Study of Several Variables Determinant Environmental Quality in Indonesia

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***Abstract-* This study aims to conduct an analysis to look at the variables that can have an impact on the Environmental Quality Index (IKLH) in 33 provinces in Indonesia in the analysis time period, namely 2012-2019. In this research using secondary data, several variables were used, namely IKLH, circular economy and also digital economy from the Central Bureau of Statistics, the City Sanitation Service and also the Ministry of Environment and Forestry of the Republic of Indonesia. This study produced some interesting research results where the circular economy variable has a significant effect on improving environmental quality in Indonesia, while the circular economy variable by residents of provinces in Indonesia has not been able to support improving environmental quality in Indonesia. The waste management and urban waste production in this study did not have a significant impact on improving environmental quality and the variables showing the application of the digital economy had a significant effect on improving environmental quality in this study.**

***Keywords-* Environmental Quality, Circular Economy, Digital Economy.**

I. INTRODUCTION

For the past few years, exploration of the integration of social, economic, and environmental analysis has been widely conducted concerning the concept of sustainable development. Klarin's research (2018) explains that the concept of sustainable development consists of integrative social-economic development elements with the environment. A relevant and increasingly popular approach is the green economy approach.

The initiation from green economy concept in sustainable development goals can be carried out through the implementation of the circular economy. According to Korhonen et al., (2018), the circular economy is a concept of utilizing natural resources and economics that includes reuse, remanufacturing, and refurbishment activities to reduce energy and resource demand. Several previous studies have founded that the application of the circular economy can repair environmental quality, reduce carbon emissions, help expand water resource reuse activities, and support forest protection efforts through the utilization of forestry waste (Dwi Putranto, 2021; Lazaridou et al., 2021; Liu et al., 2018; Voulvoulis, 2018).

The development of the Internet of Things (IoT) increasingly rampant and contributes to the economy and the environment. Developments in economic activities are marked by the presence of the digital economy. According to Øverby & Audestad (2018), the digital economy is an economy based on the utilization of Information and Communication Technology (ICT). Several previous studies have found some application of the digital economy can reduce air pollution levels, reduce industrial wastewater disposal, and support the protection of forest economic values (Bezrukova et al., 2019; Z. Li et al., 2021; Sun et al., 2022).

Related from application of the circular economy and its impact on Environmental Quality Index (EQI) as a whole or its sub-indices, several studies have analyzed the relationship between the two. Dwi Putranto's research (2021), with study case of 10 provinces on Sumatra Island economics, found that all dimensions of the circular economy which include resource efficiency dimensions, waste disposal, and waste management significantly influence the EQI variable in Sumatra Island. Majeed & Luni's research (2020) uses circular economy dimensions that include the use of waste processing and renewable energy.

Furthermore, related a some impact of the circular economy on water quality, research by Voulvoulis' (2018) explains that problems underlying reuse activities for water resources, such as public perception and policy barriers, can be more effectively overcome through a broader understanding of the circular economy. The study explains the importance of monitoring the level of water contamination used for reuse activities to ensure that reuse activities on water resources remain in line with community needs. Furthermore, the impact of the circular economy on improving water quality can be traced to the application of the circular economy in building design. Based on research by Rahla et al. (2021) explains that the selection of materials that require less energy and carbon with minimal and reusable water use is crucial in applying circular building principles to minimize negative impacts on the environment. Foster's research (2020) explains that refuse, rethink, reduce, and reuse strategies used in circular building development processes will help manufacturing processes eliminate fossil fuel use, increase green open space, and restore the life cycle of water resources.

The impact of the circular economy on land coverage quality and the application of the circular economy can be traced to its impact on the forestry sector. Research by Lazaridou et al. (2021) explains application from circular economy activity can support forest protection efforts through the utilization of forestry waste which is usually a source or cause of forest fires and forest pest growth media. One form of circular economy application to maintain forest quality is the implementation of wood cascading, an efficient method for reusing wood that has expired intending to balance the supply and demand for forest wood products (Taskhiri et al., 2019:303).

