aspects of life is health development. Health development strives to raise people's awareness, willingness, and capacity to live a healthy lifestyle in order to achieve the best possible level of public health. As a result, health development is one of the primary initiatives to increase the quality of human resources, which aids in the acceleration of attainment of national development goals.

From an economic standpoint, the importance of health considerations for Human resources will be strongly tied to the quality of human resources (quality of human resources). Health status, education, and per capita income level will influence the high and low quality of human resources HR. In economic activities, the three indices of human resource quality will have an indirect impact on a country's human development index.

One of the most important components in accomplishing this health progress in Indonesia is health infrastructure. According to the World Health Organization (WHO), health is a condition of physical, mental, and social well-being, not only the absence of sickness and physical infirmity. In practice, the health status is measured by life expectancy.

Figure 2. Life expectancy at birth, total (years, 1970-2019)

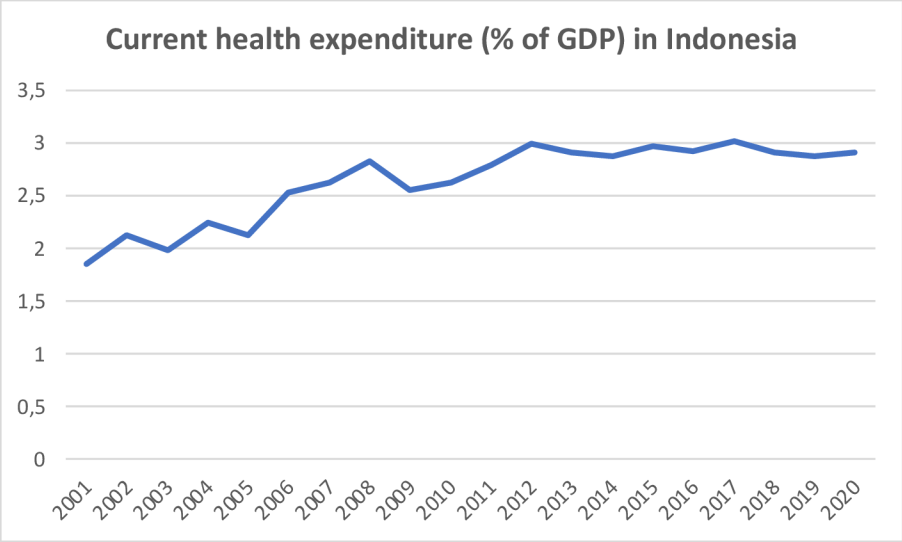


Source: World Bank (2020)

One significant discovery is that in Indonesia, life expectancy at birth has grown by 9 years, from 62.32 years in 1990 to 71.7 years in 2019 (figure 2). This rise in life expectancy is primarily attributed to Indonesia's achievement in combating infectious illnesses, pregnancy-related disorders, neonatal diseases, and nutrition-related diseases. Because of the growth in life expectancy, the demographic structure has changed: 65 percent of the population is of productive age, and the population aged 60 and above will climb to 12 percent in 2025 and 16 percent in 2035. At the same time, Indonesia is seeing changes in morbidity, mortality, and disability trends (Adetunji, 2018).

According to (WHO), health expenditure comprises all spending for the provision of health services, family planning activities, nutrition programs, and health-related emergency help, but excludes expenditures for the supply of drinking water and sanitation. Health funding is an essential component of health-care delivery systems. General government health spending as a proportion of overall government spending - This indicator is defined as the level of general government health spending (GGHE) expressed as a percentage of total government spending. It depicts the proportion of public spending on health in relation to the overall value of public sector activities. This indicator covers not just resources channeled through government budgets, but also health-related expenditures channeled through government bodies by parastatals, extrabudgetary entities, and, most significantly, mandatory health insurance. The indicator relates to public-sector resources gathered and pooled, encompassing all revenue modalities.

Figure 3. Current health expenditure (% of GDP) in Indonesia (2001-2020)



Source: World Bank ((2020)

The indicator total health spending as a percentage of GDP - is defined as the level of total health expenditure represented as a percentage of GDP, where GDP is the value of all final products and services produced within a country in a given year. It gives statistics on the proportion of a country's wealth allocated to health.

As can be seen from the figure 3 above, health-care spending has risen over the last two decades. Even if the proportion is not substantially growing, taking it into account might be a role in Indonesian health improvement.

4.1.3 Electricity, Gas and Water Infrastructure analysis of Indonesia

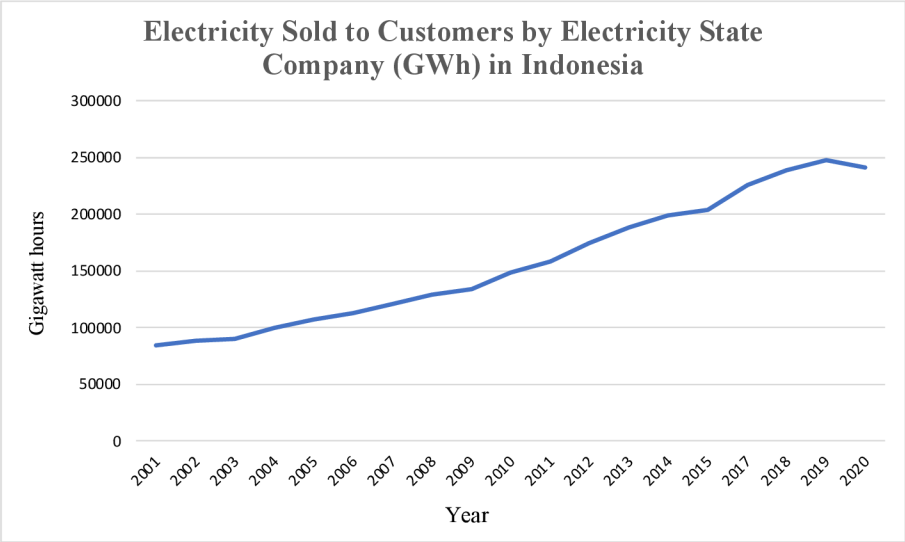
The electricity, gas, and clean water industries play a key role as a raw resource for industry, as well as a fuel, a commodity, and a major foreign exchange earner. In addition, to address the requirements of the community on a daily basis. The power, gas, and clean water sectors are controlled by three State-Owned Enterprises, namely PT. PLN (State Electricity Company), PGN (State Gas Company), and PDAM (Regional Drinking Water Company), each of which generates essential community goods like as electricity, gas, and clean water.

Electricity is a source of energy that civilization need in everyday living and industrial activity. Electricity has transformed a consumptive need into a constructive requirement in life. Because electricity is one of the most important factors in improving productivity through the use of more complex technology, such as in families when turning on televisions, water pumps, washing machines, irons, and other electrical equipment. Then there's the

demand for electricity to power industrial operations like the textile, transportation, entertainment, and health care industries. As a result, economic development may be said to be determined by the availability of resources and the exploitation of these electrical resources.

The electricity sector involves both the generation and distribution of power, both of which are organized by the State Electricity Company (PLN)/non-PLN. Except for power generated for consumption by the sector itself, by-product electricity generated by plantation firms, mining, industrial, and other sectors is included (BPS). Power production comprises the quantity of KWH of electricity generated and sold, as well as transmission and distribution losses. As seen in the figure 4 below, the amount of electricity supplied is rising at a steady rate. It might imply that the country's demand for power is likewise growing.

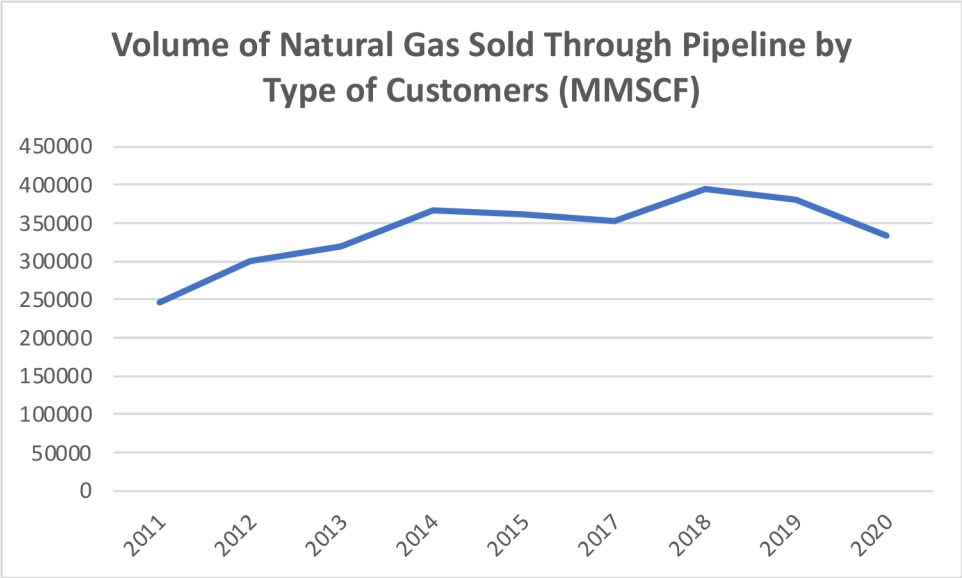
Figure 4. Electricity Sold to Customers by Electricity State Company (GWh) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

The gas sector includes the production and distribution of city gas for sale to other sectors as well as to homes. Gas is an alternate energy source to oil since natural gas reserves are bigger than oil reserves, which are becoming increasingly rare, and gas has a lower competitive price than oil. Gas derived from the combustion of coal and oil refinery leftovers, as well as the process of distributing gas to the community, is used in the production of city gas. The volume of natural gas sold through pipeline by different types of consumers is illustrated in figure 5.

