

# Development of Poverty Index for Districts in Kedah by Using CRITIC and Simple Additive Weighting Methods

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**Abstract** Poverty is a major problem either in this country or globally as it is like a vicious cycle that is endless. In Peninsular Malaysia, there are four states: Kelantan, Terengganu, Perlis and Kedah that still recorded higher incidences of poverty than the national average. The differences in development among regions, states and rural-urban areas maintain a wide gap even though the economic growth was reported by all the states. This might be attributed to some key factors that could have effects on poverty in a smaller region. It is argued that the factors prescribing the index have different levels of importance or weights towards the poverty incidence. Hence, this paper aims to determine the weightage of poverty indicators that affect the poverty rate in smaller area in Kedah and to develop the corresponding poverty index in Kedah. This paper used the CRiteria Importance Through Intercriteria Correlation (CRITIC) weighting method to determine the importance of five indicators. It is revealed that the most important indicator is the size of household followed by income, expenditure, head of household, and residence. Moreover, the poverty index was also developed for 12 districts in Kedah by using Simple Additive Weighting (SAW) method. Results showed that the district with highest poverty index value is Kuala Muda while the lowest is Bandar Baharu district. This paper contributes to changes of poverty information so that the government and Non-Governmental Organizations (NGO) can design appropriate policies to reduce higher poverty rate in Kedah and plan on providing more aids for the targeted group especially in districts with higher poverty index values.

Consequently, it is hoped that these governmental and non-governmental initiatives could help poor people to motivate themselves to have a better education so that they can enhance their economic productivity for the betterment of their lives.

**Keywords** Poverty, Poverty Index, Objective Weight, CRITIC Weighting Method, SAW

## 1. Introduction

Poverty generally refers to a situation of one who lacks a level amount of money or material condition. This issue is prevalent not only in developing countries but also in developed countries (Kumah & Boachie, 2016). Thus, even though the developed countries already have extensive anti-poverty programs in combating poverty in form of funds and advices, but these programs are not enough to get people out of poverty. As Malaysia has the vision to be a developed nation in 2020 (Abdul Razak, Harun, & Md. Zain, 2016) with zero poverty (Yasin Elhadary & Narimah Samat, 2015), a change from absolute poverty to relative poverty is required.

A comprehensive poverty index will be able to assist policymakers in developing poverty eradication initiatives based on the dimensions and indicators of poverty (Gopal, Abdul Rahman, Malek, Jamir Singh, & Law, 2021). Various indices of poverty such as Inequality-adjusted

Human Development Index (IHDI) complement the Human Development Index (HDI), Human Poverty Index (HPI) and Multidimensional Poverty Index (MPI) have been developed by the Oxford Poverty and Human Development Initiative (OPHI) with the United Nations Development Programs of Human Development Report Office (Alkire & Santos, 2014) to reduce poverty. Hence, this study focuses on developing a new poverty index for all districts in Kedah. Kedah is chosen because, up to date, there is no specific poverty study that focuses on smaller geographical segments of state of Kedah. Furthermore, by having an index that covers smaller segments of a state, related authorities would be provided with closer and detailed information about the poverty incidences.

In relation to poverty monitoring in Malaysia, the government uses income-based metric namely Poverty Line Income (PLI) (Bhari, et al., 2018). PLI 2016 has classified poverty into two groups which are poor and hard-core poor categories. A poor category refers to the group of households with monthly incomes lower than food poverty line. The ability to meet other basics need is known as non-food PLI including education, clothing, health care, transportation and communication, rent, utilities and recreation. Food poverty line was measured based on the daily needs of each individual in the family according to the food calorie recommendation of the PLI (Bhari, et al., 2018). Meanwhile, Chamhuri and Mia (2016) stated that hard-core poor category is considered if their earning is less than half of the PLI. As stated by 2019 Economic Planning Unit (EPU), the average PLI at national level is RM2,208 per month on the basis of the 2019 methodology. However, the average Food PLI is RM1,038 per month with an average household size of 3.9 individuals.

