

Investigating the Factors of Committing Crime by Foreign Workers Using Fuzzy Techniques

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HIGHLIGHTS

- Fuzzy TOPSIS was used to determine and rank the factors of committing crime involving foreign workers.
- There are six factors which are affecting the foreign workers to commit crime.
- Wage discriminant is the highest ranking for the factors of committing crime by foreign workers.
- The lowest ranking for the factors of committing a crime by foreign workers is property.

ABSTRACT

Criminal activities have a huge detrimental impact on society and the country. Foreign workers are among the contributors to the crime rate in Malaysia. Crime rate will not decrease if the factors that influence foreign workers to commit crimes remain unclear and unexplored. Many factors are affecting the foreign workers to commit crime. This research aims to determine the ranking for the factors of committing crimes by foreign workers. The Fuzzy Technique for Order Preference with Similarity to Ideal Solution (TOPSIS) was applied to rank the factors. The alternative of this research is the factors of committing crimes by foreign workers, which are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level. The criteria chosen are ex-criminal, desperate individual, legal immigrant and illegal immigrant. Three decision-makers which are police officers must assess the factors in this research using linguistic variables ranging from "very poor" to "very good". The alternatives that would be chosen have the shortest distance to Positive Ideal Solution (PIS) and the farthest distance to Negative Ideal Solution (NIS). Finally, this study demonstrates that the highest ranking for the factors of committing crime by foreign workers is wage discrimination with a closeness coefficient value of 0.5305. The minor contributing factor with a closeness coefficient value of 0.2744 comes from poverty. Many personnel may benefit from the findings of this study. This study provides information about the factors of committing crime most associated with foreign workers, allowing employers to be aware of the risk they come with. This requires them to be more responsive to their employees, such as monitoring employee movement to track their daily activities (e.g., installing security cameras the housing facilities). Besides, employers should fairly deal with their employees and keep the workforce motivated to avoid criminal cases. A future study might broaden the scope of the project by including various sorts of criteria and alternatives.

Keywords: foreign workers, crimes, TOPSIS, multi-attribute decision making

INTRODUCTION

Malaysians will have to face the fact that the nation is very dependent on foreign workers in which their existence is fast becoming a norm. The International Labour Organisation Conventions and Recommendations typically use the word “migrant workers”, which is usually limited to low-wage fields possibly attributable to low-wage income associated with it. Besides, a migrant worker can be defined as a person in a situation where they are not a citizen, should be appointed, involved, or engaged in paid activities. Alternatively, it also denotes an individual working in a nation other than that their citizenship is documented (Rajkumar, 2001). The majority of the number of foreign workers in Malaysia is from Indonesia, currently at 728,870 workers. Nepal has 405,898 workers, Bangladesh with 221,089 workers, Myanmar with 127 705 workers, India with 114, 455 workers, and Laos has the lowest number of foreign workers with 39 workers (Nasa, 2017).

There were many fights and crimes between foreign workers. For example, in the Senai Technology Park Industrial Area, Johor Bahru, there was a fight between factory workers there involving foreign workers from Myanmar, Pakistan, and India, resulting in serious injuries (Nordin, 2021) and twenty suspects have been detained in Malaysia for an investigation into the killings, twelve Myanmar migrants have admitted their role in nine of the killings, which saw bodies dumped and throats cut (Leong, 2014). Moreover, there are also many cases involving the murder of citizens by foreigners, such as a local man who died after an attack by a group of four foreign men at the night market site in Section 25, Shah Alam (Zain, 2018) and a Nigerian arrested on charges of killing the Serdang Hospital Chief Nurse whose body was found in condominium units in Cyberjaya (Tee, 2019). Many criminal cases committed by foreign workers threaten the lives of citizens. Therefore, this study investigates the main factor of committing crimes among foreign workers to overcome the crimes.

