Measurement of Sustainable Development with Electrification of Households in Indonesia

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ABSTRACT

This study offers sustainable development measurement using three variables, namely; The human development index (HDI) represents sustainable social economic development, and the environmental quality (EQ) represents Environmental Sustainability, while the exogenous variable is household electrification (EoH). With analysis using structural equation modeling, the results showed; EoH positively and significantly correlated to HDI. EoH is negatively correlated and significant to EQ. HDI significantly negatively correlated with EQ. Electrification of Households causes the occurrence of sustainable social economic development, and vice versa, the electrification of households causes the occurrence of environmental sustainability, and the relationship of sustainable social economic development causes the occurrence of environmental sustainability. Research novelty is the role of moderation from EoH to the relationship between HDI and EQ so that provinces with low household electrification with provinces with high household electrification will differ in environmental damage due to sustainable social economic development. Reference for policy makers to replace fossil fuel power plants that supply the electricity in households with environmentally friendly power plants.

Keywords: Sustainable Development, Household Electrification, Structural Equation Modeling

JEL Classifications: Q01, L94, C38

1. INTRODUCTION

Access to electricity is an essential driver of economic development. Cheap and easy-to-obtain electricity is crucial for households and development progress. Meanwhile, in large part, Indonesia’s major power plants are produced through fossil fuels, which causes a heavy ecological burden. Households in Indonesia unevenly supplied electricity. There are areas where 33% of households with electricity, and there are areas where 99% of households with electricity.

The conception of three pillars of sustainability (social, economic, environmental) represented by three circles that intersect with overall sustainability at the center of the slice of the three rings is an attempt to reconcile economic growth as a solution to social and ecological problems (Purvis et al., 2019). The primary purpose of the research is to measure sustainable development with the Electrification of Households in Indonesia. The research’s novelty is to analyze the role of household electrification (EoH) moderation in the relationship between HDI and environmental quality (EQ). This research focuses on thirty-three provinces in Indonesia with 9 years of data, namely from 2011 to 2019. To measure the achievement of sustainable development, environmental dimensions, economic dimensions, and social dimensions can be used as environmental sustainability index (EQI) and human development index (HDI) (Strezov et al., 2017).

Increased government spending on electricity supply infrastructure impacts improving the human development index (Sulistyowati et al., 2017). The opposite relationship also shows the same, as conveyed by (Sarkodie and Adams, 2020), that the human
development index positively impacts electricity access. According to (Caraballo Pou and Simón, 2017), there is a positive impact of renewable and renewable energy consumption on the human development index. The effect of reducing renewable energy on CO$_2$ emissions is less than the pollution effect of unrenewable energy. There is a difference between developed and developing countries with the relationship between electricity consumption per capita and the human development index (Nadimi and Tokimatsu, 2018). The growth of household electricity consumption impacts sustainable economic and environmental development. Climatic conditions have a tremendous impact on household electricity consumption and should be a significant consideration in making different household electricity policies (Meng et al., 2019).

From existing studies, research gaps on the relationship of human development index (HDI) to environmental quality (EQ) founding in different research results. The results of empirically proven studies that there is a positive and significant relationship between HDI and EQ are, among others, conveyed by (Shanty et al., 2018) that human quality positively affects environmental quality. The Human development index, positively related to the environmental performance index, explained that the higher accumulation of human resources would lower environmental damage and better environmental performance (Jain and Nagpal, 2019). Education is proving to reduce emissions (Balaguera and Cantavella, 2018).

The results of different researches were presented by (Hickel, 2020) states that countries with high human development indexes (HDI) also contribute the most to climate change and other ecological damage forms. (Syaiufudin and Wu, 2020), emphasize short-term goals by focusing on economic and social aspects and ignoring environmental elements; Increased education level has further compensated for the increase in CO$_2$ emissions per capita from economic growth. There is a U-shaped relationship between real income and ecological footprint (Destek et al., 2018).

Finally, the study results can provide useful references to measure a country’s sustainable development in a fast and straightforward way and help policymakers design and plan development on the right path of sustainable development.

### 2. RESEARCH FRAMEWORK

This study has successfully produced a report on the results of the analysis relationship between household electrification (EoH) and sustainable social economic development (HDI) as well as the relationship between household electrification (EoH) and environmental quality (EQ). This paper continued by analyzing sustainable development’s measurement by analyzing the relationship of achievement of sustainable social economic development (HDI) to environmental quality (EQ).

Literature Studies presents a summary of the concepts of sustainable development and indicators adapted from previous studies. The proposed concept of the sustainable development measurement model and testing hypotheses. Here is an overview of the methodology—first, the collection of analyzed indicators data, then analyzed by structural equation modeling (SEM) using Warp Partial Least Squares WarpPLS-SEM (WarpPLS) stable and reliable results.

#### 2.1. Environmental Quality (EQ)

Based on data from the Indonesian Ministry of Environment and Forestry, the National Medium-Term Development Plan (RPJMN) year 2015 to 2019 that environmental quality management policy direct at improving the Environmental Quality Index that reflects water quality conditions, air, and land cover, which strengthenest by increasing the capacity of environmental management and environmental law enforcement.