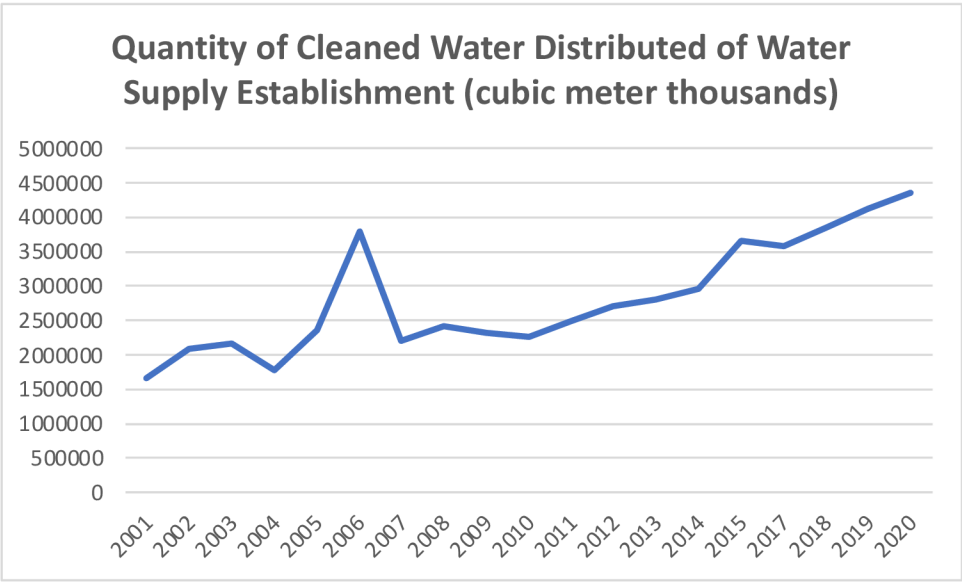
Figure 5. Volume of Natural Gas Sold Through Pipeline by Type of Customers (MMSCF) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

Furthermore, the clean water industry includes cleaning, filtration, and other chemical operations to generate clean water, as well as its transport via pipes to families and other sectors as users. The community desperately needs the clean water provided by PDAM because clean water is a critical requirement in people's lives since humans and all living things on this planet require water as a source of life. Figure 6 below shows increase throughout the year for the water supply.

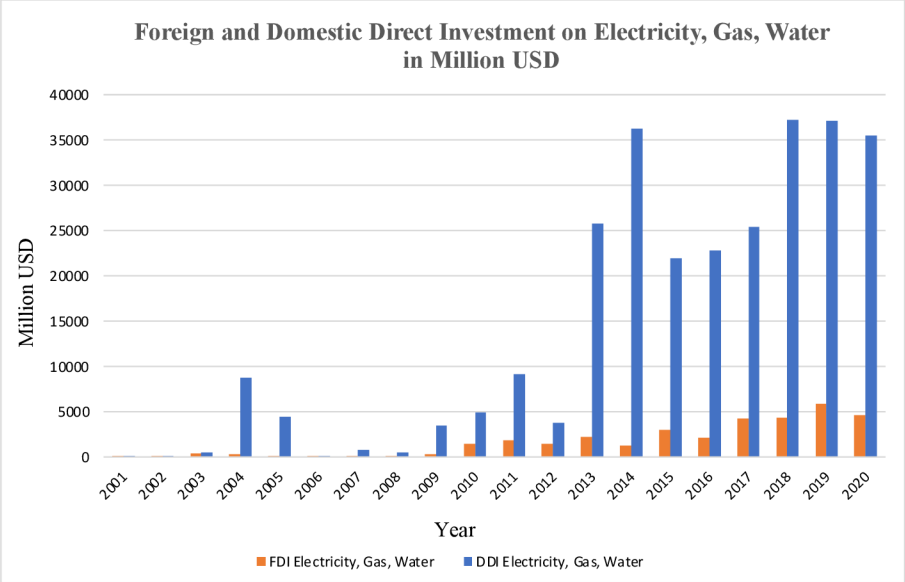
Figure 6. Quantity of Cleaned Water Distributed of Water Supply Establishment (cubic meter thousands) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

Investment in electricity, gas, and water may have a significant influence on economic development. Increased demand for electricity, gas, and water will have an influence on supply, requiring infrastructure construction. Investment is required to provide demand to customers. As can be seen in figure 7 below, direct investment in this sector is increasing in the past ten years.

Figure 7. FDI and DDI in Electricity, Gas and Water (Million USD) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

4.1.4 Construction Infrastructure Analysis of Indonesia

Construction is an industry that is rapidly expanding. The more established a region, the more developed the construction service company, because the need for structures used for settlements, industry, public amenities, and etc. The construction service industry is one of the economic, social, and cultural activities that plays a significant part in accomplishing different aims to promote the attainment of national development goals.

Construction is an activity that involves the construction of facilities and infrastructure, such as building and civil infrastructure construction.

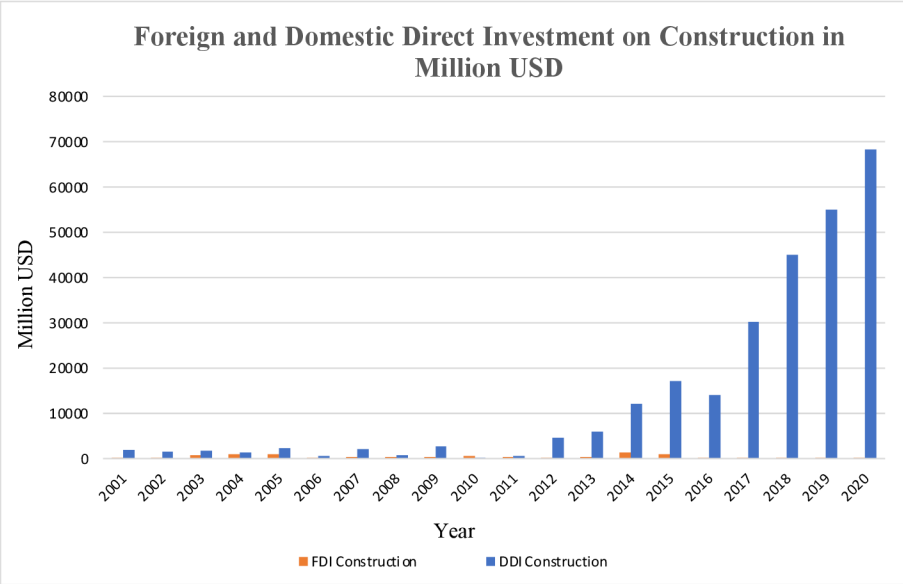
In general, the construction sector includes building and housing projects, oil and gas industrial facilities, warehouses, and factories, as well as the construction of supporting infrastructures such as roads and bridges, toll roads, flyovers, railroads, ports, airports, and clean water facilities and infrastructure.

Indonesia is a developing country that is actively engaged in development. The progress that has been carried out encompasses all sectors. Development in all areas is intended to establish a balanced and vigorous economy capable of playing a role in the

national economy. In accordance with the national development strategy, progress in each province and nationally leads to an increase in public welfare. To sustain the rate of economic growth, each province requires development in the form of physical amenities and infrastructure.

The existence of accelerated population expansion and the necessity for various classes of residential facilities, industry buildings, offices, highways, bridges, and ports are manifestations of community wellbeing. Population expansion, economic and industrial growth, particularly in metropolitan areas, all require a solid housing construction system to sustain them. The expansion of activities in the economic, industrial, and other sectors necessitates the development of facilities and infrastructure, particularly in the construction sector, so that they can grow in harmony with a planned regional development, because industrial growth will accelerate the growth of the labor force. This expansion complicates settlement issues in highly populated metropolitan areas.

Figure 8. FDI and DDI in Construction (Million USD) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

As seen in the figure 8, investment in the construction sector has increased tremendously from 2001 to 2020, particularly in terms of domestic direct investment. So far, the building industry has contributed favorably to Indonesia's GDP. According to the Ministry's Deputy for Facilities and Infrastructure, the construction sector contributed more than 10% of GDP per year from 2015 until 2020 (Kompas, 2020).