The problem of crime is one of the most severe issues among Malaysians. A study by Misman et al. (2017) shows that foreign workers are offenders in Malaysian crimes. There are five genres identified in the study. The dominant genre involves illegal migration and human trafficking followed by violent criminal incidents, drug smuggling cases and fraudulent activities. Moreover, there are adverse effects because of crime induced by foreign workers, such as bad workmanship, slow pace in technology advancement, and the existence of illegal workers (Rahman et al., 2012).

Many resources claim crime as a complex problem. Some social factors have a powerful influence on a person's ability to make choices. The factors of committing crime by foreign workers are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level. Employers often provide foreign workers in the construction and manufacturing sectors with accommodation facilities, such as houses or hostels. They live in groups in which one place can accommodate up to 10 foreign workers. However, in this region, some live in cramped, dirty, and unclean conditions, whereby the lack of proper housing and facilities may push them towards engaging in crime. If foreign workers' accommodation facilities are close to the locals, this is also associated with a higher risk of problems and crime (Marhani et al., 2012). In particular, any crime occurrences will threaten the safety of the locals in which Malaysians will feel more afraid of their surrounding situation.

Poverty and violence are linked across a wide range of violent crimes, including murder, robbery, and domestic violence (Papaioannou, 2016). Foreign workers come to Malaysia to get out of poverty and support their families. Most foreign workers work in Malaysia because Malaysia's currency is higher than their countries', such as Indonesia, Thailand, the Philippines and Myanmar. This case occurs more or less with some Malaysians working abroad to earn better wages (Ruxyn, 2016).

According to a report by Amnesty International (2010), foreign workers use hazardous equipment or work with dangerous chemicals without wearing protective clothing or receiving training on protecting

themselves, especially for low-skilled workers. When they are injured at work, their employers might refuse to pay for their medical treatment and, in some cases, pressure them to return to their home countries. Besides, after paying their employers the annual fee for renewing their work permit, salary deductions for errors during work, and costs for food and rent, foreign workers cannot be compensated for months of work or take home little or no money per month. The majority of them work long hours, including unpaid overtime. Therefore, due to insufficient money, foreign workers are at risk of committing crimes such as robbery and theft.

Chinese immigrants, mostly construction workers, are often the hardest hit. They paid between \$6,000 and \$10,000 for a visa, travel expenses, and other costs to work in Israel. Many end up on the streets, jobless, and living in Israel illegally (Ellman & Laacher, 2002). Many foreign workers are hired by deceit or fraud by employment agents, in which they are misled about the job they will do, the salaries they will earn, the hours they will work, and other working conditions. A preliminary investigation by the Home Ministry (KDN) into the cause of the influx of thousands of foreign workers in Cameron Highlands found the existence of widespread workers' syndicate fraud (ESSCOM Times, 2014). Furthermore, the study by Ozden et al. (2017) mentioned that the influx of foreign migrants is among the contributing factors to the rise in crime rates.

According to McCoy et al. (2015), foreign workers often experience high levels of stress, isolation, and loneliness, all of which lead to heavy drinking. Alcohol consumption can alter one's mental state, resulting in increased sexual risk behaviours. Additionally, Lundholm et al. (2013) have proposed a study that shows influences of alcohol and unusually high doses of benzodiazepines are proximal risk factors for violent crime such as homicide, manslaughter, assault, robbery, and sexual offences. Malaysia's economy has benefited from a pro-immigration policy for a long time. Malaysia is among the countries with a high ratio of migrants to the total population in Asia Pacific. However, most Malaysian migrants have poor level of education (Wei et al., 2018). On top of that, a study done by Anspal et al. (2011) shows the likelihood of committing crime is higher among people with lower levels of education, younger people, and males.

