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POVERTY MODELING IN WEST KALIMANTAN USING STRUCTURAL EQUATION MODELING - PARTIAL LEAST SQUARE

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Abstract: *Poverty remains a pervasive issue across various regions in Indonesia, often leading to significant repercussions such as hindering economic growth and exacerbating inflationary pressures within localities. Poverty has emerged as a formidable challenge for the global community, particularly for developing nations, including Indonesia. West Kalimantan is a province in Kalimantan Island with high poverty rates. This research examined the factors influencing poverty within West Kalimantan Province in 2022 using the Structural Equation Modeling-Partial Least Square (SEM-PLS) method. This research analyzed the interrelations among poverty, education, economy, and health dimensions. Findings indicated a significant relationship between health and education dimensions, whereas the relationships between economic dimensions and poverty, health dimensions and the economy, and education dimensions and the economy were not found significant.*

Keywords**:** *Poverty Modeling, SEM-PLS, West Kalimantan.*

1. INTRODUCTION

Poverty presents a pervasive challenge across various regions in Indonesia, often impeding economic growth and fueling inflation. It manifests as the inability to meet fundamental needs like food, clothing, and shelter [1], compromising access to education and public health services [2]. Chambers posits that poverty encompasses five dimensions: powerlessness, dependency, geographical and sociological isolation, vulnerability to emergencies, and lack of property [3]. Thus, it transcends mere financial inadequacy, encompassing educational and health deficits, legal injustices, susceptibility to crime, and limited autonomy [4].

This global predicament, especially prevalent in developing nations, spurred the establishment of the United Nations Development Programme (UNDP) to combat poverty. Through policy development, capacity building, and resilience enhancement, UNDP addresses inequality and discrimination, striving to uplift impoverished communities [4]. The World Bank identifies five key influencers of poverty: employment type, gender disparities, education access, healthcare availability, and infrastructural adequacy [5].

Remarkably, Indonesia witnessed a significant decline in poverty rate in March 2022 to the lowest rate [6]. This achievement is particularly noteworthy amid the challenges posed by the Covid-19 pandemic, with the poverty rate dropping to 9.54% [7]. Beyond financial strain, the pandemic exacerbated issues of employment, healthcare access, and education, underscoring the multifaceted nature of poverty [8]. Consequently, a multidimensional approach to poverty measurement is imperative for effective poverty reduction efforts [9].

West Kalimantan, the fourth largest province in Indonesia, faces the highest poverty rate among the Kalimantan islands [10]. In September 2022, it was observed that approximately 356.51 thousand individuals (6.81%) were living below the poverty line [11]. This issue extends beyond mere financial constraints, encompassing challenges in health, education, and active participation in development, among other dimensions of human development. Previous research, in general, has shown that the health, education and economic sectors are recursively linked to poverty. Education has a negative and insignificant effect on poverty levels in the districts/cities of West Kalimantan Province, while health is shown to have a significant negative effect on poverty

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[12]. On the other hand, economic growth in various sectors influences income redistribution and plays a role in poverty reduction [13].

Understanding poverty as a multi-dimensional dilemma, this research employs Structural Equation Modeling-Partial Least Squares (SEM-PLS) to explore its causes, effects, and influencing factors. Through analyzing the interconnectedness of educational, economic, health, and poverty dimensions, the research aims to uncover the intricate relationships within West Kalimantan's poverty landscape. The findings are anticipated to offer valuable insights to central, provincial, and regional authorities, aiding them in identifying the primary factors driving poverty in the province. With this understanding, tailored welfare enhancement programs can be devised, leveraging the unique strengths of each district and city to uplift communities across Indonesia.

2. METHOD

2.1. Data Source and Research Variables

The research regarded secondary data sourced from the publication "Statistics on People's Welfare for West Kalimantan Province" [11]. The research encompassed 2 cities and 12 districts within West Kalimantan Province as its observation units. Three endogenous latent variables—economic status, poverty level, and education were examined alongside one exogenous latent variable, representing the health dimension [14]. Detailed indicators for each latent variable are outlined in Table 1.