The construction and building sector in Indonesia is seeing an increase in value that is expected to continue. One of the causes is the strong demand for housing and the rapid

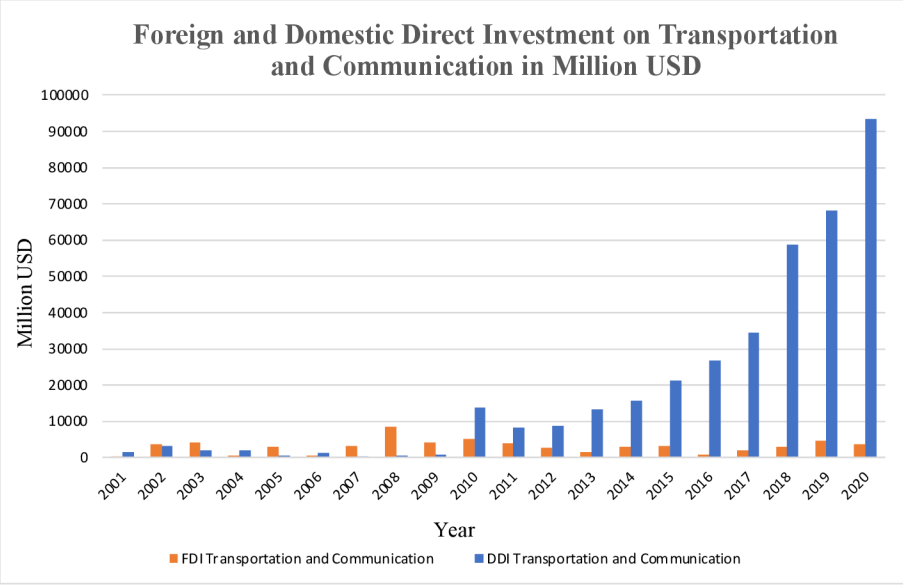
expansion of the property industry in various major cities throughout Indonesia. Investment in the construction sector is critical to the government's objectives for public infrastructure. Long-term growth requires public infrastructures such as roads, water supplies, and residential infrastructure.

4.1.5 Transportation and Communication Infrastructure Analysis

Transportation is a vital way of ensuring a country's prosperity, particularly in supporting community economic activity and regional development. Similarly, information and communication technology may be used to boost corporate rivalry, efficiency, and the multiplier impact of a country's economic growth.

The number of fleets as a mode of transportation, both on land, at sea, and in the air, reflects developments in the more fast transportation industry.

Figure 9. FDI and DDI in Transportation and Communication (Million USD) in Indonesia (2001-2020)



Source: Central Bureau of Statistics of Indonesia (2020)

The figure 9 above depicts FDI and DDI data during the previous two decades, from 2001 to 2020. Investment in the transportation and communication sectors has risen year after year. We can see that domestic direct investment in transportation and communication is dominating. Starting from year 2010 there's exponential increasing in the investment to year 2020. We believe that this caused by rapid increase in mobility and technology that pushed this sector to grow very fast.

4.2 Analysis of Infrastructure in Indonesia

4.2.1 One-equation model

Linear regression has been used for analysis with time series data from 2001 to 2020 to determine the correlation between GDP growth and expenditure on health; direct investment on electricity; gas and water, direct investment on construction; and direct investment on transportation and communication for infrastructure analysis in indonesia. It was also examined to determine whether infrastructure investment have a positive or negative influence on GDP. Using SW Gretl's solution to this problem, the method was utilized to estimate these parameters: the Ordinary Least Square Method (OLSM).

The study conducted preliminary tests such as unit root using ADF test, multicollinearity test, normality test, heteroscedasticity test, and autocorrelation test.

At the start of my study, I adopted an economic and econometric model that included assumptions, mathematical and statistical models with endogenous, exogenous, and stochastic variables, parameters, variable declaration, and unit declaration.

Economic and econometric models (one-equation model)

The assumptions for the economic model are:

- GDP will increase if current health expenditure rises;
- GDP will increase if direct investment on electricity, gas and water rises;
- GDP will increase if direct investment construction rises;
- GDP will increase if direct investment on transportation and communication rises.

The economic model is as follow:

$$y_{1t} = f(x_{1t}, x_{2t}, x_{3t}, x_{4t}), \text{ or}$$

Gross Domestic Product (GDP) = f(expenditure on health, direct investment of electricity, gas, water, direct investment of construction, direct investment of transportation and communication). This means that GDP is influenced by expenditure on health; direct investment of electricity, gas, and water; direct investment of construction; direct investment of transportation and communication.

The Econometric model for the analysis as follow:

$$y1t = \gamma 0 + \gamma 11 x1t + \gamma 12\ x2t + \gamma 13\ x3t + \gamma 14\ x4t + u1t$$

Where,

y1t as endogenous (dependent, explained) variable;

x1t, x2t, x3t, x4t, as exogeneous (explanatory) variables in time;

u1t as stochastic variable (residual term);

$\gamma 0$, $\gamma 12$, $\gamma 12$, $\gamma 13$, $\gamma 14$, as parameters;

Declaration of variables:

y1t = GDP, Million USD.

x1t = Current Health Expenditure, Million USD.

x2t = Direct Investment in Electricity, Gas, Water, Million USD.

x3t = Direct Investment in Construction, Million USD.

x4t = Direct Investment in Transportation and Communication, Million USD.

u1t = Random error, ~ nid (0, $\sigma 2$)

Table 1. Dataset for the research

Year	GDP Current (Million USD)	Current health expenditure (Million USD)	Direct Investment in Electricity, Gas, Water (Million USD)	Direct Investment in Construction (Million USD)	Direct Investment in Transportation and Communication (Million USD)
t	y1	x1	x2	x3	x4
2001	160446.95	2973.04	137.30	2069.40	1886.50
2002	195660.61	4145.07	95.60	1906.00	6839.00
2003	234772.46	4649.97	829.20	2561.40	6182.20
2004	256836.88	5774.65	9073.00	2427.00	2474.20
2005	285868.62	6060.48	4511.45	3308.30	3584.30
2006	364570.51	9230.54	193.30	682.80	1874.60
2007	432216.74	1132.76	865.70	2559.20	3591.40
2008	510228.63	14408.12	546.70	1307.90	8959.10
2009	539580.09	13750.78	3791.90	3284.10	4979.60
2010	755094.16	19807.94	6358.40	686.00	188580
2011	892969.11	24921.68	10999.60	951.90	11929.00
2012	917869.91	27439.03	5311.40	4826.20	11420.20
2013	912524.14	26593.43	28053.10	6560.00	14628.30
2014	890814.76	25560.58	37545.58	13481.28	18715.84
2015	860854.24	25518.61	24975.74	18119.95	24623.77
2016	931877.36	27250.75	24934.10	14226.00	27519.80
2017	1015618.74	30686.64	29668.90	30559.00	36373.10
2018	1042271.53	30269.36	41648.69	45227.80	61766.99
2019	1119091.26	32090.82	43085.32	55252.44	72810.32
2020	1058423.84	30746.53	40132.75	68478.80	96863.20

Source: World Bank (2020) *and Central Bureau of Statistics of Indonesia* (2020)

4.2.2 Data Analysis Tests

Unit Root Test

The first step is to do a stationary test on the selected variable to determine whether or not a unit root exists. The time series data for period between 2001 and 2020 were tested for stationarity or non-stationarity using the Augmented Dickey-Fuller (ADF) test.

The null hypothesis assumes that the series is non-stationary, implying the presence of a unit root, whereas the alternative hypothesis assumes that the series is stationary. The

chosen alpha level is 0.05. The null hypothesis will be rejected if the P value is less than 0.05, and the alternative hypothesis will be accepted since it reveals that there is no unit root in the series and that it is stationary.

The hypothesis for ADF test is as followed:

H_0: Unit root is present in time series sample. Series is not stationary

H_1: Unit root is not present in time series sample. Series is stationary

The following tables show result of ADF-test on original datased:

Table 2. ADF test result on original dataset

Variables	*ADF p-value*	*Result*
y1	0.7139	H_0 cannot be rejected
x1	0.7337	H_0 cannot be rejected
x2	0.8366	H_0 cannot be rejected
x3	1	H_0 cannot be rejected
x4	1	H_0 cannot be rejected

Source: GRETL computation

The results of the ADF test using the original data reveal that the null hypothesis cannot be rejected, indicating that none of the variables are stationary. Therefore, the data must be transformed into stationary ones.

Table 3. ADF test result on transformed variables

Variables	*ADF p-value using log differences*	*ADF p-value using first differences*
y1	0.1524	0.09026
x1	0.4456	0.03324
x2	0.002804	0.0001999
x3	6.464e-05	0.2433
x4	3.305e-05	0.8874

Source: GRETL computation

Using log differences, each variable will be transformed into a stationary data. However, even after converting the GDP and current health expenditure into log differences, I discovered that they are still not stationary. Therefore , I'm transforming these variables by utilizing the first differences approach. As a consequence, GDP and current health expenditure are demonstrated to be stationary.

