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Path Analysis Model in Determining the Crime Rate During the Covid 19 Pandemic in North Sumatera

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Abstract. Path analysis is a research method that is mainly used to examine the strength of direct and indirect relationships among various variables. This is in line with one of the objectives of research in social science, namely to determine the existence of a causal relationship. Path analysis can be applied to a social issue, currently the world is worried about the spread of COVID-19. The existence of policies in controlling the spread of COVID-19 disrupts various aspects of life. This study was conducted to determine the factors that cause crime in North Sumatra and to determine the effect of the COVID-19 on the rise of crime rates using the path analysis method. In this study, it was concluded that although there are several exogenous variables that have decreased influence on endogenous variables in 2020, but in this year, which is the pandemic period, the coefficient of determination has the best level.

Keyword: Path Analysis, Crime, Endogenous Variable l, Exogenous Variable

Abstrak. *Analisis jalur merupakan suatu metode penelitian yang utamanya digunakan untuk menguji kekuatan dari hubungan langsung dan tidak langsung diantara berbagai variabel. Hal tersebut sejalan dengan salah satu tujuan penelitian di bidang pengetahuan sosial yaitu untuk mengetahui adanya hubungan kausal. Analisis jalur dapat diterapkan dalam suatu permasalahan sosial, saat ini dunia sedang di khawatirkan oleh penyebaran COVID-19. Adanya kebijakan dalam penganggulangan penyebaran COVID-19 membuat terganggunya berbagai aspek kehidupan. Penelitian ini dilakukan untuk mengetahui faktor-faktor penyebab kriminalitas di Sumatera Utara serta mengetahui adanya pengaruh pandemi COVID-19 terhadap meningkatnya angka kriminalitas menggunakan metode analisis jalur. Pada penelitian ini diperoleh kesimpulan bahwa walaupun terdapat beberapa variabel eksogen yang mengalami penurunan pengaruh terhadap variabel endogen pada tahun 2020, tetapi pada tahun 2020 yang merupakan masa pandemi memiliki tingkat koefisien determinasi yang paling baik.*

Kata Kunci: *Analisis Jalur, Kriminalitas, Variabel Eksogen, Variabel Endogen*

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1. Introduction

Several statistical techniques have been developed to assist social scientists in dealing with studies involving the analysis of hypothetical relationships between variables, one of which is path analysis. Path analysis was introduced by Sewal Wright in 1921[1]. Sewall Wright is a geneticist who developed path analysis to make hypothetical studies of causal relationships using correlation.

Path analysis is an analytical technique used to analyze causal relationships between variables arranged in temporary order by using path coefficients as the value in determining the magnitude of the effect of exogenous variables on endogenous variables [2]. The model is depicted in the form of circles and arrows where a single arrow indicates the cause.

It can be concluded that path analysis is a research method primarily used to examine the strength of direct and indirect relationships between various variables. Path analysis is also used to draw and test a mathematical model using the underlying equation. This is in line with one of the objectives of research in the field of social knowledge, namely to determine the existence of a causal relationship.

Path analysis can be applied to one of the current social problems. In a research of path analysis on criminality incidents in Indonesia in 2018 that path analysis can detect the magnitude of the factors, either directly or indirectly, on the crime rate [3]. The existence of a virus outbreak that has hit various parts of the world since December 2019 including Indonesia, has disrupted various aspects of life, one of which is crime. Regarding crime prevention during the COVID-19 pandemic, he stated that the cause of the increase in crime was due to the difficult economy during the pandemic [4].

By using path analysis which is a statistical analysis that can be used to analyze causal relationships and direct or indirect effects of several variables as well as an increase in crime during the COVID-19 pandemic, this study was conducted.

