Association of Poverty Categories, Educational Characteristics, and Area of Residence in Indonesia Using a Three-Way Log-Linear Model

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ABSTRAK

Tabel kontingensi adalah salah satu cara untuk menyajikan data dengan semua variabel kategorik. Analisis yang digunakan untuk memodelkan tabel kontingensi adalah model *log-linear*. Model *log-linear* juga digunakan untuk mengestimasi parameter dan melihat hubungan antar variabel. Tujuan dari penelitian ini adalah ingin memanfaatkan model *log-linear* tiga arah tersebut untuk memodelkan dan melihat hubungan antara variabel kategori kemiskinan, karakteristik pendidikan (tingkat pendidikan dan kemampuan membaca dan menulis) kepala rumah tangga, dan daerah tempat tinggal di Indonesia pada tahun 2023. Penelitian dilakukan dengan membentuk model *log-linear saturated* dan *homogeneous* terlebih dahulu, lalu membandingkan selisih nilai *deviance* dari kedua model tersebut dengan nilai *chi-square* tabel atau dapat juga dengan melihat nilai AIC terkecil untuk menentukan model terbaik. Hasil yang diperoleh adalah model *saturated* yang signifikan. Artinya terdapat hubungan antara variabel kategori kemiskinan, tingkat pendidikan kepala rumah tangga, dan daerah tempat tinggal. Terdapat pula hubungan antara variabel kategori kemiskinan, kemampuan membaca dan menulis kepala rumah tangga, dan daerah tempat tinggal. Selain itu, terdapat kecenderungan kemiskinan yang lebih besar bagi kepala rumah tangga yang memiliki pendidikan sekolah dasar atau lebih rendah, serta tidak dapat membaca dan menulis.

Kata kunci: Tabel Kontingensi; Model *Log-Linear*; Kemiskinan; Karakteristik Pendidikan; Daerah Tempat Tinggal

ABSTRACT

Contingency tables are one way to present data with all categorical variables. The analysis used to model the contingency table is a log-linear model. The log-linear model is also used to estimate parameters and see the association between variables. This research aims to utilize the three-way log-linear model to model and see the association between poverty category variables, educational characteristics (level of education and reading and writing ability) of the head of the household, and area of residence in Indonesia in 2023. Research is done by forming a saturated and homogeneous log-linear model first, then comparing the difference in deviance values from the two models with the table chi-square value or choosing the smallest AIC value to determine the best model. The results obtained are a significant saturated model. This means that there is an association between the poverty category variable, the education level of the head of the household, and the area of residence. There is also an association between the poverty category variable, the reading and writing ability of the head of the household, and the area of residence. In addition, there is a greater tendency for poverty for heads of households who have a primary school education or less and cannot read and write.

Keywords: *Contingency Table; Log-Linear Model; Poverty; Characteristics of Education; Area of Residence*

INTRODUCTION

Often in research, the data used is of the categorical type. One way of presenting categorical data is with a contingency table. The contingency table consists of rows and columns in the form of the category level of each observed categorical variable. One development of contingency table analysis is the log-linear model. The log-linear model is used to model the number of cells in a contingency table and describe the association between categorical variables [1] and measure propensity ratio statistics such as contrast values or odds ratio [2]. In this study, researchers want to model the poverty category, educational characteristics (level of education and reading and writing ability) of the head of the household, and area of residence in Indonesia using a three-way log-linear model, so that we can find out how the association and tendency of the variables. Because poverty and education are very complex problems and have existed for a long time, especially in developing countries like Indonesia. Moreover, we know that poverty and education in urban areas tend to be better than in rural areas. These two things are related to the welfare of the Indonesian people. Therefore, with this modeling, it is hoped that it can help the government to better understand the conditions of poverty and education in urban and rural areas. So, if there is still an association and gap between poverty and education in urban and rural areas, the government can take more appropriate policies to overcome this, so that people in Indonesia will be more prosperous in the future.

