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Modeling The Proportion of Measles Cases in North Sumatra by The Jack-Knife Partial Least Squares Method

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ABSTRACT

Measles is still a health problem in various parts of the world, especially in developing countries, one of which is Indonesia. In 2022, North Sumatra will be one of the provinces included in the list of regions with extraordinary event status (KLB). According to data obtained from the North Sumatra Provincial Health Service, there will be 127 measles cases in 2022 spread across 33 districts/cities in North Sumatra. PLSR can handle multicollinearity problems which can produce point estimates. To measure the accuracy estimates in PLSR, analytical techniques or empirical techniques such as Jackknife are needed, which is a technique for estimating the standard error of an estimator through a resampling process. So combining Jackknife interval estimation and PLSR becomes an appropriate method for handling data that has multiconference. Based on the presentation of the results and discussion above, it resulted in modeling the proportion of measles cases in North Sumatra in 2022 using the Jack-Knife Partial Least Squares method. Jack-Knife Partial Least Squares is intended to form a more robust and simple model, so that it can provide predictions efficiently while involving minimal explanations. The Jack-Knife Partial Least Squares model succeeded in showing the highest value of each variable, variable y is y_2 = 0,9744, variable x_1 is x_13 = 0,9472, variable x_2 is x_21 = 0,9933, variable x_3 is x_31 = 0,9962, variable x_4 is x_41 = 0,9957, variable x_5 is x_53 = 0,8912.

Keyword : modeling; proportion; measles; Jack-Knife Partial Least Square

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1. INTRODUCTION

Measles is a systemic infectious disease (Hulu, et al., 2020) caused by the measles virus (genus Morbillivirus, family Paramyxoviridae). The measle virus paramyxivirus of the genus Mor Billivirus is 120 to 250 nm in diameter, with a single-stranded negative RNA genome, and is closely related to rinderpest and canine distemper viruses (Ismartini & Sunaryo, 2010)

The measles disease, also known as morbili or measles, is a highly infectious disease (Sitohang, 2020). Early symptoms The disease is characterized by fever, cough, colds and conjunctivitis followed by redness on the skin (rash) (Hulu, 2020). The spread of the measles virus can occur through direct contact with infected secretions, contact with contaminated objects, and inhalation of droplets in the air containing the virus. The measles virus is one of the most easily transmitted microorganisms between individuals. It's very difficult to break the chain of measles transmission, as the disease is contagious to other people 4 days before the rash starts up to 4 days after it starts. The incubation period of measles occurs 7 to 18 days from the onset of the virus into the body until it causes clinical symptoms. Although measles is highly contagious and can lead to death, it can be prevented through immunization programmes. (Hulu, et al., 2020) Immunization is one of the most effective health programmes in health development, especially to prevent pain, disability, and death from immunizable diseases (PD3I) (Kemenkes, 2018).

Since 1982, Indonesia has been implementing routine measles immunization for children aged nine months. In the course of the three basic periods of the measles routine immunization program running, the coverage achieved nationally has been high enough but not even throughout the region leaving the area of potential emergency (KLB) (Kemenkes, 2023).

North Sumatra in 2022 is one of the provinces on the list of territories with a state of emergency. (KLB). According to data obtained from the Health Ministry of the Province of North Sumatra in 2022 as many as 127 cases of measles spread in 33 districts/cities in north Sumatra of them: the city of Medan has measles cases of 66 cases, Deli serdang 14 cases, Langkat, Serdang Berdagai, Sibolga respectively 6 cases, Batu Bara 8 cases, Tapanuli South and Binjai respectively 3 cases, Nias, Tabanuli South, Labuhanbatu, Samosir, North Lawas Padang. Padang Lawas, and Gunungsitoli respectively 1 case, as well as Simal Sungun 2 cases (Agustiawan, 2020). Based on the data, reference is required as early prevention of measles virus that can be avoided by the public and the government. Therefore, a significant study of the factors of measles cases in North Sumatra is needed (Sugiyono, 2018).

Statistical analysis is an analysis of samples that will then be generalized to describe a population characteristic (Tiro & Aidn, 2019). One of the regression analysis is that it can be used to identify the factors that influence the proportion of cases of measles. The smallest square method (MKT) is one of the methods used to calculate the regression coefficient (Nurdin *et al.*, 2018). MKT cannot be applied to data that has multicolinearity. Partial Least Squares Regression (PLSR) is one of the methods that can solve the problem of multicolinearity that can produce point estimates to measure accuracy estimates on PLSR requires analytical techniques or empirical techniques such as Jackknife which is a technique to estimate the standard error of an estimator through a resampling process (Rodliyah, 2016). So the combination of Jackknife interval estimates and PLSR becomes a suitable method for dealing with a picking data multicolinearity (Tyas, 2019).