Four states in Peninsular Malaysia, Kelantan, Terengganu, Perlis and Kedah still recorded high incidences of poverty than the national average (Majid, Jaffar, Che Man, Vaziri, & Sulemana, 2016). There exist differences in development between regions, states and rural-urban area that maintain the wide gap even though the economic growth was reported by all the states in this country. This might be attributed to some key factors that could have effects on poverty in a smaller region such as districts and sub-districts in Malaysia that were not well investigated. There are few studies on poverty that have been conducted in smaller areas which were districts in Terengganu and Kelantan. For examples, Chamhuri and Mia (2016) have conducted research in Kelantan; Zahari, Siwar, Idrus and Idris (2018), and Zakaria, Ng and Rahman (2018) focused on poverty in Terengganu. These studies offer in-depth insight into poverty statistics in smaller areas and socio-demographic distribution of poor households. However, to the best of authors' knowledge, no research has been conducted in investigating poverty level in northern area especially for districts in Kedah.

In literature, there are few factors revealed by other

researchers (Stoyanova & Tonkin, 2018; Libois & Somville, 2018; Chaudry & Wimer, 2016; Mastrucci, Byers, Pachauri, & Rao, 2019) which affected poverty rate such as the size of household, head of household, income, expenditure, and residential. Lanjouw and Ravallion (1995) found that the poverty and size of household in Pakistan are closely related as the living cost of the family is dependent on the consumption per person. For a certain level, poverty will increase if the family size increases. According to Sasmal and Sasmal (2016), income and expenditure also affect the rate of poverty. Here, the measurement of poverty is based on the level of consumption is fall short of the norms or whose income is below than poverty line income.

Based on literature that had been discussed earlier, this paper considers five poverty factors, namely the size of household, head of household, income, expenditure, and residential. The contribution of these indicators towards poverty should be investigated. It is normal that these factors contribute differently to overall poverty assessment since the indicators are different and should have different relative importance towards poverty.

Thus, the objective of this paper is to fill this gap by determining the weightage of five poverty indicators by using CRiteria Importance Through Intercriteria Correlation (CRITIC) weighting methods which addresses the interdependence between the criteria. Diakoulaki, Mavrotas and Papayannakis (1995) proposed the CRITIC approach which uses correlation analysis to identify differences between each criterion. It is based on principle by using contrast intensity of each measure. It is considered as standard deviation. Conflict between criteria is regarded as the correlation coefficient between the criteria (Marković, et al., 2020). CRITIC method is becoming popular as an objective weighting method as it can integrate both contrast strength and dispute found in the decision problem. It can be suggested that this method is more appropriate for assessing the weights of both conventional and modern performance measures and it includes all the details in the evaluation criteria (Ghorabae, Amiri, Zavadskas, & Antucevičienė, 2017). CRITIC method was also successfully implemented in obtaining objective weights for time and attendance software selection problem of a private hospital (Tus & Aytac Adali, 2019), supply chain risk evaluation (Rostamzadeh, Ghorabae, Govindan, Esmaili, & Nobar, 2018), Initial Public Offering (IPO) performance analysis (Yalcin & Unlu, 2017) and air conditioner selection (Vujicic, Papic, & Blagojevic, 2017).

Furthermore, Simple Additive Weighting (SAW) method was applied to construct an index of poverty for all districts in Kedah. SAW method was initiated by Churchman and Ackoff (1954) to overcome the portfolio selection problem. This method is simple in concept, easy to understand, accurate in measurement and can calculate the index score. It should be noted that the poverty index

score of the districts in Kedah would rank the districts according to their poverty levels. The district that is at the highest position is the one that has the highest score as compared to other districts (Suhandi, Terttiaavini, & Gustriansyah, 2020). As stated by Desa, Jemain and Kasim (2015), index values usually lie between zero and one. This paper also uses the same range, a lower poverty index corresponds to a lower poverty level and vice versa.

This paper is structured in four sections. The first section is an introduction to this study. The second section describes the methods of analysis: CRITIC weighting method to calculate the weights of poverty indicators and SAW method to calculate the poverty index. The third section discusses the analysis and the results. Finally, the fourth section is the conclusion of this study.