As shown in the ADF test statistics above, current GPD, expenditure on health, direct investment on electricity, gas and water, direct invetment on construction, direct investment on transportation and communication were stationary after using first and log differences. Therefore, regression analysis will be utilized to obtain an appropriate conclusion using these

variables. As a result, alternatives variables will be employed for this research when the data has been made stationary.

Table 4 Dataset of transformed variables

Year	d_x1	d_y1	ld_x2	ld_x3	ld_x4
2001					
2002	1.172.029	35213.7	-0.361995	-0.082252	1.287.918
2003	504.893	39111.9	2.160.289	0.295547	-0.100967
2004	1.124.681	22064.4	2.392.597	-0.053898	-0.915757
2005	285.832	29031.7	-0.698684	0.309779	0.370646
2006	3.170.059	78701.9	-3.150.131	-1.577.988	-0.648168
2007	2.091.225	67646.2	1.499.295	1.321.248	0.650147
2008	3.086.357	78011.9	-0.459638	-0.671272	0.914128
2009	-657.338	29351.5	1.936.722	0.920670	-0.587320
2010	6.057.157	215514.1	0.516910	-1.565.970	1.331.683
2011	5.113.742	137874.9	0.548082	0.327582	-0.458060
2012	2.517.349	24900.8	-0.728003	1.623.355	-0.043589
2013	-845.605	-5345.8	1.664.244	0.306931	0.247574
2014	-1.032.849	-21709.4	0.291457	0.720311	0.246412
2015	-41.964	-29960.5	-0.407651	0.295711	0.274342
2016	1.732.140	71023.1	-0.001669	-0.241942	0.111194
2017	3.435.887	83741.4	0.173863	0.764588	0.278924
2018	-417.281	26652.8	0.339171	0.392053	0.529540
2019	1.821.460	76819.7	0.033912	0.200201	0.164489
2020	-1.344.284	-60667.4	-0.070990	0.214612	0.285442

Source: GRETL computation

Multicollinearity Test

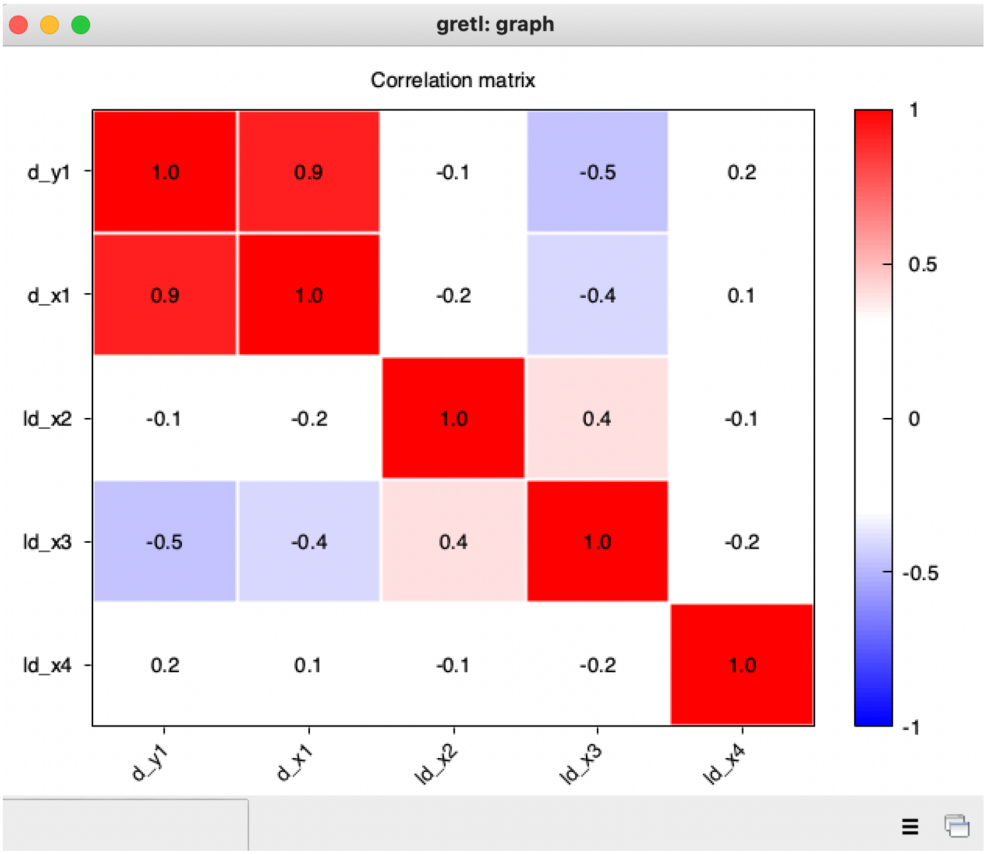
The next step is to do a multicollinearity test. The correlation matrix of the four variables is shown in the table below:

Table 5. Multicollinearity test result

d_y1	d_x1	ld_x2	ld_x3	ld_x4	
1	0.912	-0.0651	-0.4718	0.2106	**d_y1**
	1	-0.2426	-0.4137	0.1454	**d_x1**
		1	0.3924	-0.1292	**ld_x2**
			1	-0.1653	**ld_x3**
				1	**ld_x4**

Source: GRETL computation

Figure 10. Multicollinearity matrix



Source: GRETL computation

Multicollinearity test is used to see if there's a lot of correlation between variables, which might indicate multicollinearity. Multicollinearity is defined as a high degree of interdependence between independent variables. If the correlation coefficient between two

variables is +/- 1.0, they are termed completely collinear. High multicollinearity will occur when the value is closer to +/- 1.0.

In practice, the presence of multicollinearity is determined by the correlation matrix, which contains the correlation coefficients of all variables in the model; multicollinearity causes inefficient and inconsistent regression equation results. A high degree of correlation between independent variables might indicate the occurrence of multicollinearity.

According to the multicollinearity test, the level of multicollinearity between independent variables is not showing high significance. On the graph above, we can observe that there is high multicollinearity between expenditure on health (exogenous varible) and GPD (edogenous variable).

Normality Test

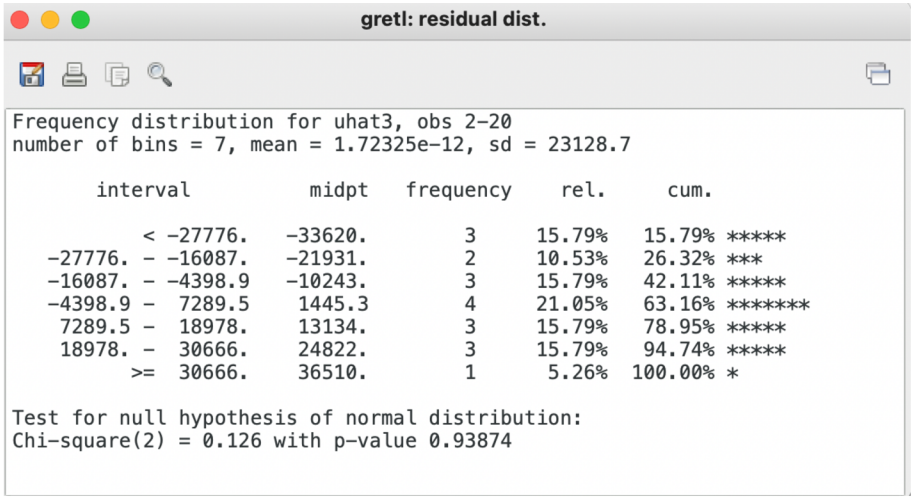
The Normality test is also being employed in this study. The test of normality is a key step in determining central tendency measurements and statistical methodologies for data processing.