Table 1. Indicators of Latent Variables

Latent Variable	Code	Indicator
Health (ξ_1)	SH1	Life expectancy[2]
	SH2	Percentage of households with access to safe drinking water[2]
	SH3	Percentage of births attended by medical personnel[2]
Education (η_1)	PD1	Literacy rate of the poor population aged 15-55[1]
	PD2	Net enrollment rate of SMA/SMK/MA/Paket C[2]
	PD3	School enrollment rate for primary education 16-18 years old
Economy (η_2)	EK1	Percentage distribution of households using PLN electricity[2]
	EK2	Percentage of population aged 5 years and above who own a cellular/wireless phone in the last 3 months[3]
	EK3	Percentage of employed to labor force[2]
Poverty (η_3)	M1	Percentage of poor population[1,2]
	M2	Poverty depth index[1,2]
	M3	Poverty severity index[1,2]

Source:

1. *Poverty Data and Information for Districts/Municipalities in Indonesia in 2022*
2. *West Kalimantan Province in Figures 2023*
3. *People's Welfare Statistics of West Kalimantan Province 2022*

2.2. *Structural Equation Modelling* (SEM)

Structural Equation Modeling (SEM) is a multivariate analysis method that offers a comprehensive approach to delineate the linear relationships between observed variables (indicators) and latent variables, which cannot be directly measured [15]. SEM encompasses regression, path analysis, and factor analysis within its general, linear, and cross-sectional framework [16]. Its versatility makes it particularly adept at modeling interconnected or correlated variables, each assessed through multiple indicators. The appeal of SEM lies in its capacity to estimate numerous relationships between variables and to elucidate the intricate patterns of association between manifest indicators and latent variables [17].

2.3. SEM-PLS Specification

The complete specification of SEM-PLS consists of three sets of relationships [15], namely:

(1) Inner model or structural model that specifies the relationship between latent variables.

$$\boldsymbol{\eta} = \boldsymbol{B\eta} + \boldsymbol{\Gamma\xi} + \boldsymbol{\zeta}$$

(2) Outer model or measurement model that specifies the relationship between indicators and latent variables. The following equation is for the part with reflective indicators:

$$\boldsymbol{x = \lambda_x \xi + \delta_x} \qquad \boldsymbol{y = \lambda_y \eta + \varepsilon_y} \qquad \boldsymbol{X_{jk} = \lambda_{jk} \xi_j + \delta_{jk}}$$

The equation for the part with formative indicators is as follows**:**

$$\boldsymbol{\xi = \pi_\xi x + \delta_\xi} \qquad \boldsymbol{\eta = \pi_\eta y + \varepsilon_\eta} \qquad \boldsymbol{\xi_i = \pi_{jk} X_{jk} + \delta_j}$$

where:

η : vector of endogenous latent variables

ξ : vector of exogenous latent variables

Β: matrix coefficients for endogenous latent variables

Γ : matrix coefficients for exogenous latent variables

ζ : latent variable measurement error

x : indicator on exogenous latent variable

y : indicator on the endogenous latent variable

λ_x, λ_y : loading matrix describing simple regression coefficients

π_ξ, π_η : multiple regression coefficients of latent variables and indicator blocks

$\delta_\xi, \varepsilon_\eta$: residuals from regression

(3) Weight relation or the relationship weight on latent variables based on specifications on the outer model and inner model. The equation for estimating exogenous and endogenous latent variables in PLS is as follows:

$\xi_j = \sum_k w_{jk} X_{jk}$, for exogeneous variable

$\eta_j = \sum_k w_{jk} Y_{jk}$, for endogenous variable

w_{jk} estimates the latent variable as a linear combination of its indicators.

2.4. SEM-PLS Specification

The SEM-PLS test was performed through the following steps.

a. Measurement Model Testing (*Outer Model*)

The measurement model or the outer model defines how each part of the indicator relates to its latent variable. The outer model evaluation is carried out by testing the validity and reliability which consists of:

1) Validity Test

In SEM-PLS, the measurement model assessed the validity of latent variables through convergent validity, while the evaluation of indicators for latent variables used discriminant validity. Convergent validity was evaluated by looking at the loading factor values, where an indicator was considered valid if the loading factor on the measured indicator had a value of $\geq$ 0.6 [18]. If an indicator had a value below 0.6, modifications were made by deleting the indicator from the model. Additionally, discriminant validity was assessed by examining the cross-loading values between the indicators and their latent variables, and by conducting the Fornell-Larker Criterion test. The Fornell-Larker Criterion test was carried out by comparing the √AVE value with other latent variables. A good measurement model was indicated if the cross-loading value or correlation between the indicator and the latent variable was higher than the correlation with other indicators of the latent variable in other blocks [18].This could be observed in the diagonal and vertical direction of each variable column. Furthermore, the validity value could also be seen from the Average Variance Extracted (AVE) value, where the model was considered good if the AVE value of each latent variable was greater than 0.50 [18].