2. Literature Review

2.1 Path Analysis

Path analysis is an analytical technique used to analyze causal relationships between variables arranged in a temporary order by using path coefficients as a value in determining the magnitude of the effect of exogenous variables on endogenous variables [2]. The model is depicted in the form of circles and arrows where a single arrow indicates the cause. The terms used in path analysis are as follows:

a. Path model is a path model is a diagram that connects exogenous, intermediate, and endogenous variables. The pattern of the relationship is shown by using arrows.

b. Exogenous variables in a path model are all variables for which there are no explicit causes or in the diagram there are no arrows leading to them.

c. Endogenous variables are variables that have arrows pointing towards them.

d. Intervening variables are variables that have arrows pointing towards them and from these direction variables in a path diagram model.

e. The path coefficient is a coefficient that shows the direct effect of an exogenous variable on endogenous variables in a path model. The steps for calculating the path coefficient can be done as follows:

- Draw a Path Diagram
- Calculate the correlation matrix between variables

$$r_{YX_i} = \frac{n(\sum X_i Y) - (\sum X_i) \times (\sum Y)}{\sqrt{\left\{n \times \sum X_i{}^2 - \left(\sum X_i\right)^2\right\} \times \{n \times \sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

$$R = \begin{bmatrix} 1 & r_{12} & \dots & r_{1i} \\ r_{21} & 1 & \dots & r_{2i} \\ \dots & \dots & 1 & \dots \\ r_{i1} & r_{i2} & \dots & 1 \end{bmatrix} \quad (2)$$

- Calculating the inverse of the correlation matrix between the exogenous variables

$$R^{-1} = \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1i} \\ C_{21} & C_{22} & \dots & C_{2i} \\ \dots & \dots & \dots & \dots \\ C_{i1} & C_{i2} & \dots & C_{ii} \end{bmatrix} \quad (3)$$

- Calculate all path coefficients ($\rho_{x_i y}$) where i = 1,2,3,…,n using the following formula:

$$\begin{bmatrix} \rho_{x_1 y} \\ \rho_{x_2 y} \\ \dots \\ \rho_{x_i y} \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1i} \\ C_{21} & C_{22} & \dots & C_{2i} \\ \dots & \dots & \dots & \dots \\ Ci_1 & C_{i2} & \dots & C_{ii} \end{bmatrix} \begin{bmatrix} r_{x_1 y} \\ r_{x_2 y} \\ \dots \\ r_{x_i y} \end{bmatrix} \quad (4)$$

f. Direct Effect (DE) is the magnitude of the direct effect of exogenous variables on endogenous variables.

$$DE = (\rho_{YX_i}) \quad (5)$$

g. Indirect Effect (IE) is the magnitude of the indirect effect of exogenous variables through variables that intervene in endogenous variabels.

$$IE = (\rho_{YX_i})(\rho_{X_u X_i}) \quad (6)$$

h. Coefficient of determination, namely the total magnitude of the overall effect of exogenous variables on endogenous variables.

$$R^2_{y(X_1,X_2,\ldots,X_i)} = (\rho_{YX_1} \quad \rho_{YX_2} \quad \cdots \quad \rho_{YX_i}) \begin{bmatrix} r_{YX_i} \\ r_{YX_2} \\ \cdots \\ r_{YX_3} \end{bmatrix} \tag{7}$$

i. The path diagram is used to describe the relationship between variables. Some describe path diagrams as follows:

- The relationship between variables is represented by single-headed (→) and double-headed (↔) arrows.
- The one-headed arrow shows the effect of an exogenous variable (causal variable) on an endogenous variable (effect variable), eg : $(X_1 \rightarrow X_2)$
- The double-headed arrow represents the correlative relationship between exogenous variables, eg: $X_1 \leftrightarrow X_2$
- Other variables that cannot be described (cannot be measured) are shown by a certain variable called residual (error).

2.2 Crime

The existence of irregularities in people's lives will cause problems that can disturb the community, these deviations can be called crime or crime. In this study, the indicator used is the number of crimes (total crime), namely the number of crimes recorded in the Police in one year or commonly referred to in police data as the number of reports.

2.3 The Factors Causing Crimes During Pandemic

The World Health Organization (WHO) declared COVID-19 as a global pandemic on March 11, 2020.Pandemic is an epidemic that spreads simultaneously everywhere covering a wide geographic area [5]. Of course the spread of a disease has a negative impact on many aspects of life. The existence of policies to prevent the spread of the virus not only has an impact on the health sector, but also on economic, educational, and social aspects that cause social vulnerabilities such as crime.

In many cases, crimes occur due to several factors. These factors include internal factors which include urgent economic needs, employment factors (unemployment or having a job), and

welfare factors. External factors include educational factors, and social factors or environmental influences [6].

Movement is a condition in which a person included in the labor force wants to get a job but has not yet got it [7]. Unemployment is often a problem in the economy because of social problems, productivity and society will be reduced so that it can cause social problems.