##### 2.1.1. Land cover quality index (LCQ)

The land cover quality index (LCQ) improves the forest cover index (FCI) used before 2015. Improvement of the LCQ calculation method elaborates several key parameters that describe conservation aspects, rehabilitation aspects, and spatial rust rural areas but can present and easily be understood. Land cover quality index data in thirty-three provinces from 2011 to 2019 in Table 1 the following:

##### 2.1.2. Environmental quality index (EQI)

The environmental quality index (EQI) has been developing since 2009, a national environmental management performance index and a standard reference for all parties in measuring environmental protection and management performance. EQI data in thirty-three provinces in Indonesia, from 2011 to 2019 in Table 2 the following:

##### 2.1.3. Air quality index

Air pollution is one of the problems faced by some regions of the world and is no exception in Indonesia. The trend of declining air quality in several major cities in Indonesia in recent decades. Also, the need for transportation and energy is increasing in line with the increasing population. Increased transportation and energy consumption will increase air pollution that will impact human health and the environment. Air quality index (AQI) data in thirty-three provinces in Indonesia, from 2011 to 2019 in Table 3 the following:

#### 2.2. Human Development Index

According to the explanation of Indonesia’s Central Statistics Agency (BPS), HDI is an important indicator to measure success in building people’s quality of life. HDI can determine the rating or level of development of a region (Province). For Indonesia, HDI is strategic data because, in addition to being a measure of government performance.

##### 2.2.1. Mean years school

Mean years school (MYS) defines the number of years used by the population to undergo formal education. MYS data in thirty-three provinces in Indonesia from 2011 to 2019 in Table 4 is the following:

##### 2.2.2. Old school expectations

The old school expectation figure (HLS) defines the length of education in school (in years) that the child expects to be felting at a certain age in the future. OSE data in thirty-three provinces in Indonesia from 2011 to 2019 in Table 5 is the following:
2.2.3. Life expectancy at birth

Life expectancy at birth (LEB) defines as the approximate average age of a person from birth. LEB data in thirty-three provinces in Indonesia from 2011 to 2019 in Table 6:

2.2.4. Adjusted per capita expenditure (ACE)

Adjusted per capita expenditure (ACE) defines Per capita expenditure of constant or real food commodities and non-food. ACE data in thirty-three provinces in Indonesia from 2011 to 2019 in Table 7 is the following:

2.3. Household Electrification (EoH)

The percentage of Households with PLN Electricity Lighting Source is; sources of electrical lighting in households managed by the state electricity company (PLN). EoH data in thirty-three provinces in Indonesia from 2011 to 2019 in Table 8:

### 3. RESEARCH METHOD

This research uses multivariate statistical methods, with structural equation modeling (SEM). Research involving multivariable analyses is worth doing multivariate analysis if the variables are observed in unison or simultaneously conducted the study. Data analysis is done simultaneously on research in which variables are interconnecting, both theoretically and empirically. In the process of multivariate analysis, the relationship between variables included in the calculation process. Interpretation of the analysis results made comprehensively, and this is in harmony with the nature that multivariate analysis already considers the relationship between variables.

Using variance-based and factor-based structural equation models (SEM), using the least-squares and factor-based methods. (Kock, 2015c) (Kock, 2015a). There is a ten model fit and quality index (Kock, 2010) (Kock, 2014) (Kock, 2015), as follows (Table 9):

Based on WarpPLS User Manual Version 7.0;
- For APC, ARS, and AARS, this P-value computing through a process that involves estimating resampling plus a correction to counteract the standard error compression effect associated with adding a random variable, in a way analogous to Bonferroni corrections
- It is recommending (ideally) that AVIF and AFVIF be equal to or lower than 3.3, especially in models where most
variables are measuring through two or more indicators. A looser (acceptable) criterion is that both indexes are equal to or lower than 0.5, especially in models where most variables are single indicator variables (and thus not latent variables real).

- GoF. Like ARS, the GoF index, which refers to the Tenenhaus GoF in honor of Michel Tenenhaus, is a measure of the model’s explanatory power (Kock, 2015d). (Tenenhaus et al., 2005) define GoF as the intermediate product’s square root to which they refer to the mean commonality index and the ARS.

- The SPR index is a measure that the model’s extent does not depend on the example of Simpson’s paradox (Kock, 2015b) (Kock and Gaskins, 2016). An example of the Simpson paradox occurs when the path coefficients and correlations associated with a pair of related variables have different signs. Ideally, the SPR should be equal to 1, which means that there are no examples of Simpson’s paradox in the model; an acceptable SPR value is equal to or >0.7, which means that at least 70% of the paths in the model is free of the Simpson paradox.