II. LITERATURE REVIEW

Research by Husgafvel et al. (2018) found that companies in the European Union have positive expectations for the application from circular economy activity can be related and impactful to the economy. The study also explains that recycled wood has great potential for use in the packaging process. Although the concept of wood cascading is not as widespread as the circular economy, industries in the forestry sector that produce pulp and paper are considered to be able to contribute to improving forest land coverage quality (Jarre et al., 2020:8). The results of Taskhiri et al. research (2019) explain that cascading activities have a positive influence on economic and environmental sustainability compared to conventional wood utilization methods.

Regarding the application activity of digital economy and its impact on air quality, several studies have produced different results. Z. Li et al.'s research (2021), explains that digital economic development can significantly reduce PM2.5 indicators that explain the level of air pollution in the region. X. Li et al.'s research (2021), with a case study explains that there is an inverted “U” and non-linear relationship between the application activity of digital economy and carbon emissions

Research by Sun et al. (2022) found application from digital economy activity will reduce industrial wastewater discharge. This condition can be achieved because the digital economy improves the industrial structure, ultimately impacting the reduction of wastewater discharge. The study also shows that the application of the digital economy can significantly reduce wastewater discharge in large cities. Research by Mondejar et al. (2021) explains that there is an urgency to develop an artificial intelligence-based system to identify water quality to support the acceleration of appropriate decision-making related to water resources. This condition is considered to ensure an improvement in the quality of life of people in urban areas.

Furthermore, implementation from digital economy activity and its impact on forest land coverage can be traced to the existence of the concept of digitalization of forests. Digital economy can be support forest digitization related to monitoring efforts, data acquisition, and research analysis to be used as considerations in policy-making to protect economic values in forests related to incidents of forest fires, illegal logging, and others (Singh et al., 2021:5). These results are confirmed by Bezrukova et al. (2019), explains integration digital economic and data forecasting, the level of investment attractiveness in the forestry sector, and the level of technological progress is highly possible in efforts to integrate the digital economy into the protection of economic values in forests.

Based on literature studies and theoretical reviews, the assumed in this study was formulated as follows:

1. It is assumed the variable comparison of the use of coal energy and IVA has a negative effect and has significance in the 2012-2019 time period on the EQI variable in 33 provinces in Indonesia
2. It is assumed the variable comparison of distributed clean water values and IVA has a negative effect and has significance in period 2012-2019 time period on the EQI in 33 provinces in Indonesia
3. It is assumed a comparison of distribution variables carried out on clean water and population is suspected to have a negative effect and is marked in the 2012-2019 time period on the EQI variable of 33 provinces in Indonesia
4. It is assumed that the variable volume of waste transported has a positive and significant effect in the 2012-2019 time period on the EQI variable of 33 provinces in Indonesia
5. It is assumed that the volume of ratio variable for waste production in urban areas and the population in urban areas has a negative also significant effect in the 2012-2019 time period on the EQI in 33 provinces in Indonesia
6. It is assumed that the Index of Information and Communication Technology Development (ICT-DI) has a positive relationship and has a significant impact in the 2012-2019 time period on the EQI in 33 provinces in Indonesia

If a relationship is drawn between previous studies and empirical data, it appears that in the case of regional Indonesia, there is a gap in environmental quality between provinces in eastern Indonesia and western Indonesia. Data from the Environmental Quality Index (EQI) shows that in 2019, the EQI value of West Papua Province could reach a figure of 83.96 while in the same year, DKI Jakarta Province was only able to record an EQI figure of 42.84 points (Kementerian Lingkungan Hidup dan Kehutanan RI, 2020). Based on these conditions, this study was prepared with the aim of knowing and analyzing several variables that influence Environmental Quality Index provinces in Indonesia during the period 2012 - 2019.