Research using the Jack-Knife Partial Least Squares method was conducted by (Ismartini & Sunaryo, 2010). The results of this study showed the application of the PLSR and Jackknife processes to the analysis of poverty data in NAD showed that all the regression coefficients produced by PLSR are significantly positive to measure the number of poor population in the area and the research related to the measurement factor has been carried out (Hulu, 2020) with the title "Factors Affecting KLB Childhood Primary School Childhood measure" The research produced the factors affecting the incidence of KLB childhood primary school age measurements are the history of contact with measles and population density, the study used a mix study methods namely case control with a sample of 81 people and using multivariate analysis with Logistic regression test obtained the value then H0 rejected, the analysis demonstrated that the historical contact with cases of measles of primary-school age children and the odds ratio of the results is so great that the students in primary schools who have a history of contacts with patients with measures have a chance of occurrence of a logistical regression trial (Sari, 2020).

2. RESEARCH METHOD

2.1 Research Phases

This research uses quantitative research, i.e. research methods based on the philosophy of positivism, which is used to research on a particular population or sample, data collection using research instruments, data analysis of quantitational/statistical nature, with the aim of testing the hypotheses that have been establishe (Sugiyono, 2019). The type of data that will be used in this research is secondary data. Secondary data is data obtained by an organization or company from a party in a form that is already in place (Hidayati *et al.*, 2019). The data collection technique was carried out through documentation studies using official documents of the North Sumatra Health Service and obtained from the North Sumatera BPS. The variables studied in this study are the assumptions of the factors that influence the proportion of cases of measles in North Sumatra.

Table 1. Latent Variables and Indicators of Latent variable compilation Research

No.	Variabel Laten	Indikator
1	A case of scabies(y_1)	Proportion of measles cases(Y_1) Percentage of measles immunization coverage(Y_2) Orevalensi Balita Stanting(Y_3)
2	Health(x_1)	Vitamin A supplementation from 6 to 11 months old(X_{11})

		Vitamin A donation from 12 to 59 months old(X_{12})
		Percentage of households having access to adequate drinking water(X_{13})
		Percentage of Poor Population(X_{21})
3	Chemistry(x_2)	Open Deployment level(X_{22})
		Population Density(X_{23})
		Regional Gross Domestic Product(X_{31})
4	Economy(x_3)	Growth RateRGDP(X_{32})
		Labour Force Participation Level(X_{33})
		Number of Doctors(X_{41})
5	SDM Health(x_4)	Ali Gizi's number(X_{42})
		Amount of Public Health Energy(X_{43})
		Number of General Hospitals(X_{51})
6	Health Service Facilities(x_5)	Number of Puskesmas(X_{52})
		Jumlah Posyandu(X_{53})

The steps taken in resolving this problem are :
Data Scale data so that each variable has a similar range of values

1. Data Preparation
   - Data collection: Collect the data needed for analysis
   - *Preprocessing* Data:
   - Normalization: Scale data so that each variable has a similar range of values.
   - Handling Missing Value: Enter missing values or delete incomplete data.
2. *Jack-Knife PLS* PLS inititaion
   - Determine the number of observations in the data set (N).
   - Iteration preparation:
   - Make initial settings for the N-iteration
   - Separate the N observation for validation on the Jack-Knife iteration.
3. Jack-Knife iteration
   - For each N-iteration:
   - Separate the N-observation from the dataset for validation.
   - Train Partial Least Squares model on modified datasets (without N observation).
   - Do predictions on separated N observations.
   - Save the prediction and evaluation of model performance on this iteration.
4. Model Evaluation
   - Calculate evaluation metrics:
   - R-squared, Mean Squared Error, or other metric for any iteration.
   - Compare predictions with actual values on separated observations.
   - Aggregate the evaluation results of each iteration.
5. Interpretation of Results
   - Analysis of overall model performance:
   - Identifikasi observasi yang berpengaruh besar pada performa model.
   - Evaluation of model performance consistency with and without specific observations.
6. Summary

   Take conclusions about the stability and validity of the model. Research Procedures