There are numerous applications of the Fuzzy TOPSIS method available in the literature. One of them is the use of the new fuzzy TOPSIS-based multi-criteria approach to personnel selection. The study was conducted by Chen et al. (2006) and proposed a fuzzy systemic approach to extend TOPSIS to solve the problem of supplier selection based on supplier profitability, relationship closeness, technical capacity, consistency of conformance, and factors of conflict resolution. A closeness coefficient was defined according to this comprehensive approach to determine the ranking order of all suppliers by measuring the distances to the fuzzy positive ideal solutions and fuzzy negative ideal solutions at the same time and also to control decision-making issues with outsourcing. Furthermore, the study by Ece and Uludag (2017) shows the applicability of the Fuzzy TOPSIS method in optimal portfolio selection and an application in built-in self-test (BIST). The purpose of the study is to recognize the existence of alternative approaches to decide the optimal combination of selection from the risk and revenue perspective of individual and corporate investors who would like to calculate their capital market savings.

According to Sahin et al. (2020), TOPSIS fuzzy multi-criteria decision algorithm can be applied for dry bulk carrier selection. The decision-making process for ship investment is a complex and challenging process of trade-offs. This study aims to lead decisions on purchasing dry bulk carriers based on a multi-criteria decision analysis algorithm based on a Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) multi-criteria decision analysis algorithm. Expert questionnaires are used to develop and modify a set of requirements and a set of alternatives based on different features. The proposed method provides weights for given criteria to provide ranked alternatives, identifying the optimal solution. From the previous studies, it is clear that the Fuzzy TOPSIS method can be used to determine the ranking order of the criterion and also to control the decision-making issues. Hence, this paper is driven by the main objective of determining the ranking factor of committing crimes by foreign workers by using

the Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Foreign workers in this study are referred to low-skilled foreign workers in Malaysia in the context of economic sectors, such as manufacturing, construction, services, and agriculture sectors. This population is chosen due to their higher risk of committing crimes (Marhani et al., 2012), whereby criminal cases involving them include violence, robbery, housebreaking, and vehicle thefts. Furthermore, the factors involved are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level.

METHODOLOGY

The data on crime factors involving foreign workers were collected by distributing questionnaires made using Google Forms. Three police officers who have experience in managing criminal cases committed by foreign workers were selected as a decision-maker to answer the questions. The rating varies from 'very low' (VL), 'low' (L), 'medium' (M), 'high' (H), and 'very high' (VH).

Fuzzy Theory

A fuzzy set \bar{a} in a universe of discourse X is characterised by a membership function, $\mu_{\bar{a}}(x)$ that maps each element x in X to a real number in the interval $[0,1]$. The membership function, $\mu_{\bar{a}}(x)$ is termed the grade of membership of x in \bar{a} . The nearer the value of $\mu_{\bar{a}}(x)$ to unity, the higher the grade of membership of x in \bar{a} .

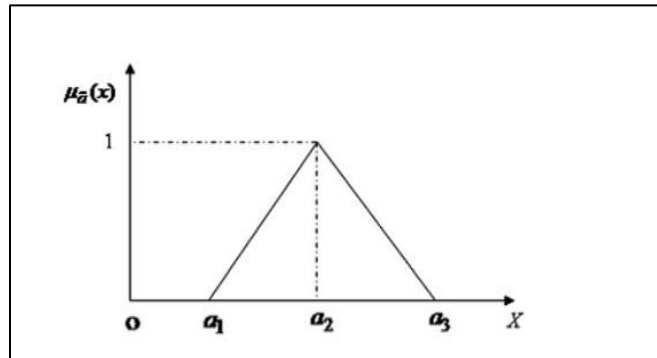


Figure 3.1: Triangular fuzzy number system

This study used the triangular fuzzy system and can be represented as above in Figure 3.1. A triangular fuzzy number is represented as a triplet $\bar{a} = (a_1, a_2, a_3)$. The membership function, $\mu_{\bar{a}}(x)$ of triangular fuzzy number is given as:

$$\mu_{\bar{a}}(x) = \begin{cases} \frac{x - a_1}{a_2 - a_1}, & \text{if } (a_1 \leq x \leq a_2) \\ \frac{a_3 - x}{a_3 - a_2}, & \text{if } (a_2 \leq x \leq a_3) \\ 0, & \text{otherwise} \end{cases}$$