Hyphothesis:

H_0: Normal distribution of random variable

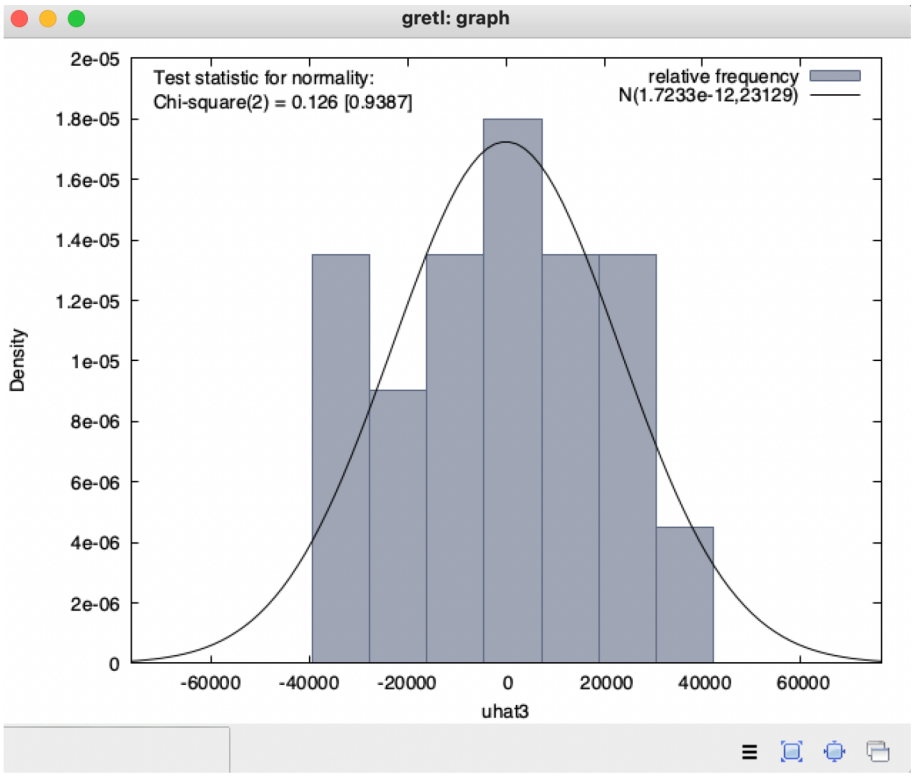
H_1: Not normal distribution of random variable

Figure 11. Normality test



Source: GRETL computation

Figure 12. Normality distribution



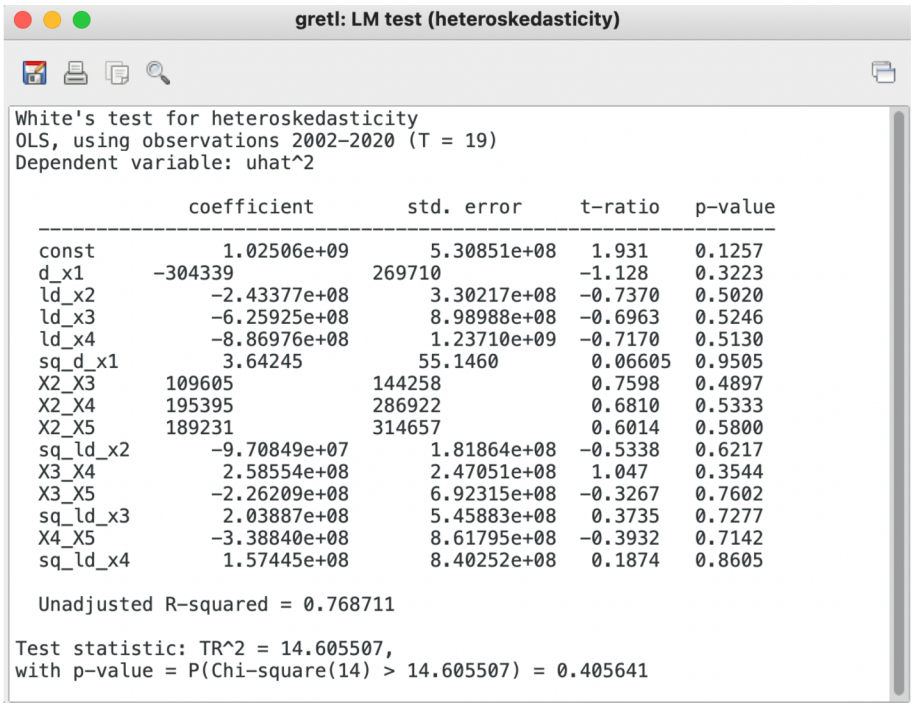
Source: GRETL Computation

As can be seen in the graph above, the null hypothesis is not rejected since the p-value is 0.9387 when the level of significance is set to 0.05. This means that the data has normal distribution.

Heteroscedasticity Test

The Heteroscedasticity test is the other test used to evaluate the data. Furthermore, Testing of Homoscedasticity was investigated in order to determine if the variance of the error term is a function of the regressors using the White Test. The null hypothesis (H_0) states that the error variances are all the same (homoscedasticity). The error variances are a multiplicative function of one or more variables, according to the alternative hypothesis (H_1) (there is a heteroscedacticity).

Figure 13. Heteroscedacity test



Source: GRETL Computation

The P value of 0.405641 is larger than 0.05, according to the results of the test. As a result, the alternative is rejected and the null hypothesis is not rejected, implying that the model has no heteroscedasticity.

Autocorrelation Test

Dublin-Watson test is also utilized to verify the model. The DW-test determines whether or not the model is autocorrelated.

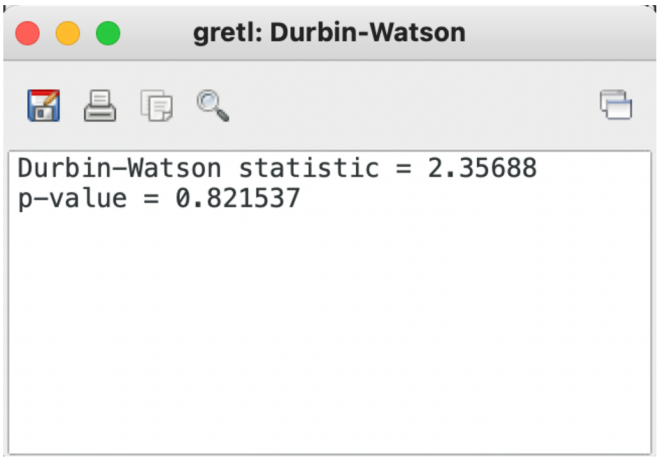
Hypothesis

H_0: no autocorrelation

H_1: the presence of positive or negative autocorrelation

Darbin-Watson test done in Gretl software:

Figure 14. Durbin-Watson Test



Source: GRETL Computation

Figure above shows that the value is 2.35688, which is close to 2, indicating that there is no autocorrelation in this model. The DW-test p-value is also 0.821537, which is greater than the significant alpha threshold, indicating that there is no autocorrelation and that my estimates based on OLS posses the properties of minimum variance, efficiency and unbiasedness.

4.2.3 Estimation of parameters using OLSM

The OLS (Ordinary Least Square) method is used to calculate the equation's coefficients.

Table 6. Cofficient estimation

Variable	*Coefficient*
const	6435.65
d_x1	26.2292
ld_x2	11171.3
ld_x3	−14145.9
ld_x4	8453.94

Source: GRETL Computation

The estimated model is:

$$\mathbf{d\_y_{1t} = 6435.65 + 26.2292\ d\_x_{1t} + 11171.3\ ld\_x_{2t} - 14145.9\ ld\_x_{3t} + 8453.94\ ld\_x_{4t} + u_{1t}}$$

The meaning of multifactorial linear regression coefficients: a regression coefficient represents the increase in the outcome per unit of increase in the m-th component with fixed values for the other factors.

If the sign in the regression equation is "+," the dependent and independent factors have a direct relationship (the regression equation's line is directed "up"), and if the sign is

"-," the dependent and independent factors have a feedback relationship (the line of the regression equation is directed "down") (the line of the regression equation is directed " down"). The size of the dependent variable is shown by the regression intercept, assuming the independent variable is 0. The absolute values of the regression coefficient and intercept are dependent on the units of measurement of the dependent and independent variables.

4.2.4 Model Verificaiton

Economic Verification

If all the exogenous variables values are zero, the GDP will be 6435.65 (Million USD). If the current health expenditure increase by 1 Million USD then GDP will increase by 26.2292 (Million USD). If the direct investment on electricity, gas, and water increase 1 Million USD, the GDP will increase by 11171.3 (Million USD). If the direct investment on construction increase by 1 Million USD then the GDP will decrease by 1415.9 Million USD. If the direct investment of transporation and communication increases by 1 million USD then the GDP will increase by 8453.94 million USD. Economic verification entails confirming that the parameters that have already been calculated make sense.

Indonesia's GDP is positively correlated with current health expenditure, direct investment in electricity, gas, and water, and direct investment in transportation and communication. Direct construction investment, on the other hand, failed to pass the economic test. In Indonesia, there is a negative link between construction investment and GDP (economic growth). My economic assumptions are contradicted by this outcome.

Statistical Verification

Several tests will be used for statistical verification to validate the model. F-test, R^2 test, adjusted R^2 test, and significant test for each variable are among the testing approach.

Table 7. Regression Result

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*	
const	6435.65	7576.57	0.8494	0.4099	
d_x1	26.2292	2.90234	9.037	3.22e-07	***
ld_x2	11171.3	4643.32	2.406	0.0305	**
ld_x3	−14145.9	7848.07	−1.802	0.0930	*
ld_x4	8453.94	9241.45	0.9148	0.3758	
Mean dependent var		47261.94	S.D. dependent var		62003.18
Sum squared resid		7.49e+09	S.E. of regression		23128.67
R-squared		0.891775	Adjusted R-squared		0.860853
F(4, 14)		28.83995	P-value(F)		1.26e-06

Source: GRETL Computation

R-squared is a statistical measure of how well the regression line approximates the real data points, and its coefficient of determination is a measure of how well the regression line approximates the real data points. It expresses how well the variation in the dependent variable can be explained by the variance in the independent variables.