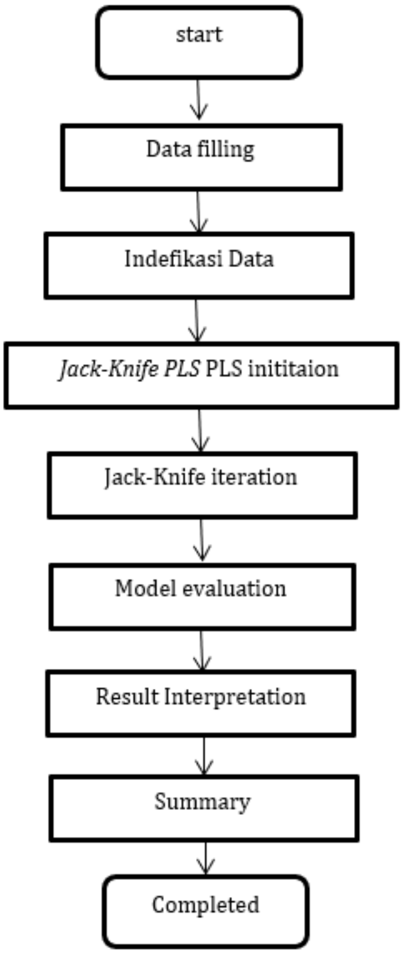

Figure 2. Research Procedures

3. FACTS AND INTERPRETATIONS

Data analysis was carried out on the proportion of cases of measles in North Sumatra in 2022. The data set consists of 1 dependent variable and 7 independent variables with 33 observations. The data structure used includes data on the proportion of measles related to health data, economic data, data on human resources and data related to the environment. This research uses SEM analysis with PLS approach using R software.

3.1 Measurement Model Evaluation (Outer Model)

External models with indicators of formative properties can be evaluated using resampling methods. Metode Resampling jackknife

Table 2. Jackknife weight resampling values

Parameter	Weight	SE	Thit	Pvalue
Y1	-0,3624	0,0060	-59,9492	0,0000
Y2	1,2147	0,0046	264,8099	0,0000
Y3	0,1963	0,0036	55,1978	0,0000

X11	-0,2481	0,0030	-83,6167	0,0000
X12	0,1774	0,0037	47,9422	0,0000
X13	0,7673	0,0025	309,1149	0,0000
X21	1,0772	0,0017	629,1179	0,0000
X22	-0,0720	0,0018	-39,8066	0,0000
X23	0,0707	0,0022	31,4800	0,0000
X31	0,9860	0,0037	264,6271	0,0000
X32	0,0768	0,0031	25,0114	0,0000
X33	-0,0766	0,0023	-32,9412	0,0000
X41	0,9646	0,0036	267,1127	0,0000
X42	-0,0730	0,0031	-23,9049	0,0000
X43	0,0848	0,0057	14,9957	0,0000
X51	0,4694	0,0068	68,9908	0,0000
X52	-0,1020	0,0042	-24,4247	0,0000
X53	-0,4998	0,0176	-28,4305	0,0000

Based on Table 2. As can be seen, the overall indicator has a P value ≤ 0.01; this means that the indicator contributes to measuring the latent variable at a real rate of 1%. There are 3 indicators that make up each variable.

3.2 Structural Model Evaluation(Inner Model)

The percentage of variants described, or R^2 for each endogenous variable, can be used to evaluate the internal model. Furthermore, the Q^2 value can be utilized to view the internal evaluation of the model. The R^2, and Q^2, values are derived from the equation (fill) on the sub(fill) and are shown in the table below.

Table 3. R2 and Q2 values on Jackknife resampling

Variable	R^2	Q^2
Health	0,6507	
Chemistry Economy	0,7832	0,9998
SDM Health	0,8315	

Health Service Facilities	0,9622
A case of scabies	0,6180

Based on Table 3. As can be shown, R2 values for health variables, FPK, Covid cases, and Poverty, Economics, and Human Resources (SDM) are 0.6507, 0.7832, 0.8315, 0.9622, and 0.6180. It shows that the economic variables, health SDM, FPK, and maggot cases can account for 65,07% of the poverty variable. Health SDM variables and FPK variables can be used to describe the economy variable as 78,32%. Considering everything, this model performs quite well, accounting for 99.98% of poverty in East Java; the remaining 0.02% is explained by errors and other variables that are not included in the error model.