2) Reliability Test

In SEM-PLS, the consistency of the indicators used is measured through a reliability test, which involves examining Cronbach's Alpha and Composite Reliability values. Cronbach's Alpha and Composite Reliability tests were performed to assess the validity of instruments in a research model or to measure the internal consistency of latent variables. Reliability was considered satisfactory if Cronbach's Alpha and Composite Reliability for each latent variable had a value greater than 0.70 [18]. The subsequent step involved testing Discriminant Validity through the Fornell-Larker Criterion and Cross Loading tests. The Fornell-Larker Criterion test was conducted by comparing the $\sqrt{AVE}$ value with that of other latent variables. The requirement was that the correlation value of one $\sqrt{AVE}$ with the variable construct itself had to be greater than that of the other variable constructs. This comparison was observed in both the diagonal and vertical directions of each variable column.

b. Structural Model Testing (*Inner Model*)

Structural model or inner model was developed as concept and theory-based frameworks to describe the relationships and significance of interactions between latent variables. Hypothesis testing was conducted through t-statistical comparisons utilizing bootstrap resampling. The bootstrapping procedure was employed to estimate path coefficients within the obtained structural model. It was required that the resulting t-statistics values exceed the t-table threshold (1.96), or if using p-values, they should fall below the significance level, typically set at 0.05 [18].

3. RESULTS AND DISCUSSION

3.1. Descriptive Analysis

In this research analysis, the SmartPLS application was used with the SEM-PLS method. As an initial stage of data exploration, descriptive analysis was conducted to gain general overview.

Table 1. Descriptive Statistics of Research data

Indicator	Minimum	Average	Maximum	Std. Deviation
SH1	68.82	71.94	74.00	1.50
SH2	42.69	51.43	61.47	6.13
SH3	63.06	83.19	112.79	13.64
PD1	82.68	95.82	100.00	4.24
PD2	42.68	51.98	61.61	6.40
PD3	56.40	68.95	79.38	7.19
EK1	69.46	89.30	100.00	9.77
EK2	51.97	63.44	79.94	6.99
EK3	90.08	95.38	98.67	2.81
M1	4.12	7.07	11.44	2.40
M2	0.40	1.05	2.04	0.53
M3	0.06	0.27	0.66	0.12

According to Table 1, in West Kalimantan Province, the highest percentage of poor people (M1) is found in Melawi Regency at 11.44%, while the lowest is in Kubu Raya Regency at 4.12%. Moving on to Health variable, the highest Life Expectancy Rate (SH1) indicator in West Kalimantan Province is observed in Bengkayang Regency at 74%, with the lowest at 68.82% in North Kayong Regency. Regarding the percentage of households with access to adequate drinking water sources (SH2), Pontianak City shows the highest value at 61.47%, whereas Melawi Regency displays the lowest at 42.69%. For the indicator of the percentage of women assisted by medical personnel during childbirth (SH3), Mempawah Regency records the highest value at 112.79%, whereas Melawi Regency shows the lowest at 63.06%.

In the Economic variable, Pontianak City exhibits the highest percentage of households using electricity (EK1) at 100%, while Sekadau Regency displays the lowest at 69.46%. In terms of the Percentage Proportion of Individuals Owning Mobile Phones (EK2) indicator, Pontianak City also shows the highest value at 79.94%, with Sekadau Regency recording the lowest at 51.97%. Furthermore, Sekadau Regency demonstrates the highest

Percentage of Employment of the Labor Force (EK3) indicator at 98.67%, while Pontianak City presents the lowest at 90.08%.