III. RESEARCH METHOD

Variabel

This research was designed in a quantitative way with the aim of seeing the link between the circular economy and the digital economy. The time period used in this research is the period 2012-2019 and uses environmental quality data from 33 provinces in Indonesia. For several reasons, the authors did not include North Kalimantan Province to get the results from the best research and coupled with technical reasons where the availability of data from that province has limitations.

In several variable selections that have been made by the author, the authors include the opinion of Su et al. (2013) in reference to the dimensions of the circular economy in this study, namely the dimensions include resources, disposal and waste management. This research will also refer to circular economy variable research conducted on Dwi Putranto's research (2021).

The resource efficiency dimension variable uses proxy data between the ratio variable between IVA and coal use and IVA with the distribution value of clean water in the ratio of the population in a province. This study also uses the dimensions of waste disposal with a proxy data approach between urban waste production and the number of residents in urban areas plus the waste management ratio variable by proxying the variable volume of waste that can be transported. The ICT-DI variable is also used as a variable to see the implementation of the digital economy.

This study uses secondary data in the form of unbalanced panel data due to incomplete data publication for certain provinces in certain years. The details of the variables used in this study are summarized in Table 1.

Variabel	Sumber
Environmental Quality Index	Kementerian Lingkungan Hidup dan Kehutanan (KLHK) RI
Value of Coal Usage/IVA	Badan Pusat Statistik (BPS) RI
Value of Clean Water Distributed by Clean Water Company/IVA	Badan Pusat Statistik (BPS) RI
Clean Water Distributed/Provincial Population	Badan Pusat Statistik (BPS) RI
Urban Waste Production/Urban Population City	Dinas Kebersihan Kota
Volume of Transported Waste	Dinas Kebersihan Kota
Information and Communication Technology Development Index (IC-TDI)	Badan Pusat Statistik (BPS) RI

Sources: Multiple Sources (processed)

This study uses an analytical tool using panel regression data with several functional models estimated in this study are as follows:

EQIit - F (CIVAit, WIVAit, WPOPPROVit, VWASTEit, WAPOPPROVit, TDIit)
EQIit = Environmental Quality Index
CIVAit = Ratio between IVA and Value of Coal Usage
WIVAit = Ratio between IVA and Value of Clean Water Distribution
WPOPPROVit = Ratio between Provincial Population and Distribution of Clean Water
VWASTEit = Volume of Transported Waste
WAPOPPROVit = Ratio between urban population city and urban waste production
TDIit = Information and Communication Technology Development Index

Data Analysis

This research also performs several shape transformations into logarithmic form for several variables so that the coefficients in the regression are interpreted as elasticity or also as a percentage of price changes. The analysis in this study refers to research by Batara et al. (2018)

Panel Data Regression Model

According to Hill et al. (2011), the selection between the Common Effect Model (CEM) or Fixed Effect Model (FEM) is based on the Chow test. In general, the Chow test follows an F distribution, where when the Chow test result is significant at a certain alpha level, the selected model is FEM. Furthermore, the selection between the Random Effect Model (REM) or FEM is based on the Hausman test, where when the Hausman test result is significant at a certain alpha level, the selected model is FEM.

Conducting classical assumption tests

The CEM and FEM panel data regression models are estimated using the Ordinary Least Square (OLS) method, while the REM panel data regression model is estimated using the Estimated Generalized Least Square (EGLS) method. According to Gujarati (2003), regression estimated by the OLS method requires the fulfillment of several classical assumption tests as follows.

Table 2. Classical Assumption Tests

Test	Method
Normality	Jarque – Bera
Multicollinearity	Korelasi Parsial
Heteroscedasticity	Park
Autocorrelation	LM

Source: Gujarati (2003)

Conducting assumed testing and feasibility testing of panel data regression models

According to Gujarati (2003), hypothesis testing to determine the significant effect of independent variables is done with a one-tail t-test. If t probability < alpha, then independent variable has a significant effect on the dependent variable. Meanwhile, the feasibility test of the panel data regression model will carried out with an F-test and adjusted R^2.