Table 4. Statistical Test values of measurement models on Jackknife resampling

Parameter	***loading_factor***	SE	Thit	***Pvalue***
Y1	0,8541	0,0024	363,4195	0
Y2	0,9744	0,0010	1023,3908	0
Y3	0,5613	0,0025	222,9595	0
X11	-0,6182	0,0027	-226,8467	0
X12	0,6485	0,0020	327,1110	0
X13	0,9472	0,0020	465,4460	0
X21	0,9933	0,0001	6785,6614	0
X22	0,4399	0,0023	193,1492	0
X23	-0,6433	0,0026	-250,8880	0
X31	0,9962	0,0001	9592,0736	0
X32	0,8429	0,0043	198,0309	0
X33	0,7443	0,0057	130,6055	0
X41	0,9957	0,0002	4978,9072	0
X42	0,5525	0,0020	274,4308	0
X43	0,8527	0,0010	843,8479	0
X51	0,6891	0,0073	94,0061	0
X52	0,4517	0,0031	144,4275	0
X53	-0,8912	0,0015	-586,0146	0

3.3 Testing Hypothesis Measurement Model (Outer Model)

On the PLS hypothesis testing on the measurement model is performed using the jackknife resampling method.

Table 4. Statistical Test values of measurement models on Jackknife resampling

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X22	0,4399	0,0023	193,1492	0
X23	-0,6433	0,0026	-250,8880	0
X31	0,9962	0,0001	9592,0736	0

X32	0,8429	0,0043	198,0309	0
X33	0,7443	0,0057	130,6055	0
X41	0,9957	0,0002	4978,9072	0
X42	0,5525	0,0020	274,4308	0
X43	0,8527	0,0010	843,8479	0
X51	0,6891	0,0073	94,0061	0
X52	0,4517	0,0031	144,4275	0
X53	-0,8912	0,0015	-586,0146	0

Based on Table 4. It is clear from the Jackknife approach that each indication has a value of P ≤ 0.01. This indicates that any indicator with a real world significance rate of 1% has an impact on any latent variable

3.4 Structural Model Hypothesis Testing (Inner Model)

Tabel 5. Statistical Value of Structural Model Tests on Jackknife Resampling

Track	Koefisien	SE	Thit	Pvalue	Description
X1 -> X2	0,9273	0,0018	502,7611	0,0000	Meaning
X1 -> X3	0,2921	0,0065	45,0274	0,0000	Meaning
X1 -> X4	0,0623	0,0055	11,3790	0,0000	Meaning
X1 -> X5	0,2882	0,0071	40,5018	0,0000	Meaning
X1 -> Y	-0,0490	0,0164	-2,9808	0,0048	Meaning
X2 -> X3	0,2921	0,0065	45,0274	0,0000	Meaning
X2 -> X4	0,0832	0,0040	20,6291	0,0000	Meaning
X2 -> X5	-0,1852	0,0101	-18,3109	0,0000	Meaning
X2 -> Y	-0,0225	0,0212	-1,0614	0,2270	No Significance
X3 -> X4	0,8307	0,0066	126,5904	0,0000	Meaning
X3 -> X5	0,9518	0,0066	143,9887	0,0000	Meaning
X3 -> Y	0,4886	0,0341	14,3216	0,0000	Meaning
X4 -> X5	-0,0713	0,0047	-15,0318	0,0000	Meaning
X4 -> Y	0,4579	0,0199	22,9963	0,0000	Meaning
X5 -> Y	-0,0412	0,0243	-1,6987	0,0943	No Significance

On the result above we can see that the entire path has a significant influence except on the relationship X_1 to Y and X_5 to Y because it has a Pvalue > 0.05. Through the coefficient column we can also determine the properties of the relationship of the two variables in a similar path to the relation X_1 to X_2 in which this relationship has a positive cofficient which means that if X_1 increases then X_2 will also increase by 0.9273 according to the size of its coeffizient.

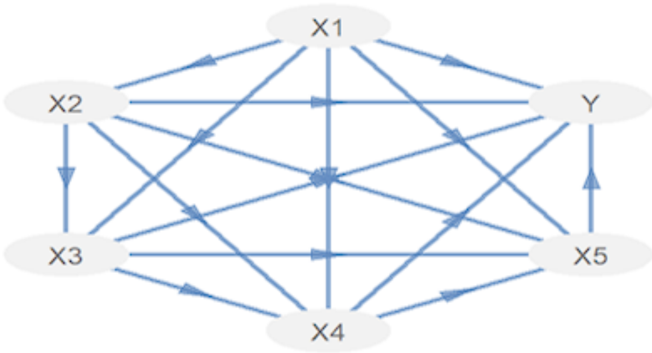

Figure 2. Structural Model Diagram Jackknife Resampling Results

3.5 Research Variable Interface Influence

Below are the relationships - direct, indirect, concise, and analyzed - that exist between the endogenous latent variable and the latent exogenic variable.