The poverty problem in Indonesia itself is a problem that continues to be considered and addressed today. According to Badan Pusat Statistik (BPS), the economic inability to fulfill basic needs (food and non-food) for a decent life as measured in terms of expenditure is considered poverty. Residents are said to be poor if their average per capita expenditure per month is below the poverty line, namely IDR 486,168 [3]. The number of poor people in Indonesia continues to fluctuate, but the decline is not significant. This makes Indonesia still ranked fourth as a poor country in Southeast Asia. Reducing poverty to 6.5% to 7% in 2024 is the national development target stated in the Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020-2024 [4]. However, this value is still far from the poverty rate in 2023 which will still be 9.36%.

One of the causes of poverty is low human resources caused by low levels of education. The low levels of education in urban and rural areas are different, where at each higher level of education, more people in urban take that education than people in rural. The reading and writing abilities of people in urban and rural areas are also different, where more people in rural cannot read and write. This happens because there is still a gap or unequal distribution of quality education in urban and rural areas. The number of schools in rural tends to be fewer than in urban areas and access is sometimes not easy, because the locations of schools are sometimes far from residential areas. Facilities, infrastructure, school buildings, and the number and quality of teaching staff in rural are still less than in urban areas. Access to education through technology is also still difficult for schools in rural areas. In addition, the expensive cost of education for higher levels of education makes many people in rural with low incomes prefer not to continue their education.

Research conducted by [5] in his research entitled "Potret Pendidikan di Daerah Terpencil Kampung Manceri Cigudeg Kabupaten Bogor" explains that the low level of education in this rural occurs due to limited teachers and administrative staff, low teacher welfare, lack of facilities and school infrastructure, unequal distribution of education, educational culture and very low economic factors. If someone has difficulty getting an education or has a low level of education, it will also be

difficult to get a job. According to research conducted by Astrini, education has a big influence on poverty, because education is a form of investment in human resources where the higher a person's education, the more skills will also increase and encourage work productivity [6]. Low human productivity will result in low income received.

Research conducted by [7] their research entitled "Pengaruh Tingkat Pendidikan Terhadap Kemiskinan di DKI Jakarta" also states that education has a significant effect on poverty levels. The higher a person's education level, the lower the poverty level. A person's higher level of education will increase their understanding, skills, and abilities so that the quality of work productivity will be good. If the quality of work productivity is good, the opportunity to get a decent job will be greater. Decent work will produce higher income, so avoiding poverty and increasing welfare. High people's income will also have an impact on reducing the poverty level of a country.

Apart from that, it is also important for someone to be able to read and write to help improve their quality of life to avoid poverty. If someone can read and write even though they may not have received a formal education, then that person can at least broaden their knowledge and look for ideas to create job opportunities by opening a business as long as they have the will. So, there is still an opportunity to earn income that can help get out of poverty if the business is successful. In contrast to someone who cannot read and write, it will be difficult for that person to develop and improve their quality of life, because their income will be very dependent on other people or only on the harvest. As a result, it will be difficult for this person to escape poverty.

METHOD

This research uses secondary data from the BPS report entitled "Penghitungan dan Analisis Kemiskinan Makro Indonesia 2023" [8]. This data is data from 341,802 households in all provinces in Indonesia for urban and rural areas in March 2023. This research will form two log-linear models with two different contingency tables. As can be seen in Tables 1 and 2 the variables used in each log-linear modeling consist of three variables. All variables used are considered response variables. The data is processed by researchers in the form of totals because the data comes from BPS in the form of percentages. The data structure used to form the first log-linear model is as follows:

Table 1. Data structure for the first log-linear model

		Education Level of Head of Household			
Area of Residence	**Poverty Category**	**Not Completed in Elementary School**	**Elementary School Equivalent**	**Junior High School Equivalent**	**Senior High School Equivalent**
Urban	Poor	14957 (21.88%)	24726 (36.17%)	12380 (18.11%)	14526 (21.25%)
Urban	Not Poor	11064 (10.79%)	23102 (22.53%)	17247 (16.82%)	36556 (35.65%)
Rural	Poor	20194 (29.54%)	27071 (39.60%)	9823 (14.37%)	9605 (14.05%)
	Not Poor	21810 (21.27%)	37356 (36.43%)	17770 (17.33%)	20488 (19.98%)