(1)

where a_1, a_2, a_3 are real numbers. The maximal grade of $\mu_{\bar{a}}(x)$ is 1 which is given by a_2 while the minimal grade of $\mu_{\bar{a}}(x)$ which is 0 given by a_1 . a_1 and a_3 are the lower and upper bounds of the available area for data assessed. Let $\bar{a} = (a_1, a_2, a_3)$ and $\bar{b} = (b_1, b_2, b_3)$ be two triangular Fuzzy numbers. The distance between \bar{a} and \bar{b} is generated by utilising the following vertex method:

$$d(\bar{a} - \bar{b}) = \sqrt{\frac{1}{3}[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (2)$$

Linguistic Variable

The conversion scales are used in fuzzy set theory to convert linguistic terms into fuzzy numbers. Ratings for the criteria and their alternatives in this work required a scale of 1 to 9 by referring to Sodhi and Prabhakar (2012). Table 1 reveals the linguistic variables and fuzzy ratings generated for the criteria and their alternatives. In particular, the values were selected for the linguistic variables in the context of the triangular fuzzy numbers that account for the fuzziness and distance between the variables.

Meanwhile, interval selection was done to ensure uniform representation ranging from 1 to 9 for the fuzzy triangular numbers employed for the five linguistic ratings. For example, one may also choose (4,5,6) as opposed to (1,1,3) to represent Very Low should they wish to do so; however, this will render the “1 to 9” ratings to begin at 4 rather than 1. The normalisation step considered such rating scale shifts accordingly. Regardless, prior literature commonly practices ratings scales starting from 1.

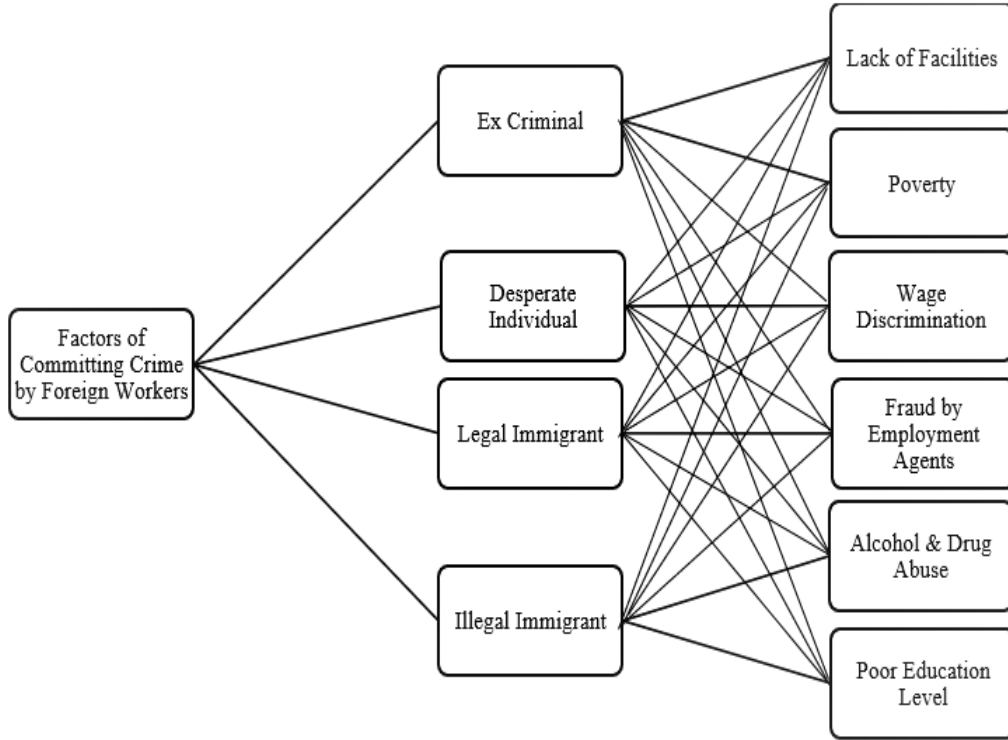
Table 1: The fuzzy ratings for linguistic variables