- RSCR index is a measure to analyze the extent to which the model is free from negative R-squared contributions, which occurs together with the example of Simpson’s paradox. When the predictor’s latent variable makes a negative contribution to the R-squared of the criterion latent variable (note: the predictor points to the criterion), it means that the predictor reduces the percentage of variance described in the criterion. Such a deduction takes into account the contributions of all predictors plus the remainder. This index is similar to SPR. Ideally, the RSCR should be equal to 1, meaning no negative R-squared contribution in the model. The acceptable value of the RSCR is equal to or >0.9, which means that the sum of the positive R-squared contributions in the model makes up at least 90% of the total sum of the absolute R-squared contributions in the model.

- The SSR index is a measure of how a model is independent of statistical emphasis examples. An example of statistical emphasis occurs when the path coefficient is more significant in absolute terms than the associated correlation concerning a pair of related variables. Like the Simpson paradox example, an example of statistical emphasis is a possible indication of a
causality problem, suggesting that the hypothesized pathway may be unreasonable or reversed. The acceptable SSR value is equal to or >0.7, which means that at least 70% of the model’s paths are free from statistical suppression

• NLBCDR. One of the exciting properties of nonlinear algorithms is that the nonlinear bivariate association’s coefficient varies depending on the hypothesized causality direction. They tend to be stronger in one direction than the other, meaning that the residuals (or errors) are larger when the direction of causality in one way or another. It can be used, along with other coefficients, as partial evidence supporting or against a hypothesized causal relationship. The acceptable value of the NLBCDR is equal to or >0.7, which means that in at least 70% of the path-related examples in the model, support for the hypothesized reverse causality direction is weak or less.

3.1. Hypotheses

The research hypothesis consists of four hypotheses and tested based on the design of research objectives. The hypotheses are:

• H1: Household electrification (EoH) has a positive effect on the human development index (HDI)
• H2: Household electrification (EoH) negatively affects environmental quality (EQ)
• H3: Human development Index (HDI) negatively affects environmental quality (EQ)
• H4: Household electrification (EoH) moderates the relationship between the human development index (HDI) and environmental quality (EQ).

3.2. Structural Equation Model

3.2.1. Outer model

- Environmental quality (EQ) = \lambda_1 (LCQ) + \lambda_2 (EQ) + \lambda_3 (AQI) + \delta_3
  (1)
- Human development index (HDI) = \lambda_4 (MYS) + \lambda_5 (OSE) + \lambda_6 (LEB) + \lambda_7 (ACE) + \delta_7
  (2)
- Household electrification (EoH) = \lambda_8 (PHL) + \delta_8
  (3)

3.2.2. Inner model

- Environmental Quality (EQ) = \gamma_1 (HDI) + \gamma_2 (EoH) + \gamma_3 (HDI)
  *(EoH) + \delta_4
  (4)

Description:

\lambda = \text{Indicator weight}
3.3. Research Model Pathway Analysis

In Figure 1, there is a research model pathway analysis.

4. ANALYSIS RESULTS

4.1. Results of the Analysis of the Research Model Path

In Figure 2, there is a result of the analysis of the research model path.

4.2. Analysis Results Model fit and Quality Index

In Table 10, there is Analysis Results Model fit and quality index.

4.3. Path Coefficients and P values

In Table 11, results from path coefficients.

4.4. Table: P-values

In Table 12, results from P-value.

4.5. Combined Loadings and Cross-loadings

The result combined loadings and cross-loadings in Table 13.

4.6. Indicator Weights

The result of Indicator weights, in Table 14.

4.7. Latent Variable Coefficients

4.7.1. R-squared coefficients

- HDI=0.517
- EQ=0.523.

4.7.2. Adjusted R-squared coefficients

- HDI=0.515
- EQ=0.519.
Table 5: Old school expectations (years)