IV. RESULT AND DISCUSSION

Chow Test

From the results of the test for selecting the appropriate model, the results of the Chow test and Hausman test were found as follows.

Table 3. Chow Statistic Test Results

Effects Test	***Prob.***
Cross-section F	0,000

Source **:** Data Processed 2022
Explanation :
Significant Level = 5%

Hausman Test

Based on table 3 which is the test result of the chow test showing significant results with a significance level used of 5%, this means that this study uses a panel regression model with the FEM model.

Table 4. Hausman Statistic Test Result

Test Summary	***Prob.***
Cross-section Random	0,000

Source**:** Data Processed, 2022
Explanation :
Significant Level = 5%

Normality Test

In table 4 which is the result of the Hausman test also showing significance using the FEM model and a significance level of 5%, then the selection of the FEM model in this study is appropriate and the results of the classical assumption test on the FEM model are as follows. Based on figure 1, which is the result from Jarque-Bera normality test, shows the probability value of the chi-square which is significance level of 5 percent and means the residual of the normal estimated model. The results on the independent variable which are below 0.8 also mean that the regression model carried out in the study has fulfilled the assumption of non-multicollinearity.

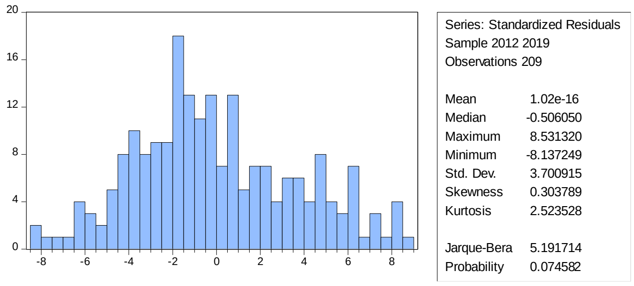

Figure 1. Normality Test Result
Source: Processed by Author

Multicollinearty Test

Referring to the criteria put forward by Gujarati (2003), using the Park test, the RESID^2 variable in Table 6 is the squared residual variable of the estimated FEM model. In fact, there are still several independent variables that have a significant effect at the 5 percent significance level. This condition indicates a violation of the homoscedasticity assumption. Therefore, based on the criteria put forward by Gujarati & Porter (2009), the estimation of the selected FEM model will be run using the EGLS method to ensure that the regression equation estimator meets the efficient Best Linear Unbiased Estimation (BLUE) rules.

Table 5. Multicollinearity Test Results

	X1	**X2**	**X3**	**X4**	**X5**	**X6**
X1	1	0,01	-0,07	0,23	0,03	-0,10
X2	0,01	1	0,31	0,03	0,14	-0,07
X3	-0,07	0,31	1	0,19	0,05	0,60
X4	0,23	0,03	0,19	1	0,63	0,16
X5	0,03	0,14	0,05	0,63	1	-0,17
X6	-0,10	-0,07	0,60	0,16	-0,17	1

Source: Data Processed,

A significance level of 5 percent. This indicates estimated regression model contains an autocorrelation problem. Therefore, similar to the healing of the homoscedasticity assumption violation, to solved the autocorrelation problem, panel data regression estimation will be carried out using the EGLS method to ensure that the regression equation estimator meets the BLUE rule (Gujarati & Porter, 2009:422).