| Fuzzy Number | Alternative Assessment | QA Weight |
|--------------|------------------------|----------------|
| (1,1,3) | Very Poor (VP) | Very Low (VL) |
| (1,3,5) | Poor (P) | Low (L) |
| (3,5,7) | Fair (F) | Medium (M) |
| (5,7,9) | Good (G) | High (H) |
| (7,9,9) | Very Good (VG) | Very High (VH) |

(Source: Sodhi & Prabhakar, 2012)

Fuzzy TOPSIS in Determining the Ranking of the Factors of Committing Crime by Foreign Workers

There are six alternatives and four criteria used in this study. The alternatives are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level. Meanwhile, the criteria are foreign workers' background status, ex-criminal, desperate individual, legal immigrant, and illegal immigrant. The alternatives and criteria will be used to recognize the significant factors of committing crimes by foreign workers. Figure 2 shows all the criteria and alternatives in identifying the factors of committing crime by foreign workers.



Figure

2: Criteria and alternatives in determining the ranking of the factors of committing crime by foreign workers

Steps in Fuzzy TOPSIS

The technique called fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) can be used to evaluate multiple alternatives against the selected criteria. In the TOPSIS approach, an alternative that is nearest to the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) is chosen as optimal. An FPIS is composed of the best performance values for each alternative whereas the FNIS consists of the worst performance values.

To summarize, the steps of Fuzzy TOPSIS are as follows:

Step 1: In a group that has K decision-makers (i.e. D1, D2, ..., Dk) as responsible for ranking and the x^{th} alternative on y^{th} criterion. The fuzzy rating and important weight of the k^{th} decision maker, about the x^{th} alternative on the y^{th} criterion. Then, the aggregated fuzzy important weight for each criterion can be described as fuzzy triangular numbers:

$$\begin{aligned}
 z_{xy}^k &= (a_{xy}^k, b_{xy}^k, c_{xy}^k) \\
 w_y^k &= (w_{y1}^k, w_{y2}^k, w_{y3}^k) \\
 a_{xy} &= \min \{a_{xy}^k\}, \quad b_{xy} = \frac{1}{K} \sum_{k=1}^K b_{xy}^k, \quad c_{xy} = \max \{c_{xy}^k\}
 \end{aligned} \tag{3}$$

$$w_{y1} = \min \{w_y k1\}, w_{y2} = \frac{1}{K} \sum_{k=1}^K w_y k2, w_{y3} = \{w_y k3\} \quad (4)$$

Step 2: After formulating the decision matrix, normalized was incorporated. Thus, the normalized decision matrix obtained is as follows:

$$R = [r_{xy}]_{m \times n}, x = 1, 2, \dots, m; y = 1, 2, \dots, n$$

$$r_{xy} = \left(\frac{a_{xy}}{c_y^*}, \frac{b_{xy}}{c_y^*}, \frac{c_{xy}}{c_y^*} \right), c_y^* = \max c_{xy} \quad (\text{benefit criteria}) \quad (5)$$

$$r_{xy} = \left(\frac{a_y}{c_{xy}}, \frac{a_y}{b_{xy}}, \frac{a_y}{a_{xy}} \right), a_y = \min a_{xy} \quad (\text{cost criteria}) \quad (6)$$

Step 3: The weighted normalized fuzzy decision matrix was constructed as follows:

$$P = [p_{xy}] \text{ where } p_{xy} = r_{xy} \times w_y \quad (7)$$

Step 4: The fuzzy positive ideal solutions, \tilde{A}^+ and fuzzy negative ideal solutions, \tilde{A}^- are ascertained as follows:

$$\tilde{A}^+ = (p_1^+, p_2^+, \dots, p_n^+) \text{ where } p_y^+ = (1, 1, 1) \quad (8)$$

$$\tilde{A}^- = (p_1^-, p_2^-, \dots, p_n^-) \text{ where } p_y^- = (0, 0, 0) \quad (9)$$