Every day the population is increasing. An uncontrolled increase in population will lead to overcrowding. One of the causes of crime which is influenced by social factors is population density [8]. Poverty is a person's inability to meet the basic needs of life. In a research on the effect of poverty on crime, obtained the results that poverty has a positive and significant effect on crime. This means that the higher the level of poverty, the crime will increase and vice versa [9] gross domestic product is the average domestic product of a country or region in one year. gross domestic product is calculated based on domestic product divided by the total population. gross domestic product is often used as a measure of the prosperity and level of development of a country or region.

3. Result and Analysis

3.1 Define and Draw a Path Diagram

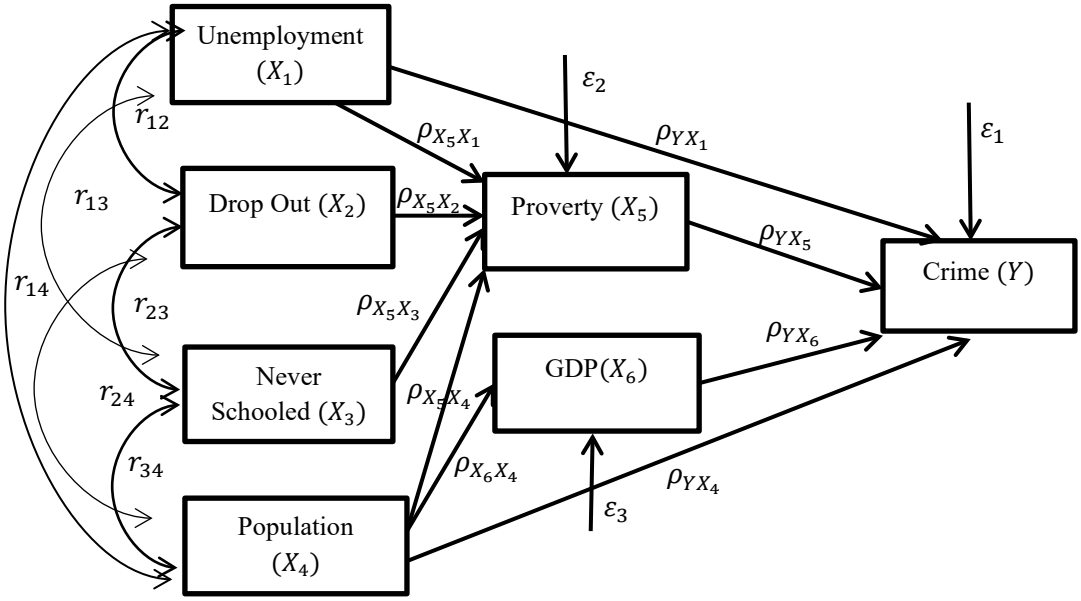

Figure 1. Path Diagram

Structural equations :

$$Y = \rho_{YX_1}X_1 + \rho_{YX_4}X_4 + \rho_{YX_5}X_5 + \rho_{YX_1}X_6 + \varepsilon_1$$

$$X_5 = \rho_{X_5X_1}X_1 + \rho_{X_5X_2}X_2 + \rho_{X_5X_3}X_3 + \rho_{X_5X_4}X_4 + \varepsilon_2$$

$$X_6 = \rho_{X_6X_4}X_4 + \varepsilon_3$$

3.2 Path Analysis in 2016

a. Calculating path coeficient

The correlation matrix is obtained as follows :

$$R = \begin{array}{c} \\ Y \\ X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \\ x_6 \end{array} \begin{array}{c} \begin{array}{ccccccc} Y & X_1 & X_2 & X_3 & X_4 & X_5 & X_6 \end{array} \\ \begin{bmatrix} 1 & 0.350 & 0.260 & -0.098 & 0.781 & -0.202 & 0.586 \\ 0.350 & 1 & 0.489 & -0.330 & 0.251 & -0.222 & 0.614 \\ 0.260 & 0.489 & 1 & -0.697 & 0.375 & -0.573 & 0.522 \\ -0.098 & -0.330 & -0.697 & 1 & -0.114 & 0.395 & -0.328 \\ 0.781 & 0.251 & 0.375 & -0.114 & 1 & -0.358 & 0.462 \\ -0.202 & -0.222 & -0.573 & 0.395 & -0.358 & 1 & -0.387 \\ 0.586 & 0.614 & -0.522 & -0.328 & 0.462 & -0.387 & 1 \end{bmatrix} \end{array}$$

b. The relationship between crime and movement, population, poverty, and gross domestic product.

