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Partial least square-structural equation modeling on the gender development index in east java

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ABSTRACT

National Term Development Plan (RPJMN) 2015-2019 Based on gender considerations, one of the essential considerations in preparing Indonesia's development plan. The global indicator used to measure the achievement of gender findings is found in the Gender Development Index (IPG). The IPG East Java in 2020 is at the upper middle level, but the disparity in human development still occurs at the district/city level. That is why studying the variables that affect the GPA value is necessary. The method used is Partial Least Square-Structural Equation Modeling (PLS-SEM) with bootstrap parameter estimation. The secondary data were obtained from the Central Statistics Agency (BPS) of East Java and SAKERNAS 2020. The results of this study are that all dimensions of GPI, namely Economy, Health, and Education, have a positive and significant impact on GPI. In comparison, the influential but insignificant variables are AHH Male and AHH Female; RLS Male and RLS Female, AHLS Male and AHLS Female. The most significant contribution is RLS Female, and the smallest is AHLS Male.

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1. INTRODUCTION

The fifth goal of the Sustainable Development Goals (SDGs) is to achieve gender equality and empower women (Dini et al., 2020). One of the efforts to achieve this goal is to integrate gender equality between regions (Zhang & Zhang, 2021). The National Medium-Term Development Plan (RPJMN) for 2015-2019 identifies gender equality as one of the considerations in preparing Indonesia's development plan (Dini et al., 2020). The global indicator used to measure the achievement of gender equality is the Gender Development Index (IPG) (Quisumbing et al., 2021). East Java is a regional group that still needs to strive for gender equality. This is because East Java in 2020 had an IPG value of 91.07, higher than the HDI value of 71.71 (Timur, 2019)(Timur, 2021). In addition, it has not met the intention of the IPG value of 92.00 (Dini et al., 2020). The condition can worsen because the disparity in human development between sex groups still tends to be high

(Rahmawati et al., 2018). The IPG value in East Java in 2020 ranked 2nd out of 6 provinces on Java Island, and if sorted nationally, the East Java IPG value was ranked 15th out of 34 provinces (Statistik, 2019). Therefore, this is an important issue that needs to be pursued and resolved by further action through a study.

Previous studies used the VECM system equation to determine the relationship between the GNI variable and other variables (a different framework model from the research the author conducted) (Bhowmik, 2020); besides that, to find out the variables affecting GNI, other studies used a qualitative comparative analysis approach of fuzzy sets (Zhang & Zhang, 2021) and the Seemingly Unrelated Regression method (Darsyah & Sara, 2016). Followed by research with different IPG value formation models also using methods that resemble SEM-PLS, namely using machine learning algorithms such as linear regression, ridge regression, and K nearest neighbors (Gupta et al., 2023). Meanwhile, the PLS-SEM method has already been used to investigate factors influencing the desires of non-consumer buyers of natural beauty products (Munerah et al., 2021). This article aims to examine the exploration model of the development of established theories, not to test or confirm views. PLS-SEM is currently widely applied in various social science disciplines, including organizational management, human resource management and management information systems (Hair et al., 2019). It can be said that gender equality is still limited in specific demographics. even supported by the results of previous research reviews and the advantages of the PLS-SEM method, namely high flexibility and does not require a large number of assumptions (Munerah et al., 2021), so based on these considerations, the PLS-SEM process is a suitable approach to be integrated to analyze what dimensions or variables affect IPG in East Java in 2020.

2. RESEARCH METHOD

The collection of secondary cross-section data in 2020 was obtained from the website of the Central Statistics Agency (BPS). Through random sampling techniques, it can be determined that the population and research samples are 38 regencies/cities in East Java. Data analysis using SmartPLS software Version 3.3.3. SmartPLS has the advantage of its suitability in recording data and conducting research analysis statistics (exploratory, confirmative, target prediction) and its flexibility in handling non-normal multivariate data, both for small sample sizes (Yudatama et al., 2019).