Meanwhile, the data structure used to form the second log-linear model is as follows:

Table 2. Data structure for the second log-linear model

Area of Residence	Poverty Category	Reading and Writing Ability			
		Latin Letters	Other Letters	Latin and Other Letters	Cannot Read and Write
Urban	Poor	24890 (36.41%)	704 (1.03%)	39328 (57.53%)	3439 (5.03%)
	Not Poor	37048 (36.13%)	513 (0.5%)	62601 (61.05%)	2379 (2.32%)
Rural	Poor	32286 (47.23%)	827 (1.21%)	27426 (40.12%)	7820 (11.44%)
	Not Poor	43416 (42.34%)	810 (0.79%)	52142 (50.85%)	6173 (6.02%)

The stages of data analysis in this research are as follows:

1. Descriptive Statistics

   This stage is used to see a general overview of the data used.

2. Formation and Testing Log-Linear Models

The log-linear model is a model that can be used to analyze categorical data in contingency tables by modeling the number of observations in each cell for all combinations of category levels of observed categorical variables. In the log-linear model, there is an assumption that all variables are considered as response (dependent) variables, or in other words there is no distinction between independent and dependent variables. This is caused by the log-linear model which shows dependencies between variables [9].

The link function used by the log-linear model is the natural logarithm [10]. Log-linear assumes the response variable to have a Poisson distribution [11] The log-linear model is an expansion of the natural logarithm of the frequency for each cell, equal to the mean (constant) plus the lambda parameter for each other variable, plus lambda for all interaction effects, both 2-factor, 3-factor interaction effects and interaction effects for higher orders, if there is interaction.

Testing in the log-linear model was carried out in stages, namely from saturated with homogeneous, homogenous with conditional, conditional with joint independence, and the last joint independence with complete independence model. If in the first stage, a significant model is found to be saturated, then model testing is not continued to the next stage. On the other hand, if the model obtained is homogenous, then model testing will proceed to the next stage. Therefore, researchers will form a saturated and homogenous model first, and then test the two models. Testing the model by comparing the difference between the deviance values of the saturated and homogenous models with chi-square table value.

3. Selection of The Best Model

At this stage, two models will be compared to select one that is significant in stages from a saturated model to a simple model without interaction. Each model compared is calculated for its deviance value. The best model is determined by the difference between two deviance values which is smaller than the table Chi-Square value or the model with the smallest AIC value. The deviance value can be calculated with the following equation [12]

$$D = 2\sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{k=1}^{K}\left[y_{ijk}log\left(\frac{y_{ijk}}{n_{ijk}\hat{\pi}_{ijk}}\right) + \left(n_{ijk} - y_{ijk}\right)\log\left(\frac{n_{ijk}-y_{ijk}}{n_{ijk}-n_{ijk}\hat{\pi}_{ijk}}\right)\right] \quad (1)$$

4. Interpretation of Model Coefficient

Interpretation of coefficients for variable parameters without interactions uses odds values and for variable parameters with interactions uses odds ratio. The values of these parameters also will be useful for estimating cell values in the contingency table. Odds are defined as the ratio of the probability that the event will occur to the probability that the event will not occur [13]:

$$Odds = p/(1-p) \quad (2)$$

The odds ratio is a ratio of two odds values. The odds ratio can be obtained [14]:

$$\theta = \exp(\beta_j) \quad (3)$$

The stages of the analysis can be described with the flowchart in Figure 1 as follows:

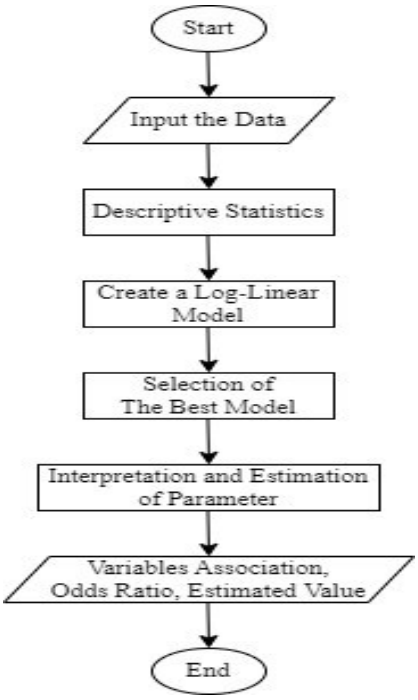

Figure 1. Research Flowchart

RESULT AND DISCUSSION

A. Descriptive Statistics

Based on Table 1, it can be seen that the percentage of heads of poor households who have low education (not completed elementary school or elementary school equivalent) is higher than non-poor households. This shows that the participation rate or interest of heads of households in rural in pursuing higher education is still relatively low compared to heads of households who live in urban. In addition, the number of heads of poor households from all levels of education is greater in rural than in urban areas. The number of households in rural who have not completed elementary school and only graduated from elementary school also shows that there are more heads of poor households.

Economic problems are also the reason why many people in rural do not pursue higher education. Most rural people work as farmers, traders, or fishermen, whose daily income is uncertain and tends to be smaller than that of people in urban. Research conducted by [15] it is

explained that "Unpredictable income in Labuan Kepak Village every month and not coming from economically well-off families is the reason why many people in this village only study up to elementary school because higher education is considered expensive". In fact, according to research conducted by [16], if the percentage of the population with higher education increases, the percentage of the poor will decrease. Although more heads of households in urban areas have higher education, the highest level of education is still high school. This can also be caused by the high cost of education at university. Meanwhile, based on Table 2, it can be seen that more heads of households who cannot read and write (Latin letters and/or other letters) are classified as poor than not poor, whether they live in urban or rural. There are more heads of households who cannot read and write in rural than in urban areas. As a result, many households are poor in rural areas.

B. Formation and Testing of Log-Linear Models

1. First Log-Linear Model

Table 3. Deviance Value, Degrees of Freedom, and AIC Model 1

Model	Deviance	DF	AIC	Model	Deviance	DF	AIC
Saturated	0	0	266.85	Homogenous	1867.3	4	2126.2

- Hypothesis:
  H_0: $\lambda_{ijk}^{ABC} = 0$ (There is no three-way interaction / The model formed is a homogenous model)
  H_1: $\lambda_{ijk}^{ABC} \neq 0$ (There is a three-way interaction / The model formed is a saturated model)
- Significance Level:
  $\alpha = 5\%$
- Test Statistics Value:
  ΔD = Deviance homogenous model – Deviance saturated model
  = 1867.3 – 0 = 1867.3
  db = db Deviance homogenous model – db Deviance saturated model
  = 4 – 0 = 4
- Critical Value:
  Reject H_0 if $\Delta D > \chi^2_{0.05;db} = \chi^2_{0.05;4} = 9.48$
- Decision:
  Reject H_0 because ΔD (1867.3) > $\chi^2_{0.05;4}$ (9.48)
- Conclusion:
  With a confidence level of 95%, it can be concluded that there is sufficient evidence to say that there is a three-way interaction or that the model formed is a saturated model.

Because the test results were rejected H_0, the test stopped or did not proceed to other model tests.