$$\begin{bmatrix} \rho_{YX_1} \\ \rho_{YX_4} \\ \rho_{YX_5} \\ \rho_{YX_6} \end{bmatrix} = [R^{-1}] \begin{bmatrix} r_{YX_1} \\ r_{YX_4} \\ r_{YX_5} \\ r_{YX_6} \end{bmatrix} = \begin{bmatrix} 0.018 \\ 0.690 \\ 0.174 \\ 0.323 \end{bmatrix}$$

Coeficient determination :

$$R^2_{Y(X_1,X_4,X_5,X_6)} = [\rho_{YX_1} \quad \rho_{YX_4} \quad \rho_{YX_5} \quad \rho_{YX_6}] \begin{bmatrix} r_{YX_1} \\ r_{YX_4} \\ r_{YX_5} \\ r_{YX_6} \end{bmatrix} = 0.699$$

In testing the hypothesis with the test criteria $F_{hitung} \geq F_{tabel}$ then $H_0$is rejected, the result is F_{count} = 16,283 more than F_{table} = 2.71. That is, at the 5% significance level, there is an overall influence between population, poverty, and gross domestic product on crime.

Based on the results of the individual coefficient tests, the results of $t_{unemployment} = 0.136$, $t_{population} = 5.745$, $t_{proverty} = 1.510$, dan $t_{GDP} = 2.194,4,$. When compared with the value of t_table with a significance of $a = 0.05$ and df = 28 the value of $t_{tabel} = 2.048$ is obtained. So that has a significant influence on crime is the population and gross domestic prodruct.

c. the relationship between mission and movement, dropouts, never schooled, and population.

$$\begin{bmatrix} \rho_{X_5X_1} \\ \rho_{X_5X_2} \\ \rho_{X_5X_3} \\ \rho_{X_5X_4} \end{bmatrix} = [R^{-1}] \begin{bmatrix} r_{X_5X_1} \\ r_{X_5X_2} \\ r_{X_5X_3} \\ r_{X_5X_4} \end{bmatrix} = \begin{bmatrix} 0.092 \\ -0.521 \\ 0.042 \\ -0.181 \end{bmatrix}$$

Coeficient determination :

$$R^2_{Y(X_1,X_2,X_3,X_4)} = [\rho_{X_5X_1} \quad \rho_{X_5X_2} \quad \rho_{X_5X_3} \quad \rho_{X_5X_4}] \begin{bmatrix} r_{X_5X_1} \\ r_{X_5X_2} \\ r_{X_5X_3} \\ r_{X_5X_4} \end{bmatrix} = 0.360$$

In testing the hypothesis with the test criteria $F_{count} \geq F_{table}$, then H_0 is rejected, the result is F_{hitung} = 3.933 more than F_{table} = 2.71. That is, at the 5% significance level, there is an overall influence between the impact, dropping out of school, never schooled, and the population on crime.

Based on the individual coefficient test, the results obtained are $t_{unemployment} = 0.528$, $t_{dropout} = -2.127$, $t_{never\ schooled} = 0.194$, dan $t_{population} = 2.194,$. When compared with the value of t_{table} with a significance of $a = 0.05$ and df = 28 the value of $t_{table} = 2.048$is obtained. So that has a significant influence on poverty is the number of dropouts.

d. Relationship between population and gross domestic product

For path coefficient calculations because there is only one exogenous variable, namely Population (X_4) and one endogenous variable, gross domestic product (X_6), then the path coefficient is the same as the correlation coefficient between the two, namely = 0.462.