The following is the latest GPI calculation based on the Central Statistics Agency (Wisnujati, 2020):

$$IPG = \frac{IPM_{Female}}{IPM_{Male}}$$

The formation of HDI is described as a geometric average of the dimensions of Health, Education, and Expenditure dimensions so that HDI can be expressed in the following formula:

$$IPM = \sqrt[3]{I_{health} x I_{education} x I_{expenditure}}\, x\ 100$$

The PLS-SEM model for IPG is formed with eight variables on the economic dimension (ξ_1), including the variable Per Capita Expenditure of Men (EKO1); variable Per Capita Expenditure of Women (EKO2) (Lukiswati et al., 2020); variable Male Income Contribution (EKO3); variable Women's Income Contribution (EKO4); variable Male Population Number (EKO5); variable Number of Women Population (EKO6); the male labour force variable (EKO7) as well as the female labour force number variable (EKO8) (Rahmawati et al., 2018). Then, four variables for the educational dimension (η_1) namely the average male schooling length (PEN1) variable; the Average variable Length of Girls' Schooling (PEN2); the variable Old Expectation Number of Male Schools (PEN3); variable

Women's Old Expectation Number (PEN4) (Rahmawati et al., 2018). Finally, there are two variables in the health dimension (η_2) namely the male Life Expectancy variable (KES1), the Female Life Expectancy Variable (KES2) (Kertati, 2021) and there are two variables for the Dimensions of the Gender Development Index (IPG) (η_3), including the male HDI variable (IPG1) and the Female HDI variable (IPG2) (Dini et al., 2020).

SEM with PLS follows a two-step analysis of a procedural approach consisting of three components: a structural model, a measurement model, and a weighting scheme. First, a measurement model that represents the relationship of variables to their respective dimensions is assessed for reliability and validity checks (Hair et al., 2019). Secondly, a structural model that describes the mutual relationship between sizes by determining the path coefficient is evaluated and checked for the degree of significance with the bootstrap procedure. Other assessment steps, such as R^2 and Q^2. Observed to test the explanatory power of the model and its predictive relevance. Here's the formula for calculating the value of Q^2:

$$Q^2 = 1 - \left(1 - {R_1}^2\right)\left(1 - {R_2}^2\right) \ldots \left(1 - {R_p}^2\right) \quad (1)$$

Further, the feasibility of the model is assessed through the fit parameter. The regression coefficient obtained during the parameter estimation process in PLS-SEM on the dimensions (construct) is used to measure each IPG index's influence. The illustrations in the path diagram model will be converted to two forms of equations, namely: (a) Outer model equation (measurement model). It describes the relationship and characteristics of the construct with its variables. Systematic equation (2) describes the reflexive variable model (Ramli et al., 2019):

$$y = \lambda_y \eta + \varepsilon_y \quad (2)$$

Information:

y : variable for the endogenous dimension (η)
λ_y : simple regression coefficient that relates the dimensions with variables.

Then proceed to the formative variable model expressed in the systematic equation (3) (Fattore et al., 2018):

$$\xi = \Pi_\xi X_i + \delta \quad (3)$$

Information:
Π_ξ : dimensional multiple regression coefficients and variable block
δ : the error value associated with the variable to the variable.

The more specific conditions above are usually also written in the form of the following outer weight equation (weighting scheme):

$$\xi = \sum_h \varpi_{\xi h} x_h$$
$$\eta = \sum_h \varpi_{\eta h} y_h$$

Information: $\varpi_{\xi h}$ and $\varpi_{\eta h}$: the value h of weight to build an estimate on the dimensions ξ and η. (b) The inner model equation or also known as the structural model is a recursive model so that the equation can be written in the form below (Ramli et al., 2019):

$$\eta_l = \sum_i \beta_{li} \eta_i + \sum_i \gamma_{li} \xi_i + \zeta_l \quad (4)$$

Information:
γ_{li} : path coefficient between endogenous dimensions (η) with exogenous (ξ)

β_{li} : path coefficient between endogenous dimensions (η) with endogenous (η) along index range i.
ζ_l : variable inner residual

2.1 Hypothesis test

Evaluation of lambda (λ), beta (β), and gamma (γ) parameters is part of hypothesis testing. PLS-SEM hypothesis testing is based on the T-statistics value obtained from the Smart-PLS bootstrap procedure. Therefore, the researcher assumes that the data is abnormal; the number of samples used is insignificant, and the sample is taken randomly from the population. The bootstrap method is appropriate for testing the hypothesis and determining the variables' significance (Garson, 2016). The bootstrap method relies on the assumption of a bootstrap sample $x^* = (x_1{}^*, x_2{}^*, \dots, x_n{}^*)$ obtained from random sampling with as many n returns as the initial sample $x_1, x_2, \dots, x_n$ included in the $\hat{F}$ empirical distribution. If the path coefficient is obtained with a value $T_{statistics} > T_{(\alpha,\ df)}$ (value 1.96 for n = 38, = 5%), it can be concluded that the path coefficient is significant/important and vice versa.