## 2. Methodology

In this paper, Kedah state has been selected as it is one of the states that has higher incidences of poverty compared to other states (Majid, Jaffar, Che Man, Vaziri, & Sulemana, 2016). Kedah is located in the North Western corner of Peninsular Malaysia. The population is slightly over two million people who are from 12 districts which are Baling, Bandar Baharu, Kota Setar, Kuala Muda, Kubang Pasu, Kulim, Langkawi, Padang Terap, Pendang, Pokok Sena, Sik and Yan.

Secondary data are obtained from Implementation Coordination Unit (ICU JPM) which consist of *e-Kasih* data from 2010 until 2020. These data consist of 12 districts in Kedah that have been categorized into two groups of poverty status which are hard-core poor and poor. Due to limited data, this paper only focuses on economic factors, namely the size of household, head of household, residential, income and expenditure.

Weight plays an important role in determining the actual degree of each criterion's dominance. In describing poverty level in Kedah, the indicator with the highest weight would be considered as the most important indicator where this paper applied CRITIC weighting method to determine the weights of the poverty indicators by using the following steps:

Step 1: normalize the decision matrix.

$$\bar{X}_{ij} = \frac{X_{ij} - X_{ij}^{min}}{X_{ij}^{max} - X_{ij}^{min}} \tag{1}$$

or  $\bar{X}_j = \frac{X_{ij} - X_{ij}^{min}}{X_j^{max} - X_j^{min}}$  (applicable to benefit indicators)

$$\bar{X}_{ij} = \frac{X_{ij}^{max} - X_{ij}}{X_{ij}^{max} - X_{ij}^{min}} \tag{2}$$

or  $\bar{X}_j = \frac{X_{ij}^{max} - X_{ij}}{X_j^{max} - X_j^{min}}$  (applicable to cost indicators)

where  $X_{ij}$  represents the observation of district  $i$  for indicator  $j$ ,

Step 2: calculate standard deviation,  $\sigma_j$  for indicator  $j$ .

$$\sigma_j = \sqrt{\frac{\sum (x_i - \mu)^2}{N}} \tag{3}$$

Step 3: determine the symmetric matrix of  $n \times n$  with element  $r_{jk}$ , which is the linear correlation coefficient between the vectors  $x_j$  and  $x_k$  as follows:

$$r_{jk} = \frac{n \sum_{i=1}^n j_i k_i - \sum_{i=1}^n j_i \sum_{i=1}^n k_i}{\sqrt{n \sum_{i=1}^n r_i^2 - (\sum_{i=1}^n r_i)^2} \sqrt{n \sum_{i=1}^n k_i^2 - (\sum_{i=1}^n k_i)^2}} \tag{4}$$

Next, measure the conflict created by criterion  $j$  with respect to the decision situation defined by the rest of criterion by using the following formula:

$$\sum_{k=1}^m (1 - r_{jk}) \tag{5}$$

Furthermore, determine the quantity of the information in relation to each criterion.

$$c_j = \sigma_j * \sum_{k=1}^m (1 - r_{jk}) \tag{6}$$

Lastly, the objective weight for indicator  $j$  is given as follows:

$$w_j^{obj} = \frac{c_j}{\sum_{k=1}^m c_j} \tag{7}$$

where  $w_j^{obj}$  is objective weightage for the  $j^{th}$  indicator.

To develop an index for poverty in Kedah, this paper used SAW method as in the form:

$$A_i = \sum_{j=1}^m w_j (\bar{X}_{ij}) \tag{8}$$

where  $w_j$  is the weightage value of indicator  $j$  and  $\bar{X}_{ij}$  is the normalized value of observation of district  $i$  for indicator  $j$ .

The greatest value of  $A_i$  is the highest ranking for poverty index for districts in Kedah.

## 3. Results and Discussion

In this study, secondary data was collected from ICU, JPM which consists of 4335 (15%) hard core poor household heads and 786 (85%) poor household heads in total as depicted in Figure 1.