| Province                        | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Aceh                            | 13.03 | 13.19 | 13.36 | 13.53 | 13.73 | 13.89 | 14.13 | 14.27 | 14.30 |
| North Sumatra                   | 11.83 | 11.97 | 12.41 | 12.61 | 12.82 | 13.00 | 13.10 | 13.14 | 13.15 |
| West Sumatra                    | 12.52 | 12.81 | 13.16 | 13.48 | 13.60 | 13.79 | 13.94 | 13.95 | 14.01 |
| Riau                            | 11.78 | 11.79 | 12.27 | 12.45 | 12.74 | 12.86 | 13.03 | 13.11 | 13.14 |
| Jambi                           | 11.60 | 11.73 | 12.17 | 12.38 | 12.57 | 12.72 | 12.87 | 12.90 | 12.93 |
| South Sumatra                   | 11.21 | 11.42 | 11.46 | 11.75 | 12.02 | 12.23 | 12.35 | 12.36 | 12.39 |
| Bengkulu                        | 11.88 | 12.20 | 12.78 | 13.01 | 13.18 | 13.38 | 13.57 | 13.58 | 13.59 |
| Lampung                         | 11.04 | 11.37 | 11.90 | 12.24 | 12.25 | 12.35 | 12.46 | 12.61 | 12.63 |
| Bangka Belitung Islands         | 10.70 | 10.79 | 10.96 | 11.18 | 11.60 | 11.71 | 11.83 | 11.87 | 11.94 |
| Riau Islands                    | 11.61 | 11.90 | 12.26 | 12.51 | 12.60 | 12.66 | 12.81 | 12.82 | 12.83 |
| DKI Jakarta                     | 11.91 | 11.96 | 12.24 | 12.38 | 12.59 | 12.73 | 12.86 | 12.95 | 12.97 |
| West Java                       | 10.91 | 11.24 | 11.81 | 12.08 | 12.15 | 12.30 | 12.42 | 12.45 | 12.48 |
| Central Java                    | 11.18 | 11.39 | 11.89 | 12.17 | 12.38 | 12.45 | 12.57 | 12.63 | 12.68 |
| Yogyakarta                      | 14.61 | 14.64 | 14.67 | 14.85 | 15.03 | 15.23 | 15.42 | 15.56 | 15.58 |
| East Java                       | 11.62 | 11.74 | 12.17 | 12.45 | 12.66 | 12.98 | 13.09 | 13.10 | 13.16 |
| Banten                          | 11.41 | 11.79 | 12.05 | 12.31 | 12.35 | 12.70 | 12.78 | 12.85 | 12.88 |
| Bali                            | 12.12 | 12.26 | 12.40 | 12.64 | 12.97 | 13.04 | 13.21 | 13.23 | 13.27 |
| West Nusa Tenggara             | 11.97 | 12.21 | 12.46 | 12.73 | 13.04 | 13.16 | 13.46 | 13.47 | 13.48 |
| East Nusa Tenggara             | 11.55 | 11.73 | 12.27 | 12.65 | 12.84 | 12.97 | 13.07 | 13.10 | 13.15 |
| West Kalimantan                 | 10.80 | 11.11 | 11.60 | 11.89 | 12.25 | 12.37 | 12.50 | 12.55 | 12.58 |
| Central Kalimantan              | 11.15 | 11.22 | 11.71 | 11.93 | 12.22 | 12.33 | 12.45 | 12.55 | 12.57 |
| South Kalimantan                | 11.14 | 11.54 | 11.67 | 11.96 | 12.21 | 12.29 | 12.46 | 12.50 | 12.52 |
| East Kalimantan                 | 12.06 | 12.46 | 12.85 | 13.17 | 13.18 | 13.35 | 13.49 | 13.67 | 13.69 |
| North Sulawesi                  | 11.50 | 11.77 | 11.88 | 12.16 | 12.43 | 12.55 | 12.66 | 12.68 | 12.73 |
| Central Sulawesi                | 11.82 | 12.09 | 12.36 | 12.71 | 12.72 | 12.92 | 13.04 | 13.13 | 13.14 |
| South Sulawesi                  | 11.82 | 12.16 | 12.52 | 12.90 | 12.99 | 13.16 | 13.28 | 13.34 | 13.36 |
| South East Sulawesi             | 12.30 | 12.45 | 12.45 | 12.78 | 13.07 | 13.24 | 13.36 | 13.53 | 13.55 |
| Gorontalo                       | 11.68 | 11.78 | 12.13 | 12.49 | 12.70 | 12.88 | 13.01 | 13.03 | 13.06 |
| West Sulawesi                   | 11.21 | 11.28 | 11.46 | 11.78 | 12.22 | 12.34 | 12.48 | 12.59 | 12.62 |
| Maluku                          | 12.85 | 12.96 | 13.35 | 13.53 | 13.56 | 13.73 | 13.91 | 13.92 | 13.94 |
| North Maluku                    | 11.79 | 12.19 | 12.48 | 12.72 | 13.10 | 13.45 | 13.56 | 13.62 | 13.63 |
| West Papua                      | 11.21 | 11.45 | 11.67 | 11.87 | 12.06 | 12.26 | 12.47 | 12.53 | 12.72 |
| Papua                           | 8.92  | 9.11  | 9.58  | 9.94  | 9.95  | 10.23 | 10.54 | 10.83 | 11.05 |
| Average                         | 11.66 | 11.87 | 12.19 | 12.46 | 12.66 | 12.83 | 12.98 | 13.04 | 13.08 |
| Standard Deviation              | 0.89  | 0.87  | 0.83  | 0.81  | 0.80  | 0.80  | 0.79  | 0.77  | 0.77  |
| Maximum                         | 14.61 | 14.64 | 14.67 | 14.85 | 15.03 | 15.23 | 15.42 | 15.56 | 15.58 |
| Minimum                         | 8.92  | 9.11  | 9.58  | 9.94  | 9.95  | 10.23 | 10.54 | 10.83 | 11.05 |

Source: Indonesian Central Statistics Agency (BPS)