2. First Log-Linear Model

Table 4. Deviance Value, Degrees of Freedom, and AIC Model 2

Model	Deviance	DF	AIC	Model	Deviance	DF	AIC
Saturated	0	0	205.64	Homogenous	373.37	3	573.01

- Hypothesis:
  H_0: $\lambda_{ijk}^{ABC} = 0$ (There is no three-way interaction / The model formed is a homogenous model)
  H_1: $\lambda_{ijk}^{ABC} \neq 0$ (There is a three-way interaction / The model formed is a saturated model)
- Significance Level:
  $\alpha = 5\%$
- Test Statistics Value:
  ΔD = Deviance homogenous model – Deviance saturated model
  = 373.37 – 0 = 373.37
  $db = db$ Deviance homogenous model – db Deviance saturated model
  = 3 – 0 = 0
- Critical Value:
  Reject H_0 if $\Delta D > \chi^2_{0.05;db} = \chi^2_{0.05;3} = 7.81$
- Decision:
  Reject H_0 because ΔD (373.37) > $\chi^2_{0.05;3}$ (7.81)
- Conclusion:
  With a confidence level of 95%, it can be concluded that there is sufficient evidence to say that there is a three-way interaction or that the model formed is a saturated model.

Because the test results were rejected H_0, the test stopped or did not proceed to other model tests.

C. Selection of The Best Model

Model testing resulted in the model formed being a three-way interaction model (saturated model). To prove that this model is indeed the best, it can be seen from the smallest AIC value. Based on Tables 3 and 4, it can be seen that the model that has the smallest AIC value is the saturated model, with a value of 266.85 for the first log-linear model and 205.64 for the second log-linear model. Therefore, the best model to be used in this research is the saturated model with the equation: $log(\mu_{ijk}) = \lambda + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_{ij}^{AB} + \lambda_{ik}^{AC} + \lambda_{jk}^{BC} + \lambda_{ijk}^{ABC}$, where A is the poverty category, B is the characteristics of education, and C is the area of residence.

D. Interpretation of Coefficients in The Best Model

1. First Log-Linear Model

The parameter coefficients λ of the saturated model obtained can be seen at Table 5, where NCES is Not Completed in Elementary School, ES is Elementary School, JHS is Junior High School, and SHS is Senior High School.The model coefficients are as follows:

Table 5. Coefficient and Odds Ration in The Best Model 1

Variable	Coefficient λ	Exp (λ)	Variable	Coefficient λ	Exp (λ)
Intercept	8.5403		Poor:SHS	0.3633	1.4382
Poor	-1.1209	0.3260	Poor:Urban	-0.9865	0.3729
NCES	1.4498	4.2623	NCES:Urban	-1.7251	0.1781

ES	1.9879	7.3004	ES:Urban	-1.5270	0.2172
JHS	1.2449	3.4727	JHS:Urban	-1.0763	0.3408
SHS	1.3873	4.0039	SHS:Urban	-0.4675	0.6266
Urban	1.0465	2.8476	Poor:NCES:Urban	1.3650	3.9157
Poor:NCES	1.0440	2.8404	Poor:ES:Urban	1.3765	3.9611
Poor:ES	0.7989	2.2231	Poor:JHS:Urban	1.2478	3.4826
Poor:JHS	0.5282	1.6958	Poor:SHS:Urban	0.8212	2.2732

Based on the odds ratio value in Table 5, it can be explained that the probability the head of the household in Indonesia is classified as poor is 0.3260 times compared to not being poor or it could be said that the probability of the head of the household not being poor is greater. The probability that the head of the household has an elementary school education is 7.3004 times compared to college and this probability is also greater than the probability for other levels of education compared to college. This means that more heads of households in Indonesia only have an elementary school education.

Regardless of the area of residence, the odds of the head of the household being classified as poor (compared to not poor), if he has not completed elementary school is 2.8404 times compared to the same odds if the head of the household is college-educated. This means that the greatest tendency for heads of households to be classified as poor is when they have not completed elementary school. Without paying attention to education level, the odds of the head of the household being classified as poor if he lives in an urban area is 0.3729 times compared to the same odds if the head of the household lives in a rural area. This means that the tendency for poor households to live in urban is smaller than those living in rural.