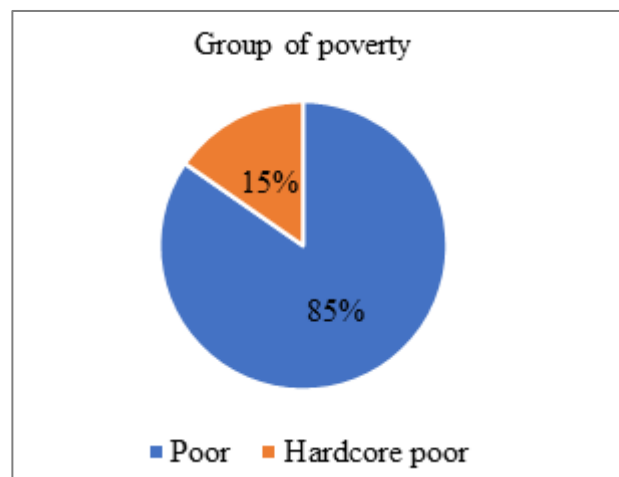


Figure 1. Group of poverty in Kedah

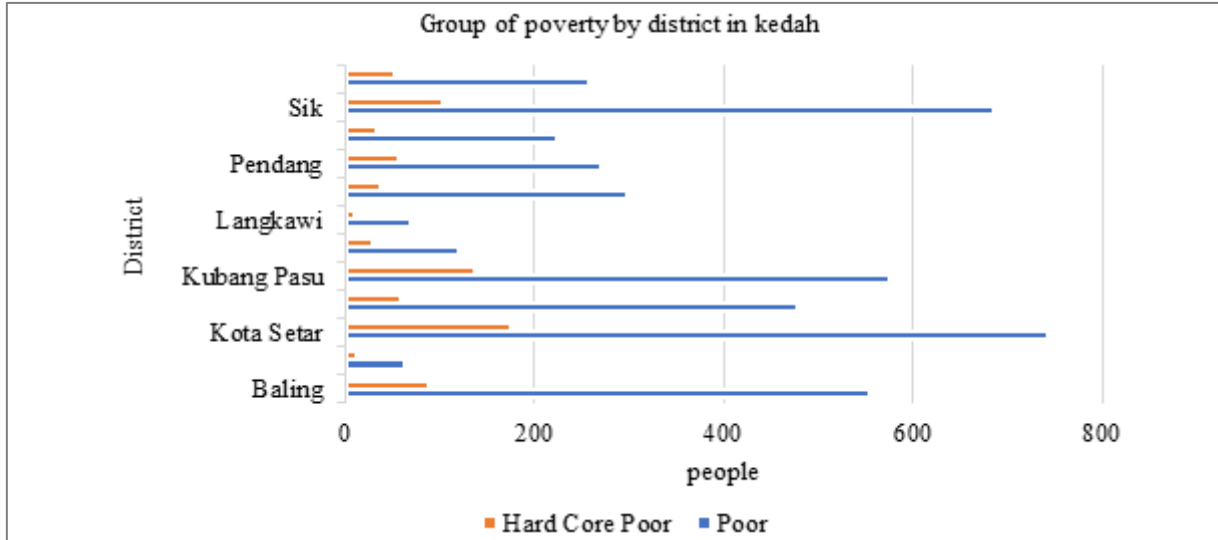


Figure 2. Group of poverty by districts in Kedah

Table 1. Standard deviation, criterion value and weighted value.

Criteria	Standard deviation, $\sigma$	Quantity of information, $C_j$	Weight Value, $W_j$	Rank
Size of Household (C1)	0.2681	1.2452	0.2922	1
Head of Household (C2)	0.3253	0.6640	0.1558	4
Residential (C3)	0.3059	0.6600	0.1549	5
Income (C4)	0.3083	0.8579	0.2013	2
Expenditure (C5)	0.3249	0.8350	0.1959	3

As shown in Figure 2, the highest number of people in the group of hardcore poor is from Kota Setar which consists of 175 people. Meanwhile, the least number of people in group of hardcore poor is from Langkawi which has only nine people. Moreover, the highest number of people in the group of poor is from Kota Setar which has 742 people. But, the least number of people in group of poor is from Bandar Baharu which has 62 people.