Figure 1: Research model pathway analysis

Source: by the author (2020)
Table 6: Life expectancy at birth (years)

| Province                  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Aceh                      | 69.15 | 69.23 | 69.31 | 69.35 | 69.50 | 69.51 | 69.52 | 69.64 | 69.87 |
| North Sumatra             | 67.63 | 67.81 | 67.94 | 68.04 | 68.29 | 68.33 | 68.37 | 68.61 | 68.95 |
| West Sumatra              | 67.79 | 68.00 | 68.21 | 68.32 | 68.66 | 68.73 | 68.78 | 69.01 | 69.31 |
| Riau                      | 70.32 | 70.49 | 70.67 | 70.76 | 70.93 | 70.97 | 70.99 | 71.19 | 71.48 |
| Jambi                     | 70.04 | 70.19 | 70.35 | 70.43 | 70.56 | 70.71 | 70.76 | 70.89 | 71.06 |
| South Sumatra             | 68.51 | 68.67 | 68.84 | 68.93 | 69.14 | 69.16 | 69.18 | 69.41 | 69.65 |
| Bengkulu                  | 67.98 | 68.16 | 68.33 | 68.36 | 68.50 | 68.56 | 68.59 | 68.84 | 69.21 |
| Lampung                   | 69.12 | 69.33 | 69.55 | 69.66 | 69.90 | 69.94 | 69.95 | 70.18 | 70.51 |
| Bangka Belitung Islands   | 69.31 | 69.48 | 69.64 | 69.72 | 69.88 | 69.92 | 69.95 | 70.18 | 70.50 |
| Riau Islands              | 68.63 | 68.85 | 69.05 | 69.15 | 69.41 | 69.45 | 69.48 | 69.64 | 69.80 |
| DKI Jakarta               | 71.87 | 72.03 | 72.19 | 72.27 | 72.43 | 72.49 | 72.55 | 72.67 | 72.79 |
| West Java                 | 71.56 | 71.82 | 72.09 | 72.23 | 72.41 | 72.44 | 72.47 | 72.66 | 72.85 |
| Central Java              | 72.91 | 73.09 | 73.28 | 73.88 | 73.96 | 74.02 | 74.08 | 74.18 | 74.23 |
| Yogyakarta                | 74.26 | 74.36 | 74.45 | 74.50 | 74.68 | 74.71 | 74.74 | 74.82 | 74.92 |
| East Java                 | 70.02 | 70.14 | 70.34 | 70.45 | 70.68 | 70.74 | 70.80 | 70.97 | 71.18 |
| Banten                    | 68.68 | 68.86 | 69.04 | 69.13 | 69.43 | 69.46 | 69.49 | 69.64 | 69.84 |
| Bali                      | 70.78 | 70.94 | 71.11 | 71.19 | 71.35 | 71.41 | 71.46 | 71.68 | 71.99 |
| East Nusa Tenggara        | 64.13 | 64.43 | 64.74 | 64.89 | 65.38 | 65.48 | 65.55 | 65.87 | 66.28 |
| East Nusa Tenggara        | 65.45 | 65.64 | 65.82 | 65.91 | 65.96 | 66.04 | 66.07 | 66.38 | 66.85 |
| West Kalimantan           | 69.26 | 69.46 | 69.66 | 69.76 | 69.87 | 69.90 | 69.92 | 70.18 | 70.56 |
| Central Kalimantan        | 69.09 | 69.18 | 69.29 | 69.39 | 69.54 | 69.57 | 69.59 | 69.64 | 69.69 |
| South Kalimantan          | 66.88 | 67.11 | 67.35 | 67.47 | 67.80 | 67.92 | 68.02 | 68.23 | 68.49 |
| East Kalimantan           | 73.10 | 73.32 | 73.52 | 73.62 | 73.65 | 73.68 | 73.70 | 73.96 | 74.22 |
| North Sulawesi            | 70.55 | 70.70 | 70.86 | 70.94 | 70.99 | 71.02 | 71.04 | 71.26 | 71.58 |
| Central Sulawesi          | 66.39 | 66.70 | 67.02 | 67.18 | 67.26 | 67.31 | 67.32 | 67.78 | 68.23 |
| South Sulawesi            | 69.12 | 69.31 | 69.50 | 69.59 | 69.80 | 69.82 | 69.84 | 70.08 | 70.43 |
| South East Sulawesi       | 69.85 | 70.06 | 70.28 | 70.39 | 70.44 | 70.46 | 70.47 | 70.72 | 70.97 |
| Gorontalo                 | 66.59 | 66.76 | 66.92 | 67.00 | 67.12 | 67.13 | 67.14 | 67.45 | 67.93 |
| West Sulawesi             | 62.78 | 63.04 | 63.32 | 64.04 | 64.22 | 64.31 | 64.34 | 64.58 | 64.82 |
| Maluku                    | 64.61 | 64.77 | 64.93 | 65.01 | 65.31 | 65.35 | 65.40 | 65.59 | 65.82 |
| North Maluku              | 66.87 | 67.05 | 67.24 | 67.33 | 67.44 | 67.51 | 67.54 | 67.80 | 68.18 |
| West Papua                | 64.75 | 64.88 | 65.05 | 65.13 | 65.19 | 65.30 | 65.32 | 65.55 | 65.90 |
| Papua                     | 64.46 | 64.60 | 64.76 | 64.84 | 65.09 | 65.12 | 65.14 | 65.36 | 65.65 |
| Average                   | 68.56 | 68.74 | 68.93 | 69.06 | 69.24 | 69.29 | 69.32 | 69.53 | 69.81 |
| Standard Deviation        | 2.73  | 2.71  | 2.70  | 2.68  | 2.65  | 2.64  | 2.64  | 2.60  | 2.54  |
| Maximum                   | 74.26 | 74.36 | 74.45 | 74.50 | 74.68 | 74.71 | 74.74 | 74.82 | 74.92 |
| Minimum                   | 62.78 | 63.04 | 63.32 | 64.04 | 64.22 | 64.31 | 64.34 | 64.58 | 64.82 |