Heterocedasticity Test

Table 6. Heterocedasticity Result Test

Method	***Panel Least Squares***	
Variabel		$RESID^2$
LCIVA	7,92E-06	

	(0,0170)**
LWIVA	-4,31E-05
	(0,0032)**
LWPOPPROV	-9,12E-05
	(0,0652)
LVWASTE	-7,62E-06
	(0,7872)
LAPOPPROV	-8,23E-05
	(0,0019)**
TDI	3,9821
	(0,0000)**

Source **:** Data Processed, 2022
Explanation:
The value of the regression coefficient is displayed
The probability of t - count is in parentheses
*** Significant Level =5%*

LM Autocorelation Test

In the results of the classical assumption test and panel data regression estimation, the final model has been obtained which has fulfilled various assumption tests previously carried out to explain the effect of the implementation of the circular economy and digital economy on environmental quality carried out in 33 provinces in Indonesia, as follows:

Table 7. LM Autocorrelation Test Result

F – Statistics	*Prob. Chi – Square*
37,184	0,000

Source **:** Data Processed, 2022
Keterangan :
Significant Level = 5%
**** significant level α=1%*

Final Model

Based on the regression results, it appears that all circular economy variables, except for the ratio variable between urban waste production and the volume of transported waste and urban population variables, individually have a significant effect on EQI. The regression coefficient between the IVA and the coal usage value ratio variable shows a negative and statistically significant relationship which is concluded according to the hypothesis, where when the IVA and the coal usage value ratio increase by 1 percent, ceteris paribus, EQI will decrease by 0.0000129 points, and it also happens the other way around.

In this study, variables that indicate the efficiency of the use of water resources have a significant influence on the EQI variable. The results of the regression coefficient of the ratio between IVA and the value of distributed clean water show the direction of the relationship from the hypothesis proposed in the study, where when the ratio between IVA and the value of distributed clean water increases by 1 percent, ceteris paribus, EQI will decrease by 0.0000173 points, and vice versa. The regression coefficient of the ratio between the value of the distribution of clean water and the total population of the province shows the opposite direction of the relationship from the proposed hypothesis, where when the ratio between the value of the distribution of clean water and the total population of the province increases by 1 percent, ceteris paribus, EQI will increase by 5.62 points, and vice versa.

Furthermore, the variable that proxies digital economic activity, namely the IC-DTI variable, shows a positive and significant relationship with EQI. These results are in accordance with the proposed hypothesis, where when the IC-DTI value increases by 1 point, ceteris paribus, EQI will increase by 2.0967 points, and vice versa.

The results of the F- test show significant results which are at a significance level of 1 percent. This shows that at least one independent variable has a significant effect on the EQI variable. The adjusted R^2 value of 0.9134 indicates that 91.34 percent of the variation in the EQI variable can be explained by all circular economy and digital economy variables, while the remaining 8.66 percent is explained by other variables outside the model.

Table 8. Final Model

Variabel	**EQI**
LCIVA	-1,29E-05
	(0,000)***
LWIVA	-1,73E-05
	(0,040)***

LWPOPPROV	5,62E-05
	(0,017)***
LVWASTE	4,33E-06
	(0,676)
LAPOPPROV	-1,05E-05
	(0,365)
TDI	2,0965
	(0,000)***
C	58,314
	(0,000)***

Weighted Statistics	
R-squared	0,9292
Adjusted R-squared	0,9134
F-statistic	58,752
Prob(F-statistic)	0,0000

Source **:** Data Processed, 2022

Keterangan :

Probabilitas t – test in parentheses

** significant level α=10%*

*** significant level α=5%*

**** significant level α=1%*

V. CONCLUSION

The results of the regression analysis presented in table 8 show that IVA and the ratio between values of coal use have a negative but significant relationship to EQI and this is linear with the initial hypothesis in the study. The existence of efficiency in the use of coal carried out by the industry has begun to be carried out towards industries based on renewable energy such as electricity. And this result is not in line with Dwi Putranto's research (2021) that in his research on the island of Sumatra, the transfer of energy used by industry does not have an impact on reducing environmental quality.