The odds of the head of the household having a high school education (compared to college) if he lives in an urban area and regardless of poverty category is 0.6266 times compared to the same odds if the head of the household lives in a rural area. This means that heads of households in Indonesia who live in urban are more likely to have a college education than those who live in rural. The odds of the head of a household being classified as poor (compared to not poor), if he has an elementary school education and lives in an urban area is 3.9611 times compared to the same odds if the head of the household is college-educated and lives in a rural area.

The results of this study show that not always living in an urban area will guarantee someone's escape from poverty. This is because life in urban is more difficult than in rural areas where money is the main resource for urban residents to fulfill all life's needs. In contrast to rural areas, even though financial conditions are low, rural residents can still fulfill basic needs such as food by utilizing harvested crops [17]. Apart from that, the expensive cost of living in the urban area can also make it more difficult for someone who lives in the urban area to fulfill their living needs if they don't have a job with a high income, or if they have a large family member.

Apart from that, population density continues to increase in urban but there are fewer employment opportunities, plus low levels of education, making the tendency for poverty in urban areas to be greater. This is because many people find it difficult to earn income to meet their daily needs. Ultimately, many people become beggars, buskers, scavengers, or homeless people.

Population density and poverty in urban areas tend to be high because many rural residents move to cities in the hope of getting decent jobs with high incomes, but their education is low.

2. First Log-Linear Model

The following are the parameter coefficients λ of the saturated model obtained:

Table 6. Coefficient and Odds Ration in The Best Model 2

Variable	Coefficient λ	$Exp\ (\lambda)$	Variable	Coefficient λ	$Exp\ (\lambda)$
Intercept	8.7279		Poor:LOL	-0.8790	0.4152
Poor	0.2365	1.2668	Poor:Urban	0.1320	1.1411
LL	1.9506	7.0332	LL:Urban	0.7949	2.2142
OL	-2.0309	0.1312	OL:Urban	0.4967	1.6434
LOL	2.1338	8.4468	LOL:Urban	1.1363	3.1153
Urban	-0.9535	0.3854	Poor:LL:Urban	-0.2336	0.7917
Poor:LL	-0.5327	0.5870	Poor:OL:Urban	0.1637	1.1779
Poor:OL	-0.2157	0.8060	Poor:LOL:Urban	0.0456	1.0467

Where LL is Latin Letters, OL is Other Letters, and LOL is Latin and Other Letters. Based on Table 6, it can be explained that the probability of the head of a household in Indonesia being classified as poor is 1.2668 times compared to not being poor. The probability that the head of the household can read and write Latin letters and other letters is 8.4468 times compared to not being able to read and write (Latin letters and/or other letters). This means that more heads of households in Indonesia can read and write (Latin letters and others).

If without paying attention to the area of residence, the odds of the head of a poor household (compared to not being poor), if he can read and write (Latin letters and others), is 0.4152 times compared to the same odds if he cannot read and write. This means that if the head of the household cannot read and write, the tendency is to be classified as poor. This is in accordance with the research conducted by [18] that the higher the literacy rate, the poverty rate will decrease, because the better the reading and writing skills, the better the quality and quality of human resources.

The odds of a poor household, living in an urban, are 1.1411 times compared to the same odds if they live in rural. However, without considering poverty, the odds of the head of the household being able to read and write (compared to not being able to read and write) who lives in urban is 3.1153 times compared to the same odds if he lives in rural areas. This means that the facilities and quality of education in rural are still less good than in urban because more heads of households in urban areas can read and write.

Then, if we pay attention to the interaction of the three variables, the odds of the head of the household being classified as poor if he can only read and write Latin letters and lives in urban is 0.7917 times. This means that if the head of a household who lives in an urban can read and write Latin letters, he is less likely to be poor. However, the odds of the head of the household being classified as poor if he can read and write (Latin letters and others) and lives in urban is 1.0467 times. This means that if heads of households who live in urban can read and write (Latin letters

and others), they are more likely to be poor. This may be caused by a low level of education or other factors not included in this research because poverty factors are very complex.