Source: Indonesian Central Statistics Agency (BPS)

Figure 2: Results of the analysis of the research model path

Source: By the author (2020)
4.7.3. Composite reliability coefficients
- EoH=1.00
- HDI=0.866
- EQ=0.864
- EoH*HDI=0.963.

4.7.4. Cronbach’s alpha coefficients
- EoH=1.00
- HDI=0.791
- EQ=0.755
- EoH*HDI=0.948.

4.7.5. Average variances extracted
- EoH=1.00
- HDI=0.620
- EQ=0.686
- EoH*HDI=0.866.

4.7.6. Full collinearity VIFs
- EoH=4.210
- HDI=2.281
- EQ=1.522
- EoH*HDI=2.199.

4.7.7. Q-squared coefficients
- HDI=0.516
- EQ=0.415.

4.8. Results of Analysis of Hypotheses
- H1: Household Electrification (EoH) has a positive effect on the human development index (HDI)
  Refer to Figure 3, that household electrification (EoH) positively affects the human development index (HDI). The greater the value of Household Electrification causes, the greater the value of the human development index (HDI) (Path coefficients=0.719, P≤0.001).

- H2: Household electrification (EoH) negatively affects environmental quality (EQ)
  Refer to Figure 4, that household electrification (EoH) negatively affects environmental quality (EQ). The greater the value household electrification (EoH) cause lower the value of the environmental quality (EQ) (Path coefficients=-0.460, P≤0.001).

- H3: Human development index (HDI) negatively affects environmental quality (EQ)
  Refer to Figure 5, the human development index (HDI) negatively affects environmental quality (EQ). The greater
Table 8: Percentage of households with lighting sources from electricity (PHL) (%)