In testing the hypothesis with the test criteria $F_{count} \geq F_{table}$, then H_0 is rejected, the result is F_{count} = 8.428 more than F_{table}= 4.16. That is, at the 5% significance level there is an influence between the population on gross domestic product.

e. Direct Effect and indirect effect

Table 1 Direct Effect In 2016

No	Direct Effect	β
1	$X_1 \rightarrow Y$	0.018
2	$X_4 \rightarrow Y$	0.690
3	$X_5 \rightarrow Y$	0.174
4	$X_6 \rightarrow Y$	0.323
5	$X_1 \rightarrow X_5$	0.092
6	$X_2 \rightarrow X_5$	-0.521
7	$X_3 \rightarrow X_5$	0.042
8	$X_4 \rightarrow X_5$	-0.181
9	$X_4 \rightarrow X_6$	0.214

Table 2 Indirec Effect In 2016

No	Indirect Effect	β
1	$X_1 \rightarrow X_5 \rightarrow Y$	0.016
2	$X_2 \rightarrow X_5 \rightarrow Y$	-0.089
3	$X_3 \rightarrow X_5 \rightarrow Y$	0.007
4	$X_4 \rightarrow X_5 \rightarrow Y$	-0.031
5	$X_4 \rightarrow X_6 \rightarrow Y$	0.069

Path Diagram

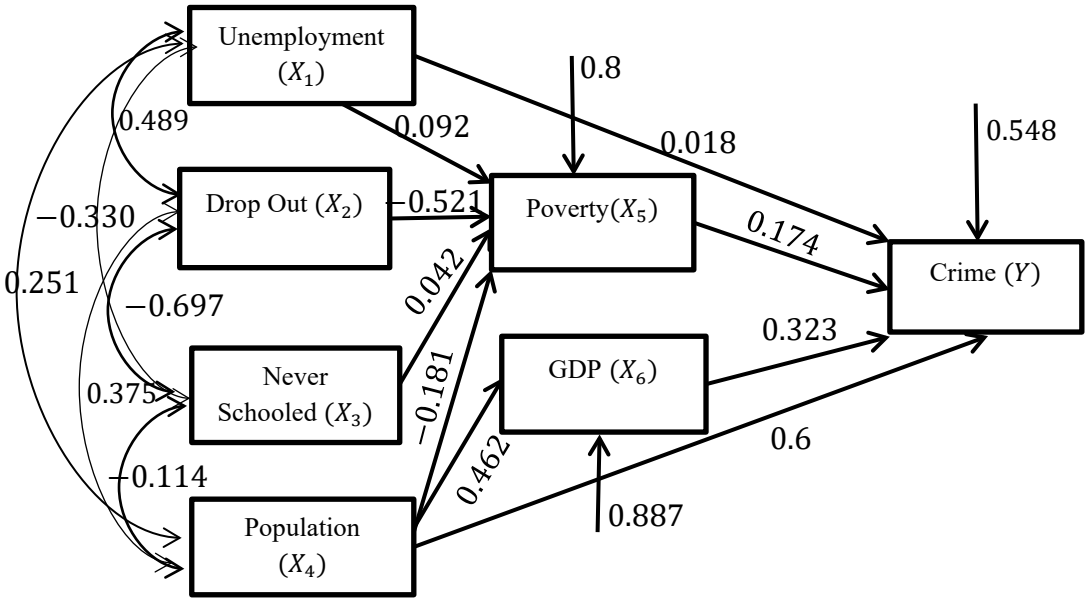

Figure 2. Path Diagram in 2016

Structural equation :

$$Y = 0.018X_1 + 0.690X_4 + 0.174X_5 + 0.323\,X_6 + 0.548$$

$$X_5 = 0.092\,X_1 - 0.521\,X_2 + 0.042X_3 - 0.181X_4 + 0.8$$

$$X_6 = 0.214X_4 + 0.887$$

3.3 Path Analysis In 2017

Path Diagram :