3. RESULTS AND DISCUSSIONS

The establishment of the concept of research framework in this article is based on the PLS-SEM research model regarding the relationship of gender equality dimensions with quality of life (Galistya, 2017). The PLS-SEM research model on the quality of life of women and adapts again to the definition of reflective and formative variables (Mikulić & Ryan, 2018). In comparison, the relationship between the exogenous and endogenous dimensions is based on previous research and theories (Joseph F. Hair et al., 2017)(Mandhani et al., 2020).

In Figure 1, an evaluation is carried out until you get the appropriate inner model. First, check the reliability variable for the reflexive variable using the outer loadings variable; (loading factor > 0.5; Cronbach's Alpha > 0.7; and rho A > 0.7); internal consistency reliability using statistical composite reliability > 0.7 (Joseph F. Hair et al., 2017); and discriminant validity using cross-loadings, by comparing the values in the cross loading table, namely the loading factor in the resulting construction is higher than all loading factors of other constructions and heterotraite-mononitrate (HTMT) < 0.90 (Mandhani et al., 2020). Another criterion is to look at the Average Variance Extracted (AVE) value for convergent validity. Composite reliability shows how well the construct is measured with a given variable, considered reliable if the score is > 0.6.

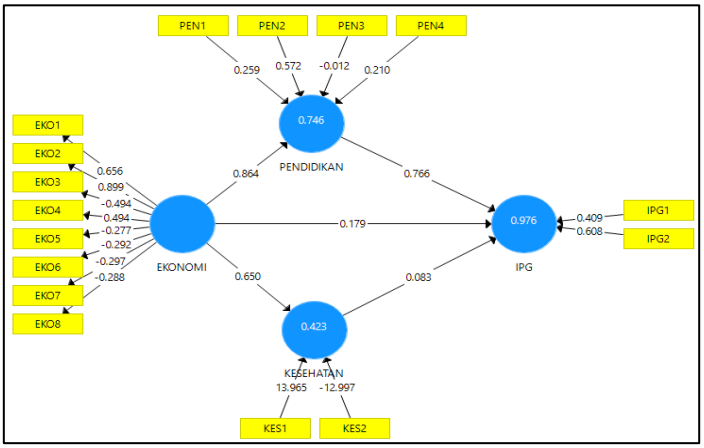

Figure 1. The path coefficient on the PLS Algorithm sourced from the Smart PLS Output Version 3.3.3

The initial analysis results show that there are still outer loadings values that are not reliable (< 0.5), so the elimination of variables one by one starts from the smallest value on an ongoing basis. After eliminating as much as 6x, the outer loadings value of EKO1 was obtained by 0.874 and EKO2 by 0.932, which means that these variables can explain more than 85% of the economic dimensions well. The ECONOMIC dimension has a composite reliability value of 0.898, a rho_A value of 0.825, and a Cronbach's Alpha value of 0.778, meaning that the reflexive measurement model on the ECONOMIC dimension is the suitable model (M. Fariz Fadillah Mardianto et al., 2021). An AVE value of 0.816 indicates that the economic variable can account for an average of 81.6% of the variants of the two constituent variables. In addition, the variables EKO1 and EKO2 also meet the criteria for discriminant validity, so it can be said that the variables are valid (Wibowo et al., 2021).

The next step is to convert the measurement model into equation (2) for exogenous variables with reflexive variables as follows:

$$EKO1 = 0.874Economy + \delta_1 \quad (5)$$

$$EKO2 = 0.932Economy + \delta_2 \quad (6)$$

Based on equations (5) and (6), the reflexive variable that predominantly contributes to the Economic dimension is Women's Per Capita Expenditure (EKO2), and the less contributing variable is Male Per Capita Expenditure (EKO1).