| Province                      | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|-------------------------------|------|------|------|------|------|------|------|------|------|
| Aceh                          | 94.44| 96.57| 96.18| 96.97| 97.48| 97.88| 98.59| 99.14| 99.06|
| North Sumatra                 | 91.32| 92.93| 93.41| 93.56| 94.26| 95.00| 95.94| 96.35| 97.30|
| West Sumatra                  | 87.13| 90.28| 90.85| 91.96| 92.60| 94.78| 95.59| 96.59| 97.17|
| Riau                          | 61.29| 65.28| 69.31| 74.48| 78.06| 82.75| 86.59| 89.91| 91.39|
| Jambi                         | 75.87| 81.47| 86.11| 85.51| 87.37| 89.91| 92.29| 93.56| 94.86|
| South Sumatra                 | 79.96| 84.26| 86.44| 88.22| 90.58| 91.92| 93.64| 95.10| 95.15|
| Bengkulu                      | 78.53| 87.20| 89.51| 92.31| 93.62| 94.78| 95.03| 97.18| 97.21|
| Lampung                       | 82.37| 84.02| 87.86| 89.85| 91.30| 91.90| 93.98| 95.55| 96.73|
| Bangka Belitung Islands       | 79.19| 86.72| 91.84| 94.63| 96.50| 96.96| 98.04| 99.13| 98.57|
| Riau Islands                  | 88.44| 87.38| 89.22| 89.18| 92.24| 94.41| 94.91| 95.67| 96.90|
| DKI Jakarta                   | 99.65| 99.81| 99.91| 99.94| 99.40| 99.45| 99.80| 100.00| 99.99|
| West Java                     | 98.11| 98.83| 99.09| 99.34| 99.09| 98.96| 99.80| 99.82| 99.62|
| Central Java                  | 98.67| 99.28| 99.50| 99.66| 99.51| 99.39| 99.90| 99.91| 99.76|
| Yogyakarta                    | 99.54| 99.40| 99.62| 99.58| 99.70| 99.61| 99.88| 99.92| 99.82|
| East Java                     | 97.59| 98.72| 98.78| 98.77| 98.86| 98.55| 99.39| 99.59| 99.42|
| Banten                        | 98.16| 98.80| 99.33| 99.49| 98.72| 99.06| 98.81| 99.59| 99.56|
| Bali                          | 97.88| 98.64| 99.41| 99.41| 99.49| 99.64| 99.81| 99.81| 99.87|
| West Nusa Tenggara            | 86.32| 92.35| 95.77| 97.92| 97.74| 97.43| 99.02| 99.11| 99.55|
| East Nusa Tenggara            | 44.33| 50.41| 59.85| 65.47| 64.11| 64.96| 66.02| 69.37| 70.07|
| West Kalimantan               | 71.27| 74.13| 75.71| 76.08| 78.19| 81.53| 82.50| 83.54| 85.18|
| Central Kalimantan            | 66.16| 68.84| 72.83| 73.74| 77.81| 76.93| 81.75| 82.79| 84.45|
| South Kalimantan              | 89.63| 92.66| 93.85| 94.61| 95.62| 95.88| 96.84| 96.87| 98.01|
| East Kalimantan               | 81.04| 81.78| 85.30| 85.20| 87.55| 91.74| 92.43| 91.96| 93.77|
| North Sulawesi                | 93.32| 95.23| 96.29| 97.88| 96.89| 97.89| 98.81| 98.67| 99.16|
| Central Sulawesi              | 73.14| 77.99| 79.78| 82.99| 84.39| 86.19| 87.31| 89.65| 90.68|
| South Sulawesi                | 87.47| 89.71| 90.57| 92.83| 93.24| 94.24| 95.78| 96.48| 96.82|
| South East Sulawesi           | 75.86| 79.33| 81.93| 82.56| 85.19| 87.51| 88.88| 92.23| 94.02|
| Gorontalo                     | 74.19| 75.23| 83.52| 88.10| 88.61| 92.92| 95.43| 96.31| 97.33|
| West Sulawesi                 | 51.31| 55.67| 59.47| 62.99| 68.43| 75.58| 77.80| 83.18| 84.83|
| Maluku                        | 71.15| 74.30| 75.97| 79.90| 81.41| 83.58| 86.41| 88.69| 89.56|
| North Maluku                  | 64.58| 68.97| 73.17| 74.36| 76.60| 79.02| 84.33| 85.04| 86.47|
| West Papua                    | 62.04| 63.95| 62.78| 68.72| 75.95| 74.87| 78.15| 82.04| 81.33|
| Papua                         | 32.40| 32.28| 35.75| 35.90| 39.16| 39.79| 41.61| 43.51| 44.49|
| Average                       | 79.77| 82.50| 84.82| 86.43| 87.87| 89.25| 90.79| 92.04| 92.67|
| Standard Deviation            | 16.74| 16.08| 14.86| 14.10| 13.01| 12.54| 12.00| 11.26| 11.03|
| Maximum                       | 99.65| 99.81| 99.91| 99.94| 99.70| 99.64| 99.90| 100.00| 99.99|
| Minimum                       | 32.40| 32.28| 35.75| 35.90| 39.16| 39.79| 41.61| 43.51| 44.49|

Source: Indonesian Central Statistics Agency (BPS)

Figure 3: Best-fitting curve and data points for a multivariate relationship between EoH with HDI
the value of the human development index (HDI) causes lower the value of the environmental quality (EQ) (Path coefficients=$-0.361$, $P\leq0.001$). The human development index (HDI) represents sustainable social economic development in Indonesia is still causing a decrease in the value of the environmental quality (EQ) represents Environmental Sustainability. The analysis results can prove empirically that development in Indonesia is not on the path of sustainable development.

- **H4**: Household electrification (EoH) moderates the relationship between the human development index (HDI) and environmental quality (EQ)

Refer to Figure 6, that household electrification (EoH) moderates the relationship between the human development index (HDI) and environmental quality (EQ). The role of moderation from EoH to

![Figure 4: Best-fitting curve and data points for a multivariate relationship between EoH with EQ](image-url)
the relationship between HDI and EQ so that provinces with low Household Electrification (Low EoH) with Provinces with high household electrification (High EoH) will differ in environmental damage due to sustainable social economic development (HDI) (Path coefficients=0.164, P=0.002).

The provinces with low household electrification (Low EoH) experience a turning point in the Value EQ=68.88, While the Provinces with high Household Electrification (High EoH), the more significant the HDI value down the EQ value at the EQ value point=35.66.

Table 11: Path coefficients

|       | EoH | HDI | EQ   | EoH*HDI |
|-------|-----|-----|------|---------|
| HDI   | 0.719 |     |      |         |
| EQ    | -0.460 | -0.361 | 0.164 |         |

Source: By the author (2020)

Table 12: P value

|       | HDI | EQ   | EoH*HDI |
|-------|-----|------|---------|
| HDI   | <0.001 |     |         |
| EQ    | <0.001 | <0.001 | 0.002  |

Source: By the author (2020)