E. Parameter Estimation

This stage is used to estimate the μ parameter value (sell value in the contingency table) according to the model obtained.

1. First Log-Linear Model

   Using the values in Table 5, one example of the equation used to estimate the μ_{111} parameter in this study is as follows:

   $log(\mu_{ijk}) = \lambda + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_{ij}^{AB} + \lambda_{ik}^{AC} + \lambda_{jk}^{BC} + \lambda_{ijk}^{ABC}$

   $log(\mu_{111}) = 8.5403 - 1.1209 + 1.4498 + 1.0465 + 1.0440 - 0.9865 - 1.7251 + 1.3650$

2. Second Log-Linear Model

   Using the values in Table 6, one example of the equation used to estimate the μ_{111} parameter in this study is as follows:

   $log(\mu_{ijk}) = \lambda + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_{ij}^{AB} + \lambda_{ik}^{AC} + \lambda_{jk}^{BC} + \lambda_{ijk}^{ABC}$

   $log(\mu_{111}) = 8.7279 - 0.2365 + 1.9506 - 0.9535 - 0.5327 - 0.1320 - 0.7949 - 0.2336$

CONCLUSION

Based on the research results discussed, it can be concluded that the poverty category, the education level of the head of the household, and the area of residence are related to each other. Apart from that, the poverty category, the reading and writing ability of the head of the household, and the area of residence are also related to each other. Poverty in Indonesia in 2023 will mostly occur among heads of households who have elementary school education or below and who cannot read and write. This shows that educational characteristics (level of education and ability to read and write) are related to poverty. The results of this research also provide information that the poverty trend of heads of households living in urban is greater than in rural. This shows that life in urban is not always easy, especially if you don't have a job with a high income because you have a low level of education and cannot read and write.

Therefore, the government needs to pay attention to and improve education in Indonesia so that all Indonesian people can obtain higher education and at least not be illiterate so that the opportunity to get a decent job with a high income is much greater. Apart from that, the government must also be able to create sufficient job opportunities for all people who are looking for work. This must be done equally in both urban and rural so that all Indonesian people can avoid poverty and live prosperously.

REFERENCES

[1] S. A. Pujiati, "Penerapan Model Log Linear Untuk Mengetahui Hubungan Antara Status Sekolah, Jumlah Guru Berpendidikan S1 Dan Angka Mengulang Pada Siswa Sd," *J-Statistika*, vol. 4, no. 1, pp. 31–34, 2018.

[2] T. A. I. Satria, N. Imro'ah, and N. M. Huda, "Penerapan Model Log Linier Dalam Menganalisis Tabel Kontingensi Dua Arah," *Buletin Ilmiah Math. Stat. dan Terapannya (BIMASTER)*, vol. 12, no. 6, pp. 545–552, 2023.

[3] A. Zaqiah, M. Triani, and I. Yeni, "Pengaruh Pendidikan, Pengangguran dan Jumlah Penduduk Terhadap Tingkat Kemiskinan di Indonesia," *Jurnal Kajian Ekonomi dan Pembangunan*, vol. 5, no. 3, pp. 33–42, 2023, [Online]. Available: http://ejournal.unp.ac.id/students/index.php/epb/index

[4] Y. M. Hutahaean and J. R. H. Sitorus, "Faktor-Faktor yang Mempengaruhi Kemiskinan Rumah Tangga Bekerja di Pulau Jawa," *Seminar Nasional Official Statistics*, pp. 1165–1176, 2022.

[5] M. Abduh, A. Angga Basiru, M. W. Narayana, N. Safitri, and R. Fauzi, "Potret Pendidikan di Daerah Terpencil Kampung Manceri Cigudeg Kabupaten Bogor," *Jurnal Citizenship Virtues*, vol. 2, no. 1, pp. 291–300, 2022.