In education variable, Sekadau Regency records 100% literacy rate among the poor population aged 15-55 years (PD1), whereas Melawi Regency displays the lowest at 82.68%. In terms of the Pure Participation Rate (APM) for SMA/Equivalent (PD2), Pontianak City has the highest rate at 61.61%, while Sanggau Regency has the lowest at 42.68%. Lastly, Singkawang City demonstrates the highest School Participation Rate for the population aged 16-18 years (PD3) at 79.38%, with Sanggau Regency recording the lowest at 56.40%.

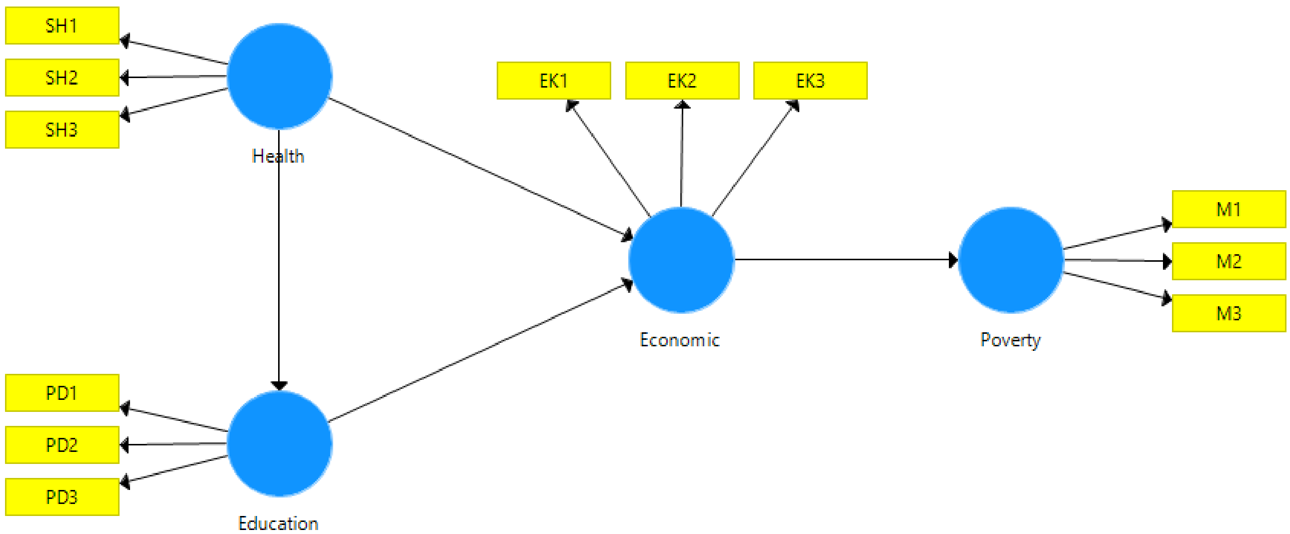

Figure 1. Conceptual Model of Poverty Structure

3.2. Research Path Diagram

The poverty structure model constructed is illustrated in Figure 1 as a path diagram, depicting the relationships between exogenous and endogenous variables. According to Figure 1, the structural model design in this research incorporates one exogenous latent variable, namely Health, and three endogenous latent variables: Education, Economy, and Poverty. These four latent variables are interconnected through paths tailored to the hypotheses under investigation in the research.

1) Outer Model Evalutaion

In Table 2, the Outer Loadings value obtained still has an indicator value below 0.6, indicating failure in fulfilling the standard. Therefore, the Convergent Validity test results cannot be accepted. Furthermore, the modification of retesting was carried out by omitting the EK3, PD1 and SH1 indicators.

Table 2. Initial Outer Loadings Value

Latent Variable	Indicator	*Outer Loadings*	Note
Economy	EK1	0.857	Valid
	EK2	0.850	Valid
	EK3	-0.942	Invalid
Education	PD1	0.496	Invalid
	PD2	0.935	Valid
	PD3	0.979	Valid
Health	SH1	0.052	Invalid
	SH2	0.924	Valid
	SH3	0.846	Valid
Poverty	M1	0.946	Valid
	M2	0.989	Valid
	M3	0.932	Valid

The new path diagram for the modified model is presented in Figure 2.