In order to determine the ranking of five poverty indicators as shown in Table 2, the standard deviation, and mathematical formula of CRITIC weighting method was applied and the results are as summarized as shown in Table 1. The standard deviation of each indicator was calculated from the normalized decision matrix.

Table 2. Ranking of by using CRITIC weighting method

Rank	Criteria	Weightage Value, $W_j$
1	Size of Household (C1)	0.2922
2	Income (C4)	0.2013
3	Expenditure (C5)	0.1959
4	Head of Household (C2)	0.1558
5	Residential (C3)	0.1549

The results in Table 2 shows that the highest weightage of poverty indicator in Kedah which affects more on the

occurrence of poverty is the size of household with the value of 0.2922, followed by income with 0.2013, expenditure with 0.1959, head of household with 0.1558, and residential with 0.1549.

Table 3. Index value of poverty indicators in Kedah

Rank	Alternative (A <sub>i</sub> )	Index Score
1	Kuala Muda (A4)	0.9092
2	Kota Setar (A3)	0.8259
3	Kubang Pasu (A5)	0.7482
4	Kulim (A6)	0.7423
5	Langkawi (A7)	0.6174
6	Padang Terap (A8)	0.5481
7	Pendang (A11)	0.5440
8	Baling (A1)	0.5433
9	Sik (A9)	0.5280
10	Pokok Sena (A12)	0.5086
11	Yan (A10)	0.5070
12	Bandar Baharu (A2)	0.4898

From Table 3, the poverty index value was calculated by multiplying the decision matrix with the weight vector that was obtained by using CRITIC weighting method. The ranking of the districts is based on the highest value

to the lowest value of index. The results show that the district with the highest poverty index value is Kuala Muda with the value of 0.9091, followed by Kota Setar, Kubang Pasu, Kulim, Langkawi, Padang Terap, Pendang, Baling, Sik, Pokok Sena, Yan and the district with the lowest poverty index value is Bandar Baharu with 0.4898. This implies that Kuala Muda has the highest incidence of poverty among the 12 districts under study. This may be attributed to the nature of people who live here because Kuala Muda is well known as a fisherman village in Kedah as its location is near to the sea. Furthermore, factors of income and residential are the top two factors that affected the level of poverty index particularly to district of Kuala Muda. Meanwhile, Bandar Baharu has the lowest incidence of poverty in Kedah. This could be due to its location which is proximity closer to Penang. Bandar Baharu is also a part of greater Penang which is the second largest conurbation in Malaysia, with a well-developed transportation infrastructure of Penang in meeting the logistical needs of the region.

### 3. Conclusion

This paper demonstrates the application of CRITIC weighting method in determining the weightage of poverty indicators for districts in Kedah. The size of household was found to have the highest weightage which means that this factor is the most importance indicator that contributes to the poverty rate in Kedah, followed by income, expenditure, head of household and residential. Moreover, this paper used Simple Additive Weighting to construct poverty index for districts in Kedah. The results show that the district with highest poverty index is Kuala Muda with 0.9091 followed by Kota Setar, Kubang Pasu, Kulim, Langkawi, Padang Terap, Pendang, Baling, Sik, Pokok Sena, Yan and Bandar Baharu. Since the majority of the people of Kuala Kedah are fishermen, the responsible authorities to the development of Kuala Muda can plan to offer relevant courses and training to the fishermen or to provide suitable fishery equipment for the hardcore poor and poor fishermen. Besides, new housing project could also be developed for the people to solve crowded homes or neighborhoods. This kind of housing project will develop the resettlement of fishermen towards better and more comfortable lifestyle.

In a nutshell, it is hoped that the initiatives to be developed by the related authorities could help poor people to motivate themselves to have a better education so that they can elevate their economic productivity. However, since this paper only focuses on the objective approach in weighting the poverty indicators, the subjective experts' opinions are needed to balance this objective perspective in order to develop a more balanced Poverty Index in Kedah.

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