In addition to reflexive variables, further evaluation of formative variables is through checking the significance of the regression coefficient (outer weights). Check the weight of each variable using bootstrapping to assess the significance of the path coefficient. The bootstrapping method with 500 sub-samples was used to measure the 2-tailed t-test value of 1.96 with significance = 5% (Mohammad et al., 2019). Here are the output results of outer weights from data analysis:

Table 1. Value of Outer Weights

Variable	*Original Sample (O)*	*T Statistics*	*P Values*
IPG1→GPA	0.516	5,345	0.000
IPG2→GPA	0.502	5.063	0.000
KES1→HEALTH	12,307	1,270	0.205
KES2→HEALTH	-11,331	1,167	0.244
PEN1→EDUCATION	0.266	0.782	0.435
PEN2→EDUCATION	0.596	1,811	0.071
PEN3→EDUCATION	0.050	0.209	0.835
PEN4→EDUCATION	0.122	0.481	0.631

Table 1 shows that the formative variables IPG1 and IPG2 are valid and significantly affect the IPG dimension. In contrast, the other variables have no significant impact but are still good on the Health or Education dimension.

The results of the multicollinearity test using the value of variance inflation factor (VIF) between dimensions showed that there were no cases of multicollinearity, so the next stage was model conversion based on the intersection (4) as follows:

a. Endogenous Dimension 1 (EDUCATION):

$\eta_1 = 0.990 + 0.991 + 0.788 + 0.880 + Y_1\ Y_2 Y_3 Y_4 \varepsilon$

$$EDUCATION = 0.990PEN1 + 0.991PEN2 + 0.788PEN3 + 0.880PEN4 + \varepsilon \quad (7)$$

b. Endogenous Dimension 2 (HEALTH):

$\eta_2 = 0.978 + 0.974 + Y_5\ Y_6\ \varepsilon$

$$HEALTH = 0.978\ KES1 + 0.974\ KES2 + \varepsilon \quad (8)$$

c. Endogenous Dimension 3 (IPG):

$\eta_3 = 0.983 + 0.982 + Y_7\ Y_8\ \varepsilon$

$$IPG = 0.983IPG1 + 0.982IPG2 + \varepsilon \quad (9)$$

Based on equations (7), (8), and (9) show that the formative variables that predominantly contribute to their respective dimensions are the Average variables Length of Schooling (PEN2), variables of Male Life Expectancy (KES1), and Male HDI (IPG1). Here's the final diagram path for an already valid variable:

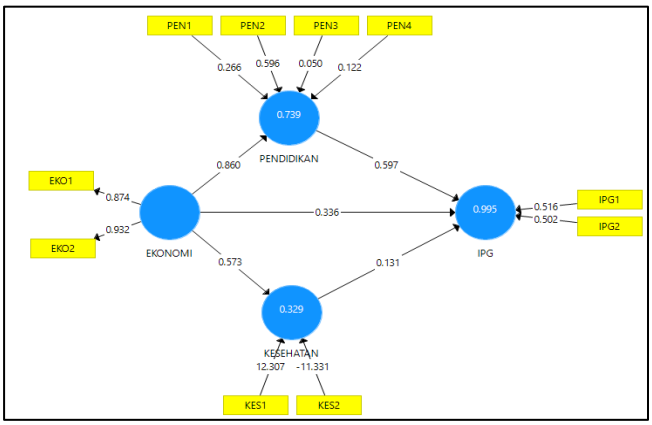

Figure 2. Bootstrapping PLS Model Struktural

Overall, the model and the relationship between the dimensions and the variables are already valid. Therefore, the second test that needs to be done is confirmation by evaluating the appropriate outer model using the following sizes:

a. Coefficients of determination (R^2)

The value R^2 will explain how much variance from the endogenous dimension can be defined by the exogenous dimension. Here are the R^2 values for each endogenous dimension:

Table 2. Endogenous Dimension Value R^2

Endogenous Dimension	Score R^2	Criteria
GPA (η_1)	0.995	Very good
HEALTH (η_2)	0.329	Currently
EDUCATION (η_3)	0.739	Well