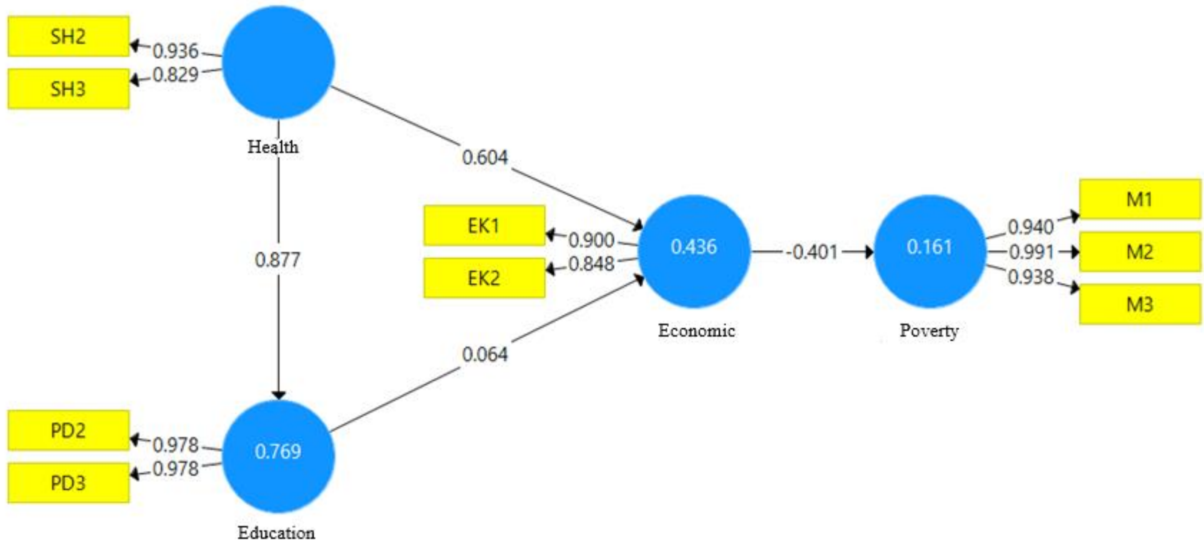

Figure 2. PLS Algorithm Results (Final Modification)

Based on Table 3, the Outer Loadings value for all indicators is above 0.6. Hence, all indicators can be declared feasible or valid for further analysis.

Table 3. Outer Loadings Value of Research Model (Modified)

Latent Variable	Indicator	*Outer Loadings*	Note
Economy	EK1	0.900	Valid
	EK2	0.848	Valid
Education	PD2	0.978	Valid
	PD3	0.978	Valid
Health	SH2	0.936	Valid
	SH3	0.829	Valid
Poverty	M1	0.940	Valid
	M2	0.991	Valid
	M3	0.938	Valid

As seen in Table 4, Cronbach's Alpha and Composite Reliability values for each latent variable surpass the standard threshold of 0.60. This indicates that the reliability of the research is at an acceptable level. Additionally, the Composite Reliability value exceeds the Cronbach's Alpha value, underscoring that all latent variables in the research meet the reliability criteria.

Table 4. *Cronbach's Alpha, Composite Reliability and AVE Values*

Latent Variable	*Cronbach's Alpha*	*rho_A*	*Composite Reliability*	*Average Variance Extracted (AVE)*
Economy	0.695	0.713	0.866	0.765
Poverty	0.955	0.987	0.970	0.915
Health	0.733	0.844	0.877	0.782
Education	0.954	0.954	0.978	0.956

Table 5 shows that the latent variable of Economy exhibits an √AVE value of 0.874, which is the highest among the correlation values of Economy with Poverty, Economy with Health, and Economy with Education. Similarly, the √AVE values for the latent variables Poverty (0.957), Health (0.884), and Education (0.978) are all the highest when compared to their respective correlations. Consequently, these findings indicate the validity of the latent variables.

Table 5. ***Fornell-Larker Criterion Value***

Latent Variable	Economy	Poverty	Health	Education
Economy (η_2)	0.874			
Poverty (η_3)	-0.401	0.957		
Health (ξ_1)	0.660	-0.549	0.884	
Education (η_1)	0.593	-0.389	0.877	0.978

Following the evaluation of measurement models to assess validity and reliability, it was determined that nine indicators within the structural model of poverty in this research are both valid and reliable. The measurement model was deemed satisfactory. The subsequent step involved testing the structural model (inner model).