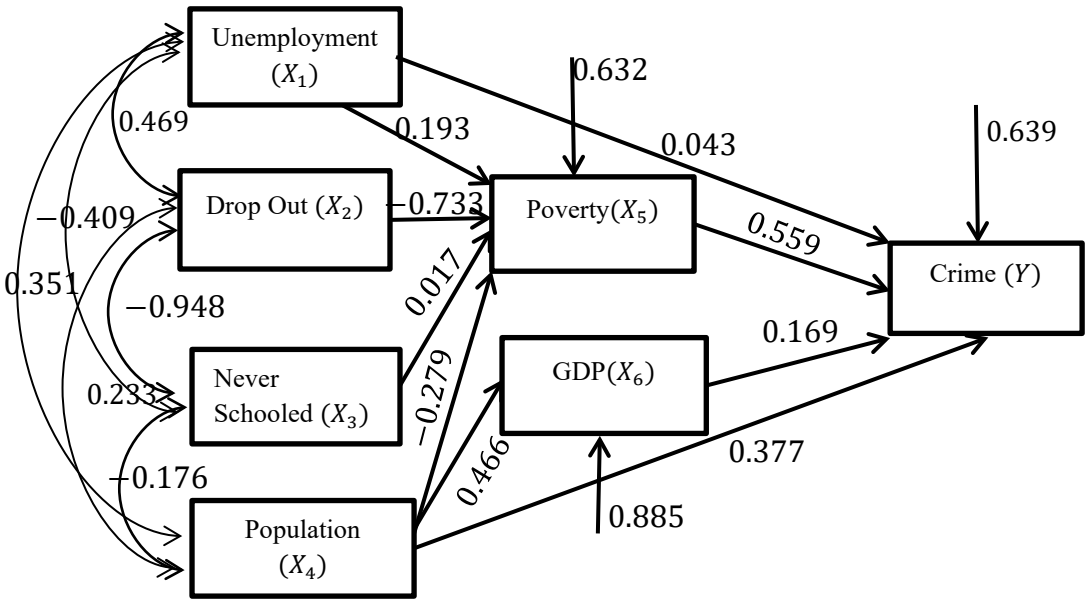

Figure 3. Path Diagram In 2017

Structural Equation :

$$Y = 0.043X_1 + 0.559X_4 + 0.169X_5 + 0.377X_6 + 0.639$$

$$X_5 = 0.193\,X_1 - 0.733\,X_2 + 0.017X_3 - 0.279X_4 + 0.632$$

$$X_6 = 0.466X_4 + 0.885$$

3.4 Path Analysisi In 2018

Path diagram :

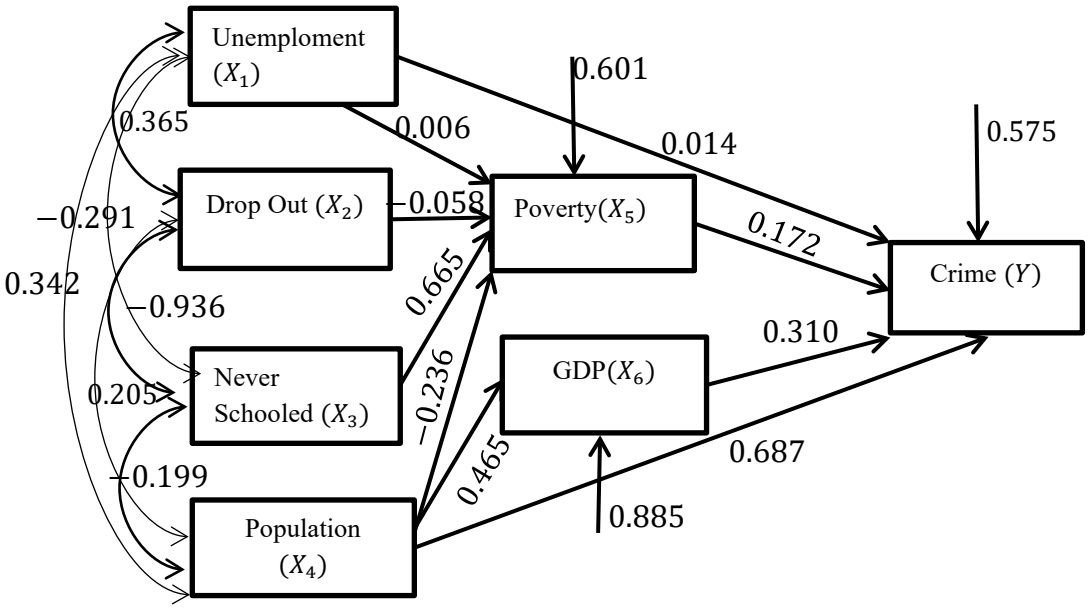

Figure 4. Path Diagram In 2018

Structural equation :

$Y = 0.014X_1 + 0.687X_4 + 0.172X_5 + 0.310X_6 + 0.575$

$X_5 = 0.006\,X_1 - 0.058\,X_2 + 0.665X_3 - 0.236X_4 + 0.601$

$X_6 = 0.465X_4 + 0.885$

3.5 Path Analysis In 2019

Path diagram :