1. Variables X_1 against variables X_2 have a direct positive effect of 0.9273, which means that variables X_1 affect variables X_2 by 92.73%
2. Variables X_1 against variables X_3 have a direct positive effect of 0,2921, which means that variables X_1 affect variables X_3 by 29,21%.
3. Variables X_1 against variables X_4 have a direct positive effect of 0,0623, which means that variables X_1 affect variables X_4 by 6,23%.
4. Variables X_1 against variables X_5 have a direct positive effect of 0,2882, which means that variables X_1 affect variables X_5 by 28,82%.
5. Variables X_1 against variables Y have a direct positive effect of 0,0490, which means that variables X_1 affect variables Y by 4,90%.
6. Variables X_2 against variablesX_3 have a direct positive effect of 0,2921, which means that variables X_2 affect variables X_3 by 29,21%.
7. Variables X_2 against variables X_4 have a direct positive effect of 0,0832, which means that variables X_2 affect variables X_4 by 8,32%.
8. Variables X_2 against variables X_5 have a direct positive effect of 0,1852, which means that variables X_2 affect variables X_5 by 18,52%.
9. Variables X_2 against variables Y have a direct positive effect of 0,0225, which means that variables X_2 affect variables Y by 2,25%.
10. Variables X_3 against variables X_4 have a direct positive effect of 0,8307, which means that variables X_3 affect variables X_4 by 83,07%.
11. Variables X_3 against variables X_5 have a direct positive effect of 0,9518, which means that variables X_3 affect variables X_5 by 95,18%.
12. Variables X_3 against variables Y have a direct positive effect of 0,4886, which means that variables X_3 affect variables Y by 48,86%.
13. Variables X_4 against variables X_5 have a direct positive effect of 0,0713, which means that variables X_4 affect variables X_5 by 7,13%.
14. Variables X_4 against variables Y have a direct positive effect of 0,4579, which means that variables X_4 affect variables Y by 45,79%.
15. Variables X_5 against variables Y have a direct positive effect of 0,0412, which means that variables X_5 affect variables Y by 4,12%.
16. Variable X_1, on variable X_3 also has an indirect positive influence through variable X_2, amounting to 0,2709. On the other hand, the direct influence of variable X_1 on variable X_3 is significant, so that variable X_3 can be said as a partial mediation variable
17. Variable X_1, on variable X_4 also has an indirect positive influence through variable X_2, amounting to 0,0771. On the other hand, the direct influence of variable X_1 on variable X_4 is significant, so that variable X_2 can be said as a partial mediation variable
18. Variable X_1, on variable X_5 also has an indirect positive influence through variable X_2, amounting to 0,1717. On the other hand, the direct influence of variable X_1 on variable $X_5$is significant, so that variable X_2 can be said as a partial mediation variable

19. Variable X_1, on variable Y also has an indirect positive influence through variable X_2, amounting to 0,0208. On the other hand, the direct influence of variable X_1 on variable Y is significant, so that variable X_2 can be said as a partial mediation variable
20. Variable X_1, on variable X_4 also has an indirect positive influence through variable X_3, amounting to 0,2427. On the other hand, the direct influence of variable X_1 on variable X_4 is significant, so that variable X_3 can be said as a partial mediation variable
21. Variable X_1, on variable X_5 also has an indirect positive influence through variable X_3, amounting to 0,2781. On the other hand, the direct influence of variable X_1 on variable $X_5$is significant, so that variable X_3 can be said as a partial mediation variable
22. Variable X_1, on variable Y also has an indirect positive influence through variable X_3, amounting to 0,1428. On the other hand, the direct influence of variable X_1 on variable Y is significant, so that variable X_3 can be said as a partial mediation variable
23. Variable X_1, on variable X_5 also has an indirect positive influence through variable X_4, amounting to 0,0044. On the other hand, the direct influence of variable X_1 on variable X_5 is significant, so that variable X_4 can be said as a partial mediation variable
24. Variable X_1, on variable Y also has an indirect positive influence through variable X_4, amounting to 0,0285. On the other hand, the direct influence of variable X_1 on variable Y is significant, so that variable X_4 can be said as a partial mediation variable
25. Variable X_1, on variable Y also has an indirect positive influence through variable X_5, amounting to 0,0119. On the other hand, the direct influence of variable X_1 on variable Y is significant, so that variable X_5 can be said as a partial mediation variable
26. Variable X_2, on variable X_4 also has an indirect positive influence through variable X_3, amounting to 0,0119. On the other hand, the direct influence of variable X_2 on variable X_4 is significant, so that variable X_3 can be said as a partial mediation variable
27. Variable X_2, on variable X_5 also has an indirect positive influence through variable X_3, amounting to 0,2781. On the other hand, the direct influence of variable X_2 on variable X_5 is significant, so that variable X_3 can be said as a partial mediation variable
28. Variable X_2, on variable Y also has an indirect positive influence through variable X_3, amounting to 0,1428. On the other hand, the direct influence of variable X_2 on variable Y is significant, so that variable X_3 can be said as a partial mediation variable