As can be observed, the R-squared value is 0.891775, indicating that the data set has a relatively high goodness of fit (the coefficient R-squared should tend to 1). Adjusted R-Squared is showing 0.860853

The following steps are involved in calculating statistical significance of parameters: stating the research question and null hypothesis, selecting a probability of error level, also known as an alpha level, with typical values of 0.1, 0.05, or 0.01 and finally computing and interpreting the statistical significance test. A statistical significance threshold of 0.05 was used.

Hypothesis:

H_0: parameters are not statistically significant

H_1: parameters are statistically significant

Table 8. Parameters p-value Test

Variable	*p-value*	*Level of Signigicance*	*Result*
const	0.4099	0.05	Parameter statistically insignificant
d_x1	3.22e-07	0.05	Parameter statistically Significant
ld_x2	0.0305	0.05	Parameter statistically Significant
ld_x3	0.0930	0.05	Parameter statistically Significant
ld_x4	0.3758	0.05	Parameter statistically insignificant

Source: GRETL Computation

When these numbers are compared to the significant level (alpha = 0.05), I find that the alternative hypothesis for direct transportation and communication investment must be rejected and the null hypothesis cannot be rejected. I did not assume that transportation and communication direct investment is irrelevant to Indonesia's GDP but, according to the model p-value showing that parameter is not statistically significant. As a result, a little increase or decrease in direct transportation and communication investment would have no negative impact on GDP.

5 Results and Discussion

5.1 Result

The following conclusions can be formed based on the outcomes of data analysis and statistical testing:

1. Current health expenditure has a positive influence on improving economic growth in Indonesia; a variable with a positive value indicates that the greater the value of the current health expenditure variable, the higher the level of economic growth will be. In the other direction, the lower the value of the current health expenditure variable, the lower the degree of economic growth. So, if another million dollars are invested, there will be an extra 26.2292 million USD in the economic growth. From a statistical standpoint, current health expenditure is statistically significant. This suggests that current health expenditure is highly correlated with GDP. Changes in this variable can have a significant impact on GDP.
2. Direct investment in electricity, gas, and water has a positive influence on Indonesia's economic growth. The coefficient demonstrates that it has a positive value. Every million dollars invested in this industry results in an increase in GDP of 11171.3 million USD. The statistical test on the variable reveals that the parameter is statistically significant. Changes in investment in power, gas, and water will have an immediate influence on the GDP of Indonesia.
3. According to the linear regression model, direct investment on construction has a negative influence on GDP growth. The statistical test of the variable yielded the finding that the parameter is statistically significant. This conclusion contradicts the economic premise that additional value on building investment will have a beneficial influence on economic growth. However, the results of my regression demonstrate that if there is additional value to building investment, it would have a negative impact on Indonesia's economic development.
4. The findings of the regression analysis test show that direct investment in transportation and communication has a positive coefficient toward economic growth. However, hypothesis testing demonstrates that investment in this area has no significant influence on economic growth. As a result, changes in direct investment in transportation and communication will have no impact on the economic growth in Indonesia.

5.2 Discussion

As can be shown, current health expenditure; direct investment in electricity, gas, and water; and direct investment in construction all have a significant impact on Indonesia's economic development. However, not all of these three variables are having a positive effect. Direct construction investment has a detrimental influence on economic growth.

Many studies have been conducted to demonstrate the link between infrastructure and economic development in Indonesia. Infrastructure has been found to have a variety of effects on a country's economic performance. Economic infrastructure adds to the economic capability and output of an economy. Public infrastructure has a positive influence on GDP that is not limited to the formation of capital stock through economies of scale, but is also competitively beneficial to the economy via the agency of network externalities (P. Aghion, 2015). Nugraha, Prayitno, and et al (2020) discovered that Infrastructure boosted economic growth in Indonesia, whereas direct economic expansion exacerbated income disparity.

Public health expenditure is inextricably linked to a country's growth and development. It has the potential to improve people's health, life expectancy, labor efficiency, productivity, and income, as well as the amount of investment in the economy (Oni, 2014). In Indonesia, it demonstrates that health care spending, life expectancy, labor force participation, and household consumption all have a substantial positive association with GDP per capita, as indicated by the probability value (Prasetyo, et al., 2019). The influence of health on worker productivity shows that there is a link between health and aggregate production. Healthy workers miss fewer days of work owing to illness and are more productive at work. Health benefits have the economic repercussions of broad economic growth and the escape from poverty's bad health traps. Barro (1996) offers his thoughts that health is a capital productive asset and a driver of economic progress. My finding in case of Indonesia has also proven that health expenditure has significant positive impact on the economic growth. Threfore, suggestions for policy improvements include institutional strengthening and budget allocation planning, particularly in the health sector. Furthermore, technological advancements might facilitate easier access to health-care services.

There is general agreement on the critical role electricity, water and gas plays in contemporary life, giving economic rewards and developmental advancement to a variety of people. Electric power is critical for economic growth and quality of life not only because it increases the productivity of capital, labor, and other factors of production, but also because

increased consumption of energy, particularly commercial energy like electricity, indicates a country's high economic status (Jumbe, 2004). Water is a basic human necessity, and the peculiarities of its management and usage are unique to each place. According to Purba (2019) water cycle systems in metropolitan areas that are efficiently managed in an integrated manner have contributed to the enhancement of public services such as power, telecommunication, health, and cleanliness, which will have a positive impact on the public and the environment. He also found out that electricity, clean water, and sanitary facilities have positive impact on Indonesia economic growth. Natural gas is regarded as a significant nonrenewable source of energy generation. On the other sector, natural gas usage has a constructive and beneficial influence on Indonesian economic growth, implying that natural gas is the primary source of economic growth in Indonesia in both the long and short run (Sinaga, et al., 2019). According to my research, direct investment in electricity, water, and gas has a beneficial influence on Indonesia's economic growth. As a result, policymakers must consider investment in this sector when making decisions.

Ofori (2003) emphasized that foreign construction accounts for a sizable share of overall world volume, with ramifications for construction industry in all nations. Ozkan (2012) found that infrastructure investments in construction have a direct relationship with GDP and have a causal effect. The utilization of construction investments as a tool for the government to stabilize the economy demonstrates the industry's critical role in national development strategy. However, according to my research, infrastructure investment has a negative influence on economic development of Indonesia.

Transport infrastructure is a critical social and economic asset; it defines space and movement. The influence of transportation infrastructure on economic growth has been thoroughly investigated (Aschauer, 1989). Transportation advancements are likely to have an impact on economic growth via increased productivity, technological spillover, and cheaper manufacturing costs (Beyzatlar, 2014). In the communication sector the use of ICT infrastructure has a large and favorable influence on economic growth (Toader & Firtescu, 2018). There is a substantial and powerful positive association between telecom investment and economic development as well as employment (Wieck & Vidal, 2011). However, according to my findings, investment in transportation and communication has no statistically significant influence on Indonesia's economic development.

6 Conclusion

One of the most important things enabling contemporary civilization is the availability of infrastructure. It is widely acknowledged as a significant component affecting economic growth in a positive way. Infrastructure expenditure by the government is critical to encouraging economic growth and poverty reduction. Economic growth is hampered by underinvestment in infrastructure, according to empirical studies. At the same time, multiple other studies have indicated that infrastructure investment may be a useful instrument in combating poverty. In this backdrop, since the turn of the millennium, infrastructure finance has been a major component of most economic growth and poverty reduction initiatives in developing nations.

The purpose of this Master's thesis was to examine Indonesia's economic growth via the influence of infrastructure. Similarly, the goal of the thesis was to evaluate the impacts of infrastructure on economic growth in several areas such as health; electricity, gas, and water; construction; transportation, and communication. Furthermore, expenditure and direct investment, both foreign and local, were essential factors in my analysis of my topic.

At the start of the thesis, the key stages of infrastructure development across the world were described. It has been thoroughly investigated what types of elements impact the improvement and growth of a country's infrastructure. It has also been believed that the bulk of papers and studies offering information regarding the relationships between infrastructure, economics, and the development process of a country. As a result, the importance of infrastructure in the country and the link between infrastructure and GDP have been described and shown.

The following section of this thesis was continued by a practical section, which was separated into two primary portions. The first is a descriptive study of each selected variable, focusing on how the key economic indicators have evolved over the last 20 years. In addition, over the last two decades, Indonesia has seen a number of significant developments. In terms of economic growth, Indonesia has made significant progress based on its GDP value. Not forget to add, progress in these specific specified sectors has been made. These can be seen in the figures shown by graph and chart and some explanation regarding these charts.