2) Inner Model Evaluation

In the evaluation of the structural model or inner model, hypothesis testing was conducted to ascertain the direction and significance of the relationships between each latent variable. This process entails t-statistical comparisons using bootstrap resampling. The t-statistics value must exceed the t-table threshold of 1.98 or have a p-value below the significance level of 0.05.

Table 6. Structural Model Path Coefficient Value

Inner Model	Original Sample (O)	Standard of Deviation (STDEV)	T Statistics (|O/STDEV|)	P-Values
Economy -> Poverty	-0.401	0.251	1.599	0.111
Health -> Economy	0.604	0.406	1.489	0.137
Health -> Education	0.877	0.038	23.086	0.000
Education -> Economy	0.064	0.399	0.160	0.873

Based on Table 6, the relationships between Latent Variables are explained as follows:

- The path coefficient linking the economic latent variable and the poverty latent variable is 1.599, which falls below the threshold of 1.96 at the 5% significance level. Moreover, the p-value of 0.111 exceeds 0.05, indicating that the hypothesis is not rejected. The conclusion in this study is in line with previous studies where no significant influence from the economic dimension on poverty [14].
- The path coefficient between the health latent variable and the economic latent variable is 1.489, below the 1.96 threshold at the 5% significance level. The associated p-value of 0.137 is also above 0.05, leading to the hypothesis not being rejected. This suggests no significant influence from the health dimension on the economic dimension [19].
- The path coefficient between the health latent variable and the education latent variable is 23.086, surpassing the 1.96 threshold at the 5% significance level. Moreover, the p-value of 0.000 is below 0.05, leading to the rejection of the hypothesis. This indicates a significant influence between the health and education dimensions. Notably, the positive coefficient implies that improvements in health positively correlate with advancements in education.

The path coefficient for the relationship between the education latent variable and the economic latent variable is 0.160. which is less than 1.96 at the 5% significance level. Additionally, the p-value is 0.873, which is greater than or equal to 0.05, indicating that the hypothesis is not rejected. Therefore, there is no significant influence between the educational dimension and the economic dimension.

Figure 3 displays a path diagram illustrating the path coefficient values between latent variables in the original sample column and the R-Squared value for endogenous latent variables.

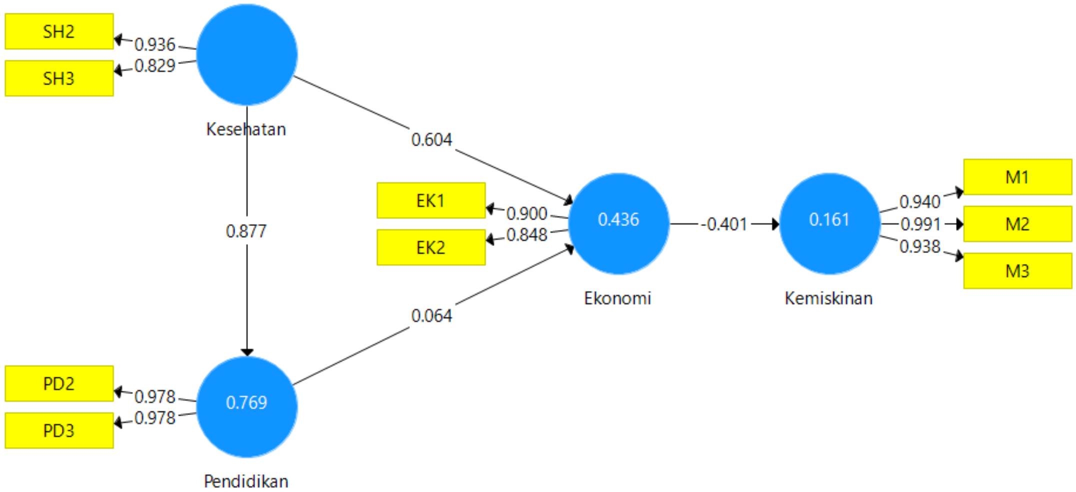

Figure 3. Bootstrapping Outcomes

Based on the results of the calculation analysis in Table 6 and Figure 3, the structural model (Inner Model) for the SEM-PLS method is obtained as follows:

$$\eta_1 = 0.877\xi_1 + \zeta_1$$
$$\eta_2 = 0.604\xi_1 + 0.064\eta_1 + \zeta_2$$
$$\eta_3 = -0.401\eta_2 + \zeta_3$$