29. Variable X_2, on variable X_5 also has an indirect positive influence through variable X_4, amounting to 0,0059. On the other hand, the direct influence of variable X_2 on variable X_5 is significant, so that variable X_4 can be said as a partial mediation variable
30. Variable X_2, on variable Y also has an indirect positive influence through variable X_4, amounting to 0,0381. On the other hand, the direct influence of variable X_2 on variable Y is significant, so that variable X_4 can be said as a partial mediation variable
31. Variable X_2, on variable Y also has an indirect positive influence through variable X_5, amounting to 0,0076. On the other hand, the direct influence of variable X_2 on variable Y is significant, so that variable X_5 can be said as a partial mediation variable
32. Variable X_3, on variable X_5 also has an indirect positive influence through variable X_4, amounting to 0,0593. On the other hand, the direct influence of variable X_3 on variable X_5 is significant, so that variable X_4 can be said as a partial mediation variable
33. Variable X_3, on variable Y also has an indirect positive influence through variable X_4, amounting to 0,3804. On the other hand, the direct influence of variable X_3 on variable Y is significant, so that variable X_4 can be said as a partial mediation variable
34. Variable X_3, on variable Y also has an indirect positive influence through variable X_5, amounting to 0,0392. On the other hand, the direct influence of variable X_3 on variable Y is significant, so that variable X_5 can be said as a partial mediation variable
35. VariableX_4, on variable Y also has an indirect positive influence through variable X_5, amounting to 0,0029. On the other hand, the direct influence of variable X_4 on variable Y is significant, so that variable X_5 can be said as a partial mediation variable

Modeling

$$Y = 0{,}8541Y_1 + 0{,}9744Y_2 + 0{,}5613Y_3$$
$$X_1 = -0{,}6182X_{11} + 0{,}6485X_{12} + 0{,}9472X_{13}$$
$$X_2 = 0{,}9933X_{21} + 0{,}4399X_{22} - 0{,}6433X_{23}$$
$$X_3 = 0{,}9962X_{31} + 0{,}8429X_{32} + 0{,}7443X_{33}$$
$$X_4 = 0{,}9957X_{41} + 0{,}5525X_{42} + 0{,}8527X_{43}$$
$$X_5 = 0{,}6891X_{51} + 0{,}4517X_{52} - 0{,}8912X_{53}$$

From the models above, we can see which variable of each latent variable has the greatest contribution or role of its Outer loading value. Particularly in the latent variable Y, the largest variable contributing is the variable y_2.

4. CONCLUSION

Based on the display of the results and the discussion above yields:

1. Modeling the proportion of measles cases in North Sumatra in 2022 using the Jack-Knife Partial Least Squares method. Jack-Knife Partial Least Squares intended to form a more robust and simple model, so that it can provide predictions efficiently by involving minimal clarification.
2. The Jack-Knife Partial Least Squares model succeeded in showing that the highest value of each variable, variable y is y_2 = 0,9744, variable x_1 is x_13 = 0,9472, variable x_2 is x_21 = 0,9933, variable x_3 is x_31 = 0,9962, variable x_4 is x_41 = 0,9957, variable x_5 is x_53 = 0,8912 .
3. Whereas the variables used are Variable Laten and Indicator, these variables have a high impact on health, poverty, economics, human resources, and health facilities, meaning that the higher health has a negative impact on the impact of measles, that is, the higher the economy, health facility, the better public health and environmental conditions, and the higher quality of human resources in northern Sumatra, the lower the impact will be on measles.

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