In the second part of my practical capter, I analyzed the impact of current health expenditure; direct investment in electricity, water and gas; direct investment in

construction; and direct investment in transportation and communication on ecnomic growth in Indonesia for 20 years observations using OLS method. The assumption was validated using economic and statistical methods. Several tests have been implemented in order to check each variable and the model. The key finding suggested that current health spending, direct investment in power, gas, and water, and direct investment in construction all had statistically significant effects on GDP growth. Direct investment in building, on the other hand, has a negative influence on economic growth, which contradicts my economic assumptions.

My findings indicated that Indonesia, as a new and rapidly growing economy, attracts investment. The government may concentrate its efforts on sectors that have a beneficial influence on economic growth, such as health, electricity, gas, and water. Infrastructure preservation and growth are critical aspects of sustaining economic activity.

7 References

Adetunji, J., 2018. *The biggest research: the life expectancy of Indonesians increases, the burden of non-communicable diseases increases.* [Online] Available at: https://theconversation.com/riset-terbesar-usia-harapan-hidup-orang-indonesia-naik-beban-penyakit-tidak-menular-meningkat-96901 [Accessed 2 March 2022].

Agénor, P.-R. & Moreno-Dodson, B., 2006. Public Infrastructure and Growth: New Channels and Policy Implications. *Policy Research Working Paper; No. 4064.*

Agénor, P.-R. & Moreno-Dodson, B., 2006. Public Infrastructure and Growth: New Channels and Policy Implications. *Policy Research Working Paper; No. 4064.*

Arsyad, L., 2016. *Ekonomi Pembangunan.* 5th ed. Yogyakarta: STIE YKPN.

Aschauer, D. A., 1989. Is public expenditure productive?. *Journal of Monetary Economics,* 23(2), pp. 177-200.

Atmaja, H. K. & Mahalli, K., 2013. PENGARUH PENINGKATAN INFRASTRUKTUR TERHADAP PERTUMBUHAN EKONOMI DI KOTA SIBOLGA. *Jurnal Ekonomi,* 3(4), pp. 251-265.

Bank, W., 1994. *World Development Report,* New York: Oxford University Press.

Bank, W., 2005. *MEETING THE CHALLENGE OF AFRICA'S DEVELOPMENT: A WORLD BANK GROUP ACTION PLAN,* Washington DC: World Bank.

Bank, W., 2017. *Quality of overall infrastructure.* [Online] Available at: https://tcdata360.worldbank.org/indicators/hf11a8bbf?country=IDN&indicator=536&viz=line_chart&years=2007,2017 [Accessed 17 February 2022].

Bank, W., 2020. *Current health expenditure (% of GDP) - Indonesia.* [Online] Available at: https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS?locations=ID [Accessed 9 January 2022].

Bank, W., 2020. *GDP (current US$) - Indonesia.* [Online] Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ID [Accessed 10 January 2022].

Bank, W., 2020. *GDP (current US$) - Indonesia.* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ID
[Accessed 9 January 2022].

Bank, W., 2020. *Life expectancy at birth, total (years) - Indonesia.* [Online]
Available at: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=ID
[Accessed 10 January 2022].

Barro, R. J., 1990. Government Spending in a Simple Model of Endogeneous Growth. *Journal of Political Economy* , 98(S5), pp. 103-125.

Barro, R., 1996. *Health and Economic Growth,* s.l.: Harvard University.

Belaid, H., 2004. Telecommunication, infrastructure and economic development. *Working Paper.*

Benhabib, J. & Spiegel, M., 2005. Human Capital and Technology Diffusion. In: *Handbook of Economic Growth.* Amsterdam: P. Aghion and S.N. Durlauf, pp. 935-966.

Beyzatlar, M. A., 2014. Granger-causality between transportation and GDP: A panel data approach. *Transportation Research Part A: Policy and Practice,* Volume 63, pp. 43-55.

BPS, 2020. *Jumlah Air Bersih yang Disalurkan Perusahaan Air Bersih.* [Online]
Available at: https://www.bps.go.id/indicator/7/115/1/jumlah-air-bersih-yang-disalurkan-perusahaan-air-bersih.html
[Accessed 2 March 2022].

BPS, 2020. *Listrik Yang Didistribusikan Kepada Pelanggan (GWh).* [Online]
Available at: https://www.bps.go.id/indicator/7/314/1/listrik-yang-didistribusikan-kepada-pelanggan.html
[Accessed 6 February 2022].

BPS, 2020. *Panjang Jalan Menurut Tingkat Kewenangan (km).* [Online]
Available at: https://www.bps.go.id/indicator/17/50/1/panjang-jalan-menurut-tingkat-kewenangan.html
[Accessed 5 March 2022].

BPS, 2020. *Realisasi Investasi Penanaman Modal Dalam Negeri Menurut Sektor Ekonomi (Juta US$).* [Online]
Available at: https://www.bps.go.id/indicator/13/1841/5/realisasi-investasi-penanaman-modal-dalam-negeri-menurut-sektor-ekonomi.html
[Accessed 15 January 2021].

BPS, 2020. *Realisasi Investasi Penanaman Modal Dalam Negeri Menurut Sektor Ekonomi (23 Sektor).* [Online]
Available at: https://www.bps.go.id/indicator/13/1842/1/realisasi-investasi-penanaman-modal-dalam-negeri-menurut-sektor-ekonomi-23-sektor-.html
[Accessed 10 March 2022].

BPS, 2020. *Volume Penjualan Gas Alam Melalui Saluran Pipa Menurut Jenis Pelanggan (MMSCF).* [Online]
Available at: https://www.bps.go.id/indicator/7/861/1/volume-penjualan-gas-alam-melalui-saluran-pipa-menurut-jenis-pelanggan.html
[Accessed 25 January 2022].

BPS, n.d. *Sektor Energi.* [Online]
Available at: https://www.bps.go.id/subject/7/energi.html
[Accessed 12 March 2022].

Camba, A. L., 2020. The Cointegration Relationship and Causal Link of Internet Penetration and Broadband Subscription on Economic Growth: Evidence from ASEAN Countries. *Journal of Economics and Business,* 3(1), pp. 1-8.

Cambridge, n.d. *Cambridge Dictionary.* [Online]
Available at: https://dictionary.cambridge.org/dictionary/english/infrastructure
[Accessed 1 September 2021].

Canning, D., 1999. Infrastructure's contribution to aggregate output. *Policy Research Working Paper Series 2246.*

Canning, D., 1999. Infrastructure's contribution to aggregate output. *Policy Research Working Paper Series 2246.*

Charlot, S. & Schmitt, B., 1999. Public infrastructure and economic growth in France's regions. *European Journal of Geography.*

Choi, C. & Yi, M. H., 2009. The effect of the Internet on economic growth: Evidence from cross-country panel data. *Economics Letters,* 105(1), pp. 39-41.

Démurger, S., 2001. Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China?. *Journal of Comparative Economics,* 29(1), pp. 95-117.

DİNÇER, H. & YUKSEL, S., 2019. Identifying the Causality Relationship between Health Expenditure and Economic Growth: An Application on E7 Countries. *Journal of Health Systems and Policies,* 1(1), pp. 5-23.

Erçelik, G., 2018. The Relationship between Health Expenditure and Economic Growth in Turkey from 1980 to 2015. *Journal of Politics Economy and Management,* 1(1), pp. 1-8.

Familoni, K. A., 2004. THE ROLE OF ECONOMIC AND SOCIAL INFRASTRUCTURE IN ECONOMIC DEVELOPMENT: A GLOBAL VIEW.

Fan, S. & Zhang, X., 2004. Infrastructure and Regional Economic Development in Rural China. *China Economic Review,* Volume 15, pp. 203-214.

Fourie, J., 2006. ECONOMIC INFRASTRUCTURE: A REVIEW OF DEFINITIONS, THEORY AND EMPIRICS. *South African Journal of Economics,* 74(3), pp. 530-556.

Gramlich, E., 1994. Infrastructure Investment: A Review Essay. *Journal of Economic Literature,* 32(3), pp. 1176-96.

Haini, H., 2019. Internet penetration, human capital and economic growth in the ASEAN economies: evidence from a translog production function. *Applied Economics Letters,* 26(21), pp. 1774-1778.

Halıcı-Tülüce, N. S., Doğan, İ. & Dumrul, C., 2016. Is income relevant for health expenditure and economic growth nexus?. *International Journal of Health Economics and Management ,* Volume 16, pp. 23-49.

Hardy, A. P., 1980. The role of the telephone in economic development. *Telecommunications Policy,* 4(4), pp. 278-286 .

Herranz-Loncan, A., 2007. Infrastructure investment and Spanish economic growth, 1850–1935. *Explorations in Economic History,* 44(3), pp. 452-468.

Herranz-Loncan, A., 2007. Infrastructure investment and Spanish economic growth, 1850-1935. *Explorations in Economic History,* 44(3), pp. 452-468.