In addition, as seen in Figure 3, the indirect relationship between Latent Variables using intervening variables can also be obtained as follows:

1) The effect of health on poverty through education and economy as intervening variables;
2) The effect of education on poverty through economy as an intervening variable;
3) The effect of health on the economy through education as an intervening variable;
4) The effect of health on poverty through economy as an intervening variable.

Table 7. Nilai Specified Indirect Effects

Inner Model	Original Sample (O)	Standard of Deviation (STDEV)	T Statistics (|O/STDEV|)	P-Values
Health -> Education -> Economy -> Poverty	-0.022	0.184	0.122	0.903
Education -> Economy -> Poverty	-0.026	0.199	0.129	0.898
Health -> Education -> Economy	0.056	0.366	0.153	0.878
Health -> Economy -> Poverty	-0.242	0.236	1.027	0.305

The explanation of Table 7 is as follows.

- The path coefficient indicating the indirect relationship between the latent variable health and the latent variable poverty is 0.122, falling below 1.96 at a significance level of 5%. Additionally, the p-value of 0.903 exceeds 0.05, leading to the non-rejection of the hypothesis. This suggests an absence of significant effect from the health dimension on poverty, with education and economy serving as intervening variables.
- The path coefficient representing the indirect relationship between the latent variable education and the latent variable poverty is 0.129, below 1.96 at a 5% significance level. Moreover, the associated p-value of 0.898 is greater than 0.05, resulting in the hypothesis not being rejected. This indicates no significant impact from the education dimension on poverty, with the economic dimension acting as an intervening variable.
- The path coefficient for the indirect relationship between the latent variable health and the latent variable economy is 0.153, falling below 1.96 at a significance level of 5%. Additionally, the p-value of 0.878 exceeds 0.05, leading to the non-rejection of the hypothesis. This implies no significant influence from the

health dimension on the economic dimension, with the economic dimension acting as an intervening variable.

- The path coefficient indicating the indirect relationship between the latent variable health and the latent variable poverty is 1.027, below 1.96 at a significance level of 5%. Additionally, the p-value of 0.305 exceeds 0.05, leading to the non-rejection of the hypothesis. This suggests no significant effect from the health dimension on poverty, with the economic dimension serving as an intervening variable.

The R-squared value for each endogenous variable is presented in Table 8.

Table 8. Nilai R-Squared

Latent Variable	R-Squared
Education (η_1)	0.769
Economy (η_2)	0.436
Poverty (η_3)	0.161

According to Table 8, the R^2 value for the poverty dimension is 0.161, indicating that only 16.1% of the variation in the poverty dimension can be explained by latent variables (economic, health, and education dimensions), while the remaining 83.9% is influenced by other factors not included in the research model. For the economic dimension, the R^2 value is 0.436, indicating that 43.6% of the variation in the economic dimension can be explained by latent variables (health and education dimensions), while the remaining 56.4% is influenced by other factors not included in the research model.

Lastly, for the education dimension, the R^2 value is 0.769, suggesting that 76.9% of the variation in the education dimension can be explained by latent variables (the health dimension), while the remaining 23.1% is influenced by other factors not included in the research model.

4. CONCLUSION

In the validity and reliability assessment of the measurement model for the poverty structure, nine indicators were identified as valid and reliable. In exploring the inner model, it was discovered that only the connection between the health and education dimensions exhibited a notable positive impact. Conversely, relationships such as the economic dimension's effect on poverty, health's influence on the economic dimension, and education's impact on the economic dimension were not statistically significant. Moreover, in examining indirect relationships, none of the latent variables emerged as significant intervening factors. In the context of the West Kalimantan region, this variable did not significantly affect poverty due to the presence of other stronger influencers. Nevertheless, it remains plausible that this research variable could hold significance within other contexts. This research only includes three dimensions to examine their impact on poverty. Hence, future researchers are encouraged to add the dimensions of standard of living quality.

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