Table 13: Combined loadings and cross-loadings

|       | EoH | HDI | EQ | EoH*HDI | Type | Standard error (SE) | P-value |
|-------|-----|-----|----|---------|------|---------------------|--------|
| PHL   | 1.000 | -0.000 | -0.000 | 0.000 | Reflect | 0.050 | <0.001 |
| MYG   | 0.150 | 0.662 | 0.515 | -0.140 | Reflect | 0.052 | <0.001 |
| OSE   | -0.738 | 0.863 | 0.071 | -0.337 | Reflect | 0.051 | <0.001 |
| LEB   | 0.420 | 0.764 | -0.183 | 0.193 | Reflect | 0.051 | <0.001 |
| ACE   | 0.234 | 0.844 | -0.312 | 0.281 | Reflect | 0.051 | <0.001 |
| LCQ   | -0.486 | 0.263 | 0.892 | -0.123 | Reflect | 0.050 | <0.001 |
| EQI   | -0.018 | 0.080 | 0.949 | -0.003 | Reflect | 0.050 | <0.001 |
| AOI   | 0.749 | -0.516 | 0.601 | 0.187 | Reflect | 0.053 | <0.001 |
| PHL*MYS | 0.339 | -0.157 | 0.193 | 0.905 | Reflect | 0.050 | <0.001 |
| PHL*OSE | -0.166 | 0.113 | -0.022 | 0.965 | Reflect | 0.050 | <0.001 |
| PHL*LEB | 0.103 | -0.127 | -0.006 | 0.914 | Reflect | 0.050 | <0.001 |
| PHL*ACE | -0.258 | 0.159 | -0.158 | 0.937 | Reflect | 0.050 | <0.001 |

Source: By the author (2020)

Table 14: Indicator weights

|       | EoH | HDI | EQ | EoH*HDI | Type | SE | P value | VIF | WLS | ES |
|-------|-----|-----|----|---------|------|----|--------|-----|-----|----|
| PHL   | 1.000 | 0.000 | 0.000 | 0.000 | Reflect | 0.050 | <0.001 | 1.000 |    |    |
| MYG   | 0.000 | 0.267 | 0.000 | 0.000 | Reflect | 0.056 | <0.001 | 1.522 | 1.000 | 0.177 |
| OSE   | 0.000 | 0.348 | 0.000 | 0.000 | Reflect | 0.055 | <0.001 | 2.420 | 1.000 | 0.191 |
| LEB   | 0.000 | 0.308 | 0.000 | 0.000 | Reflect | 0.055 | <0.001 | 1.696 | 1.000 | 0.191 |
| ACE   | 0.000 | 0.340 | 0.000 | 0.000 | Reflect | 0.055 | <0.001 | 2.443 | 1.000 | 0.191 |
| LCQ   | 0.000 | 0.000 | 0.433 | 0.000 | Reflect | 0.054 | <0.001 | 3.447 | 1.000 | 0.191 |
| EQI   | 0.000 | 0.000 | 0.461 | 0.000 | Reflect | 0.054 | <0.001 | 3.975 | 1.000 | 0.235 |
| AOI   | 0.000 | 0.000 | 0.293 | 0.000 | Reflect | 0.055 | <0.001 | 3.571 | 1.000 | 0.235 |
| PHL*MYS | 0.000 | 0.000 | 0.000 | 0.261 | Reflect | 0.056 | <0.001 | 4.436 | 1.000 | 0.235 |
| PHL*OSE | 0.000 | 0.000 | 0.000 | 0.279 | Reflect | 0.056 | <0.001 | 4.855 | 1.000 | 0.235 |
| PHL*LEB | 0.000 | 0.000 | 0.000 | 0.264 | Reflect | 0.056 | <0.001 | 3.776 | 1.000 | 0.191 |
| PHL*ACE | 0.000 | 0.000 | 0.000 | 0.270 | Reflect | 0.056 | <0.001 | 6.446 | 1.000 | 0.235 |

P<0.05 and VIF<2.5 are desirable for formative indicators; VIF=Indicator variance inflation factor; WLS=Indicator weight-loading sign (−1=Simpson’s paradox in l.v.); ES=Indicator effect size. Source: By the author (2020)

Figure 5: Best-fitting curve and data points for a multivariate relationship between HDI with EQ
5. CONCLUSIONS AND POLICY IMPLICATIONS

Sustainable development measurement with the model we offer, using three variables; The human development index (HDI) represents Sustainable Socioeconomic Development, environmental quality (EQ) represents environmental sustainability and household electrification (EoH), strong and fast enough to measure whether development in a country is already on track for sustainable development. By analyzing the relationship between household electrification (EoH) to the human development index (HDI) and analyzing the relationship between Household electrification (EoH) to environmental quality (EQ). The subsequent analysis analyzed the human development index (HDI) relationship to environmental quality (EQ). The last analysis conducted was to analyze the moderation role of household electrification (EoH) to the relationship between human development index (HDI) and environmental quality (EQ), so that the difference in environmental quality value (EQ) between provinces with low household electrification (Low EoH) with provinces with high Household Electrification (High EoH).

The research’s policy implications are a dilemma for Indonesia’s Government due to the development priorities that plan and applied. On the one hand, Household Electrification for the community is a fundamental need to create development. On the other hand, Household Electrification causes a decrease in Environmental Quality. We recommend to the Indonesian government to replace fossil fuel power plants that supply electricity to households with environmentally friendly power plants, and this can be done in stages so that people’s needs for electricity Fulfilled.

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