Iskarno, P. E., Kuncara, W. H. & Irianto, D., 2014. PENGARUH TINGKAT PENDIDIKAN DAN INFRASTRUKTUR TERHADAP PERTUMBUHAN EKONOMI DI INDONESIA (TAHUN 2008-2012). *Jurnal Pendidikan Ekonomi dan Bisnis,* 2(1).

Jumbe, C., 2004. Cointegration and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi.. *Energy Economics,* Volume 26, pp. 61-68.

Kessides, C., 1993. The contributions of infrastructure to economic development. *WORLD BANK DISCUSSION PAPERS.*

Kominfo, 2019. *Kembangkan Industri Konstruksi untuk Topang Pembangunan Infrastruktur.* [Online]

Available at: https://www.kominfo.go.id/content/detail/17348/kembangkan-industri-konstruksi-untuk-topang-pembangunan-infrastruktur/0/berita
[Accessed 3 March 2022].

Kompas, 2020. *Tahun Depan, Sektor Konstruksi Diperkirakan Tumbuh hingga 6,7 Persen Artikel ini telah tayang di Kompas.com dengan judul "Tahun Depan, Sektor Konstruksi Diperkirakan Tumbuh hingga 6,7 Persen ", Klik untuk baca: https://properti.kompas.com/read/2020/12/30.* [Online]
Available at: https://properti.kompas.com/read/2020/12/30/130000821/tahun-depan-sektor-konstruksi-diperkirakan-tumbuh-hingga-67-persen
[Accessed 5 March 2022].

Kompas, 2021. *Ministry of Finance: In the last 20 years, Indonesia's economic growth has never been below the global level.* [Online]
Available at: https://money.kompas.com/read/2021/12/06/154000326/kemenkeu--20-tahun-terakhir-pertumbuhan-ekonomi-ri-tak-pernah-di-bawah-global
[Accessed 10 March 2022].

Mankiw, G., 2011. *Principles of Economics.* 6th ed. s.l.:South-Western College Pub.

Nachrowi, N. D. & Usman, H., 2006. *Ekonometrika Pendekatan Populer dan Praktis untuk Analisis Ekonomi dan Keuangan.* Jakarta: Lembaga penerbit Fakultas Ekonomi Universitas Indonesia.

Norton, S. W., 1992. Transaction Costs, Telecommunications, and the Microeconomics of Macroeconomic Growth. *Economic Development and Cultural Change,* 41(1), pp. 175-196.

Nugraha, A. T., Prayitno, G., Situmorang, M. E. & Nasution, A., 2020. THE ROLE OF INFRASTRUCTURE IN ECONOMIC GRO\TTH AND INCOME INEQUALITY IN INDONESIA. *Economics & Sociology,* 13(1).

O'Sullivan, A., 2006. *Urban Economics.* s.l.:McGraw-Hill.

O'Brien, P. & Pike, A., 2015. CITY DEALS, DECENTRALISATION AND THE GOVERNANCE OF LOCAL INFRASTRUCTURE FUNDING AND FINANCING IN THE UK. *National Institute Economic Review ,* Volume 233.

OECD, 2002. *Externalities - OECD.* [Online]
Available at: https://stats.oecd.org/glossary/detail.asp?ID=3215
[Accessed 1 September 2021].

Ofori, G., 2003. Frameworks for analysing international construction. *Construction Management and Economics,* 21(4), pp. 379 - 391.

Oni, L. B., 2014. Analysis of the Growth Impact of Health Expenditure in Nigeria. *IOSR Journal of Economics and Finance (IOSR-JEF),* 3(1), pp. 77-84.

Owusu-Manu, D.-G.et al., 2019. The impact of infrastructure development on economic growth in sub-Saharan Africa with special focus on Ghana. *Journal of Financial Management of Property and Construction,* 24(2).

Ozkan, F., 2012. Causal relationship between construction investment policy and economic growth in Turkey. *Technological Forecasting and Social Change,* 79(2), pp. 362-370.

P. Aghion, a. X. J., 2015. Knowledge Spillovers and Growth. *Econ. J.,* Volume 125, p. 533–573.

P.Pradhana, R., Girijasankar, Mallikb & P.Bagchia, T., 2018. Information communication technology (ICT) infrastructure and economic growth: A causality evinced by cross-country panel data. *IIMB Management Review,* 30(1), pp. 91-103.

Pedroni, P. & Canning, D., 2004. The Effect of Infrastructure on Long Run Economic Growth. *Department of Economics Working Papers.*

Prasetyo, D. E., Adenan, M. & Siti, K., 2019. Study of Health Expenditure and Economic Welfare in Indonesia. *LSP-Jurnal Ilmiah Dosen ,* 6(7).

Prasetyo, R. B. & Firdaus, M., 2009. PENGARUH INFRASTRUKTUR PADA PERTUMBUHAN EKONOMI WILAYAH DI INDONESIA. *Jurnal Ekonomi dan Kebijakan Pembangunan,* 2(2), pp. 222-236 .

Purba, J. T. & Budiono, S., 2019. Availability of Electricity, Clean Water and Sanitation towards Economic. *Proceedings of the International Conference on Industrial Engineering and Operations Management.*

Queiroz, C. & Gautam, S., 1992. Road infrastructure and economic development : some diagnostic indicators. *Policy Research Working Paper Series 921.*

Röller, L.-H. & Waverman, L., 1996. Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. *CIG Working Papers FS IV 96-16.*

Sinaga, O., Saudi, M. H. M., Roespinoedji2, D. & Razimi, M. S. A., 2019. The Dynamic Relationship between Natural Gas and Economic Growth: Evidence from Indonesia. *International Journal of Energy Economics and Policy,* 9(3), pp. 388-394.

Solow, R. M., 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics,* Volume 70, p. 65–94.

Stiglitz, J., 2000. The Contributions of the Economics of Information to Twentieth Century Economics. *The Quarterly Journal of Economics,* 115(4), pp. 1441-1478.

Sukirno, S., 2016. *Macroeconomics: theory of money.* 3rd ed. Jakarta: Rajawali Pers.

Sumartiningtyas, H. K. N., 2021. *Studi: Akses Air Minum Indonesia sudah Layak, tapi Hanya 11,2 Persen yang Aman.* [Online]
Available at: https://www.kompas.com/sains/read/2021/05/01/120200423/studi--akses-air-minum-indonesia-sudah-layak-tapi-hanya-11-2-persen-yang?page=all
[Accessed 8 January 2022].

Tatom, J. A., 1993. The Spurious Effect of Public Capital Formation on Private Sector Productivity. *Policies Studies Journal,* 21(2), pp. 391-395.

Toader, E. & Firtescu, B. N., 2018. Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. *Sustainability,* Volume 10.

Todaro, M. P. & Smith, S. C., 2003. *Economic Development.* 8th ed. Boston: Addison Wesley.

Underhill & Ebray, 2010. *The handbook of infrastructure investing.* [Online]
Available at: http://gateway.library.qut.edu.au/login?url=http://site.ebrary.com/lib/qut/Top?docID=10395240
[Accessed 1 September 2021].

Utama, A., 2021. *Setengah juta rumah tangga Indonesia hidup tanpa listrik, bisakah energi bersih jadi solusi?.* [Online]
Available at: https://www.bbc.com/indonesia/indonesia-57766814
[Accessed 1 March 2022].

Wang, E. C., 2002. Public infrastructure and economic growth: a new approach applied to East Asian economies. *Journal of Policy Modeling,* 24(5), pp. 411-435.

Warsilan & Noor, A., 2015. Peranan Infrastruktur terhadap Pertumbuhan Ekonomi dan Implikasi pada Kebijakan Pembangunan di Kota Samarinda. *MIMBAR,* 31(2), pp. 359-366.

Warsilan, W. & Noor, A., 2015. Peranan Infrastruktur terhadap Pertumbuhan Ekonomi dan Implikasi pada Kebijakan Pembangunan di Kota Samarinda. *Jurnal Sosial dan Pembangunan,* 31(2), pp. 356-366.

WHO, 2022. *NUTRITION LANDSCAPE INFORMATION SYSTEM (NLiS).* [Online]
Available at: https://www.who.int/data/nutrition/nlis/info/health-expenditure
[Accessed 9 March 2022].

WHO, n.d. *Constitution.* [Online]
Available at: https://www.who.int/about/governance/constitution
[Accessed 3 March 2022].

Wieck, R. & Vidal, M., 2011. Investment in telecommunications infrastructure, growth, and employment - recent research. *International Journal of Management and Network Economics,* 2(2).

Wulandari, M., 2015. Analisis Pengaruh Investasi Infrastruktur Publik Terhadap Pertumbuhan Ekonomi di Aceh. *Jurnal Ekonomi dan Kebijakan Publik Indonesia,* 2(1).

Wylie, P. J., 1996. Infrastructure and Canadian Economic Growth 1946-1991. *Canadian Journal of Economics,* 29(1), pp. 350-355.