The findings in this study are also that there is a negative relationship between IVA and the ratio between the value of distributed clean water but it is significant to the EQI variable, this is directly proportional to the hypothesis proposed and this proves that there is an efficient use of water energy that has been carried out by industry in Indonesia and this is in line with research conducted by Dwi Putranto (2021) where the efficiency mechanism for water resources used by industry has been implemented. This result is also in line with the research of Su et al (2013) that a significant reduction in water consumption is carried out by industry rather than households.

The positive relationship between the population of the province and the ratio between the value of clean water distributed and the significance of the EQI variable means that there is a discrepancy with the hypothesis put forward, this is in accordance with the results of Dwi Putranto's research (2021) which explains that the increase in clean water consumption is faster than population growth. Rahman's research (2017) explains that although the efficiency of water resources has not occurred, the slowdown in population growth has helped reduce the burden on the environment.

The existence of an insignificant relationship between the variable volume of waste transported and the ratio of waste production in urban areas to the urban population is in line with a study conducted by Dwi Putranto (2021) where the two variables are also not significant in the economy on the island of Sumatra. The findings in the study may occur when viewed nationally, because there is no uniformity of readiness between provinces in processing waste piles in which there are geographical factor constraints.

The positive relationship to the digital economy regression and the significant EQI corresponds to the hypothesis tested and is in line with the research of Li et al (2021) where there is an inverted and non-linear U-relationship between the implementation of the digital economy and carbon emissions.

Sun et al. (2022) research found that the implementation of the digital economy can reduce the discharge of wastewater by industry. This condition can be achieved because the digital economy contributes to the improvement of the industrial structure which ultimately has an impact on reducing wastewater discharge. Singh et al. (2021) The application of the digital economy can be carried out on the environment, in particular it can be used to digitize forests to carry out data acquisition, monitoring, and also research analysis which can be used as a reference in decision making policies to protect the economic value in forests.

Based on the conclusions of this research, the suggestions proposed by the researcher to the community, industry players, and policymakers for accommodating from implementation of the circular economy and digital economy in supporting environmental quality are as follows.

1. Industry players, especially industries that still require energy sources from coal, are considered necessary to start diversifying energy use gradually. In the initial stage, industry players can combine the use of coal energy with solar heat energy and/or wind energy. The goal is to still be able to meet the needs of the community for industrial products. In the next stage, along with the development of environmentally friendly production methods, industry players can begin to adopt renewable energy sources fully in industrial operations.
2. Industry players, especially those classified as water-intensive industries, need to implement a water conservation program through intensive monitoring of industrial pipe and hose construction. This initiative aims to minimize the production of wastewater from water-intensive industries that endanger environmental quality.
3. The government is considered it necessary to map the type of water resource demand elasticity in each household province in Indonesia. The goal is to find out whether households respond to changes in water prices by drastically changing the amount of water resources requested or not. For example, when a household has an inelastic water demand elasticity category, the Government can raise water prices specifically on consumer segments with inelastic demand elasticity types.
4. Regional sanitation agencies are considered necessary to utilize waste treatment facilities other than Final Disposal Sites (TPA) owned by regions, such as waste banks, compost houses, Organic Processing Centers (POO), and others. The goal is to maximize waste collection efforts so that it can still be used as an economic resource.
5. The community is considered necessary to apply a circular lifestyle in the family environment by adapting the habit of sorting waste before disposal. The goal is to facilitate transportation, sorting, and processing of waste by relevant authorities and maintain the economic value of waste that can still be reused.
6. The community is considered necessary to utilize digital economy access to support environmental quality, for example by utilizing internet access to reduce food plastic use when ordering food online. This condition shows that the digitalization of the economy will not slow down economic activity while gradually reducing negative impacts on the environment.
7. Further research with similar topics is considered necessary to estimate more regression models in detail to capture the different responses of three regions in western, central and eastern Indonesia related to the influence of the implementation of circular economy activity and digital economy on EQI. This consideration is based on the fact that disparities in western, central and eastern Indonesia still occur in various aspects of life, so different regression models are expected to describe the conditions of these regions so that they are relevant to context.

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