The value of R^2 the dimensions of IPG are 0.995. This means that the variance of the IPG dimension can be explained by 99.5% percent by the Economic dimension. Based on the value of R^2 in Table 2, the endogenous dimensions of IPG and Education are substantial models. Meanwhile, the Economic dimension includes the standard model (Purwanto & Sudargini, 2021).

b. The Goodness of Fit (GoF)

By utilizing the average value of commonalities and the average R^2 value, for general checks, you can use the calculated value of the following Goodness of Fit (GoF) formula (Cholidah et al., 2018):

$$GoF = \sqrt{\overline{communality} \; x \; \overline{R^2}}$$

From the loading factor data set, a mean commonalities (AVE) value of 0.883 and a mean value of R^2 were obtained. It is 0.688, so the GoF value is 0.786 (GoF large), which means the model is already valid and very good at explaining experimental (empirical) data.

c. Predictive relevance (Q^2)

Another test for structural measurement is predictive relevance (Q^2), which helps to validate the model. The calculation result of equation (2) using the data in Table 2 in the value of Q^2. Of 0.99, Value Q^2, it shows the value of the predictive relevance result Q^2 which is good (appropriate) because of the value of Q^2 > (0) (Mandhani et al., 2020). This statement also means that the exogenous dimension is either (exactly) a dimension that can explain the endogenous dimension in the model.

d. Path Coefficient Test

This test is used to show the magnitude of the influence of the free dimension on the bound dimension. The higher the value of the loading factor of the free dimension on the bound dimension, the stronger the influence of the free dimension on the determined dimension (Khairunnisa et al., 2020). The following are the results of data analysis for the path coefficient test:

Table 3. Bootstrap Path Coefficient Value

Variable Path	*Original Sample (O)*	*Standard Deviation (StDev)*	*T Statistics*	*P Values*
ECONOMY→GPA	0.336	0.042	8,029	0.000*
ECONOMY→HEALTH	0.573	0.090	6,379	0.000*
ECONOMY→EDUCATION	0.860	0.032	26,682	0.000*
HEALTH→GPA	0.131	0.033	3,913	0.000*
EDUCATION→GPA	0.597	0.043	13,919	0.000*

Description: * = significant

The data output results in Table 3 show that all relationships between exogenous dimensions to endogenous dimensions have a positive path and t-statistical values > t-table. It shows that each dimension positively influences other dimensions so that it can describe the condition where any increase in value in the Economic dimension by 1% will increase the value of the IPG dimension by 0.336%, Health by 0.573%, and Education by 0.860%.

The structural model of the IPG in equation (4) would look like the following:

$\eta_3 = 0.597 + 0.131 + 0.336 + \eta_1\eta_2\gamma_3\zeta_3$

GPA = 0.597Education + 0.131Health +0.336Economy + ζ_{IPG} (10)

Based on equation (10), the Education dimension significantly influences the IPG value compared to other dimensions. Different analyses and models in this study show the same results and follow the empirical methodology regarding IPG in BPS, namely the influence of the economic, health, and education dimensions on IPG. It is hoped that the results of the PLS-SEM analysis in the form of a model of measurement and structural equations of IPG in East Java can be one of the inputs or considerations for the Ministry of Environment and Forestry in suppressing the condition of gender disparity that is still high in specific dimensions.

4. CONCLUSION

This study provides research results that the fit model of the PLS-SEM on the 2020 GPI in East Java province is formed from the variables of Per capita Expenditure and HDI (valid and significant), the variable of Expectancy of School Years, RLS, AHH (good but not significant). In addition, it was found that the education dimension is the most critical factor that directly affects the increase in GPA scores. The GPI variable is directly and significantly influenced by Economy, Education, and Health dimensions.

This finding has important implications for supporting the realization of more practical steps in increasing the GPI index value of East Java Province in the future, especially to achieve the UN SDGs (United Nations) 2030 target. In addition, it is necessary to maintain a balance of conditions in the economic dimension. And education so that the achievement value does not contain a very significant gap in it, every

stakeholder who has the authority can apply the expansion and provision of equal employment opportunities and reasonably provide moral or material support in the field of education. In the future, the author suggests that the OLS method can be used with the Fixed Effect Model (FEM) or Seemingly Unrelated Regression Analysis model. Besides, it is also necessary to consider the number of variable compositions shown by IPG modeling, trying to balance the number of latent variables used.

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