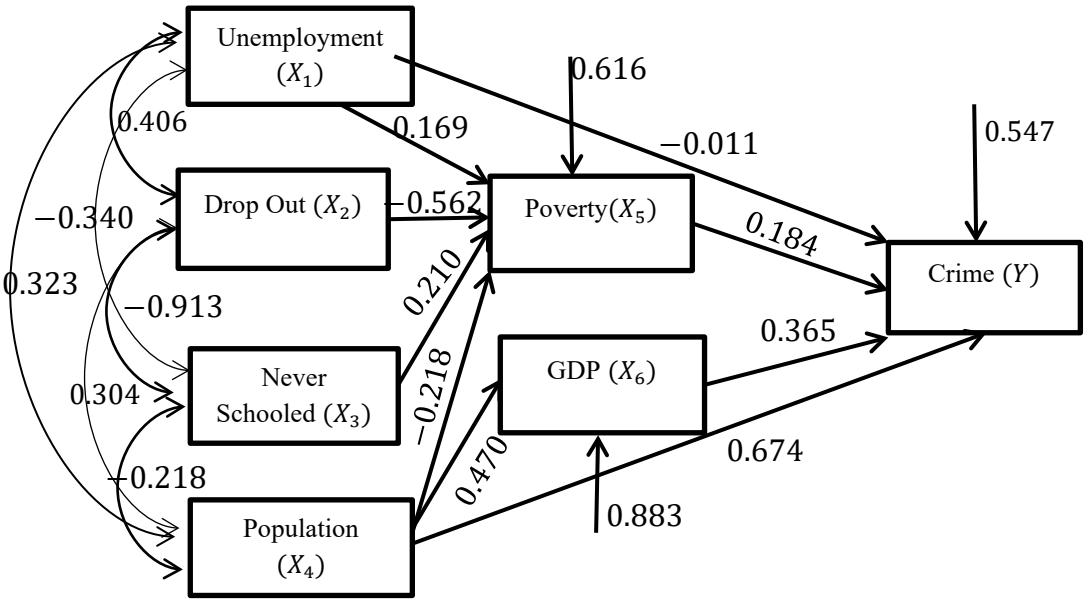

Figure 5. Path Diagram In 2019

Structural Equation :

$Y = -0.011X_1 + 0.674X_4 + 0.184X_5 + 0.365X_6 + 0.547$

$X_5 = 0.169\,X_1 - 0.562\,X_2 + 0.210X_3 - 0.218X_4 + 0.616$

$X_6 = 0.470X_4 + 0.883$

3.6 Path Analysis In 2020

Path Diagram :

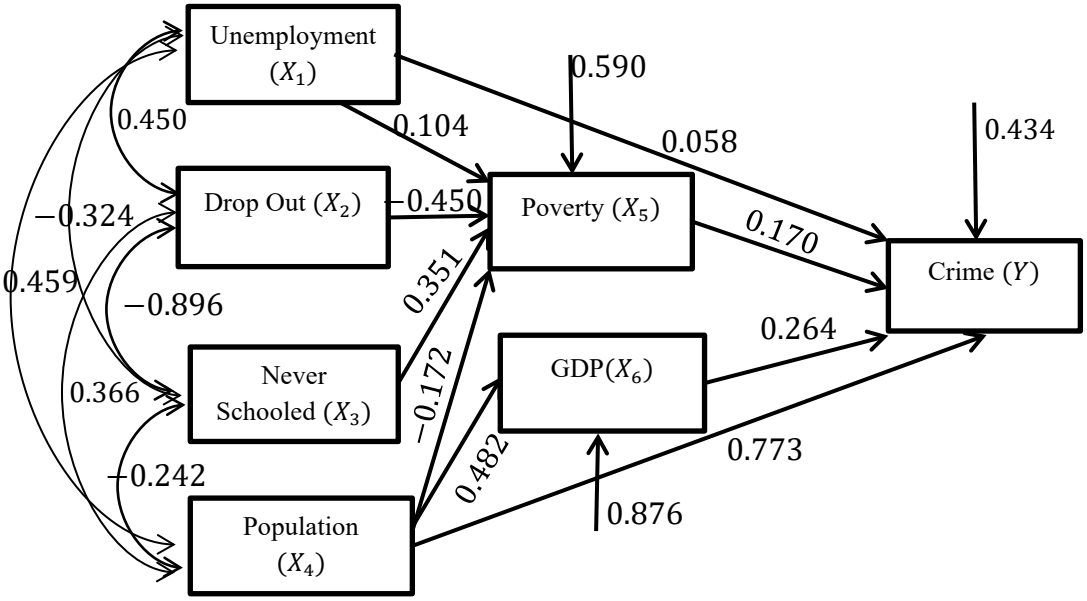

Figure 6. Path Diagram In 2020

Structural equation :