[6] Kamaruddin, N. Sudiyarti, Y. Kurnilawan, and R. Rachman, "Pengaruh Tingkat Pendidikan Terhadap Jumlah Penduduk Miskin Di Kabupaten Sumbawa Barat Tahun 2015-2019," *Jurnal Ekonomi dan Bisnis*, vol. 8, no. 2, pp. 98–106, 2020.

[7] R. Susanto and I. Pangesti, "Pengaruh Tingkat Pendidikan Terhadap Kemiskinan Di Dki Jakarta," *Journal of Applied Business and Economic*, vol. 5, no. 4, pp. 340–350, 2019.

[8] Badan Pusat Statistik, "Penghitungan dan Analisis Kemiskinan Makro Indonesia Tahun 2023," vol. 15, 2023.

[9] S. F. Sihotang, "Analisis Model Log Linier Tiga Dimensi Untuk Data Kualitatif Dengan Metode Forward," *Journal of Mathematics Education and Science*, vol. 6, no. 1, pp. 2528–4363, 2020.

[10] G. Yesiltas and I. Paek, "A Log-Linear Modeling Approach for Differential Item Functioning Detection in Polytomously Scored Items," *Educ Psychol Meas*, vol. 80, no. 1, pp. 145–162, Feb. 2020, doi: 10.1177/0013164419853000.

[11] A. A. Akinrefon, R. Emmanuel, and A. Okolo, "Log-Linear Models For Hiv/Aids Prevalence In Adamawa State, Nigeria," *Fudma Journal Of Sciences*, vol. 7, no. 3, pp. 103–109, Jul. 2023, doi: 10.33003/fjs-2023-0703-1804.

[12] E. Priscilla, J. Prinssesa, M. S. J. Aurelia, and E. S. Nugraha, "Log Linear Model on Contingency Table to Analyze Relationship between Age, Income, and Health Insurance Ownership," *Journal of Actuarial, Finance and Risk Management (JAFRM)* , vol. 1, no. 1, pp. 17–26, 2022.

[13] S. H. Park and K. Han, "How to Clearly and Accurately Report Odds Ratio and Hazard Ratio in Diagnostic Research Studies?," *Korean J Radiol*, vol. 23, no. 8, pp. 777–784, Aug. 2022, doi: 10.3348/kjr.2022.0249.

[14] Y. Rahmawati and P. C. Taylor, *Empowering Science and Mathematics for Global Competitiveness*. The Netherlands: CRC Press/Balkema, 2019.

[15] Y. H. Ladaria, J. Lumintang, and C. J. Paat, "Kajian Sosiologi Tentang Tingkat Kesadaran Pendidikan Pada Masyarakat Desa Labuan Kapelak Kecamatan Banggai Selatan Kabupaten Banggai Laut," *Jurnal Ho;istik*, vol. 13, no. 2, pp. 1–15, 2020.

[16] K. Laila Nirmala, W. Pramesti, and F. Fitriani, "Spatial Autoregresive Moving Average Pada Pemodelan Persentase Penduduk Miskin Kabupaten/Kota Di Provinsi Jawa Timur Tahun 2020," *J Statistika*, vol. 15, no. 1, pp. 158–166, 2022, [Online]. Available: www.unipasby.ac.id

[17] M. A. Lasaiba, "Perkotaan dalam Perspektif Kemiskinan, Permukiman Kumuh dan Urban Heat Island (Suatu Telaah Literatur)," *GEOFORUM*, vol. 1, no. 2, pp. 63–72, Dec. 2022, doi: 10.30598/geoforumvol1iss2pp63-72.

[18] I. Made, S. Yoga, I. Komang, T. E. Putra, and R. B. Utomo, "Pengaruh Upah Minimum dan Angka Melek Huruf Terhadap Tingkat Pengangguran dan Kemiskinan di Provinsi Bali," *Jurnal SUTASOMA (Science Teknologi Sosial Humaniora)*, vol. 01, no. 01, 2022, [Online]. Available: https://doi.org/00.00000