$$Y = 0.058X_1 + 0.773X_4 + 0.170X_5 + 0.263X_6 + 0.434$$

$$X_5 = 0.104\,X_1 - 0.450\,X_2 + 0.351X_3 - 0.172X_4 + 0.590$$

$$X_6 = 0.482X_4 + 0.876$$

3.7 Comparing the analysis result before pandemic with the time of pandemic

a. Comparing the path coefficient result

The path coefficient is a regression coefficient in standard form or also called 'β' which shows the effect of an exogenous variable on an endogenous variable in a particular path model. Beta can also be interpreted as the value of the direct effect between exogenous variables on endogenous variables. The result can be obtained :

Table 3 Direct Effect From 2016-2020

No	β	2016	2017	2018	2019	2020
1	$X_1 \rightarrow Y$	0.018	0.043	0.014	-0.011	0.058
2	$X_4 \rightarrow Y$	0.690	0.377	0.687	0.674	0.773
3	$X_5 \rightarrow Y$	0.174	0.559	0.172	0.184	0.170
4	$X_6 \rightarrow Y$	0.323	0.169	0.310	0.365	0.264
5	$X_1 \rightarrow X_5$	0.092	0.193	0.006	0.169	0.104
6	$X_2 \rightarrow X_5$	-0.521	-0.733	-0.058	-0.562	-0.450
7	$X_3 \rightarrow X_5$	0.042	0.017	0.665	0.210	0.351
8	$X_4 \rightarrow X_5$	-0.181	-0.279	-0.236	-0.218	-0.172
9	$X_4 \rightarrow X_6$	0.214	0.466	0.465	0.470	0.482

Table 4 Inderect Effect From 2016-2020

No	β	2016	2017	2018	2019	2020
1	$X_1 \rightarrow X_5 \rightarrow Y$	0.016	0.107	0.001	0.031	0.018
2	$X_2 \rightarrow X_5 \rightarrow Y$	-0.089	-0.410	-0.010	-0.103	-0.077
3	$X_3 \rightarrow X_5 \rightarrow Y$	0.007	0.009	0.114	0.038	0.060
4	$X_4 \rightarrow X_5 \rightarrow Y$	-0.031	-0.126	-0.041	-0.040	-0.029
5	$X_4 \rightarrow X_6 \rightarrow Y$	0.069	0.078	0.144	0.172	0.119

b. Comparing the results of the coefficient of determination

coefficient of determination (R^2) is used to predict and determine how much influence the exogenous variables X_1, X_2, X_3, X_4, X_5, dan X_6 together on the endogenous variable Y. The coefficient of determination test $(R^2)$is used to measure how far the model's ability to explain the variation of exogenous variables to endogenous variables [10]. The value of the coefficient of determination is in the interval of zero and one. The results of the coefficient of determination will increase well if it is close to 1. The results of the coefficient of determination from 2016 to 2020 can be obtained in the following table:

Table 5 Coefficient of Determination 2016-2020

Tahun	${R_Y}^2(X_1, X_4, X_5, X_6)$	${R_{X_5}}^2(X_1, X_2, X_3, X_4)$	${R_{X_5X_6}}^2$
2016	0.699	0.360	0.214
2017	0.591	0.600	0.217
2018	0.669	0.639	0.216
2019	0.701	0.620	0.221
2020	0.811	0.652	0.232

4. Conclusions

The Conclusion Based on the structural equations obtained, there are several exogenous variables that have increased influence during the COVID-19 pandemic, including:

1. The direct influence between jobless on crime
2. The direct influence of population on crime
3. The direct influence of population on gross domestic product

Based on the results of the coefficient of determination obtained in 2020, which is the COVID-19 pandemic, which is the year with the coefficient of determination closest to 1, it can be said that the path analysis model in 2020 is the best because the higher the coefficient of determination, the higher the variable's ability exogenous in explaining changes in exogenous variables

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