Then, the fuzzy distance of each alternative from fuzzy positive, d_x^+ and fuzzy negative ideals solution, d_x^- calculated as:

$$d_x^+ = \sum_{y=1}^n d(p_x, p_y^+) \quad (10)$$

$$d_x^- = \sum_{y=1}^n d(p_x, p_y^-) \quad (11)$$

Step 5: Then, the fuzzy closeness coefficient, \tilde{CC}_x was determined as:

$$\tilde{CC}_x = \frac{d_x^-}{d_x^+ + d_x^-} \quad (12)$$

Step 6: The ranking of the alternatives can be defined according to the closeness coefficient. The alternative with the greatest coefficient reflects the best alternative.

FINDINGS AND DISCUSSIONS

This study used the Fuzzy TOPSIS method to determine and rank the factors of committing crime involving foreign workers. Three individuals were chosen to serve as decision-makers, referring as D1, D2, D3. Three police officers who have experience in managing criminal cases committed by foreign workers were selected as decision-makers to answer the questions. All three of them were asked to rate the six alternatives, which are lack of facilities (A1), poverty (A2), wage discrimination (A3), fraud by employment agents (A4), alcohol and drug abuse (A5) and poor education level (A6) concerning the four criteria which are ex-criminal (C1), desperate individual (C2), legal immigrant (C3), and illegal immigrant (C4). The linguistic variables shown in Table 1 were used by the decision-makers to evaluate the rating of the alternatives for each criterion. The interviewees' responses were gathered and combined. Table 2 depicts the critical weight assigned to the criteria by the decision-makers. Table 3 illustrates the alternative evaluations with respect to each criterion.

Table 2: The important weight of the criteria

| Criteria | Decision Maker | | |
|----------|----------------|-----------|-----------|
| | D1 | D2 | D3 |
| C1 | L (1,3,5) | L (1,3,5) | L (1,3,5) |
| C2 | H (5,7,9) | M (3,5,7) | M (3,5,7) |
| C3 | VL (1,1,3) | M (3,5,7) | M (3,5,7) |
| C4 | L (1,3,5) | H (5,7,9) | M (3,5,7) |

Table 3: The ratings of the alternatives

| Criteria | Alternative | Decision Maker | | |
|----------|-------------|----------------|------------|-----------|
| | | D1 | D2 | D3 |
| C1 | A1 | F (3,5,7) | F (3,5,7) | F (3,5,7) |
| | A2 | G (5,7,9) | G (5,7,9) | F (3,5,7) |
| | A3 | P (1,3,5) | VP (1,1,3) | G (5,7,9) |
| | A4 | G (5,7,9) | P (1,3,5) | F (3,5,7) |
| | A5 | P (1,3,5) | G (5,7,9) | F (3,5,7) |
| | A6 | VG (7,9,9) | G (5,7,9) | F (3,5,7) |
| C2 | A1 | G (5,7,9) | G (5,7,9) | G (5,7,9) |
| | A2 | G (5,7,9) | G (5,7,9) | F (3,5,7) |
| | A3 | G (5,7,9) | P (1,3,5) | F (3,5,7) |
| | A4 | P (1,3,5) | F (3,5,7) | P (1,3,5) |
| | A5 | P (1,3,5) | VG (7,9,9) | F (3,5,7) |
| | A6 | VG (7,9,9) | G (5,7,9) | P (1,3,5) |
| C3 | A1 | VP (1,1,3) | G (5,7,9) | G (5,7,9) |
| | A2 | F (3,5,7) | G (5,7,9) | F (3,5,7) |
| | A3 | VP (1,1,3) | VP (1,1,3) | G (5,7,9) |
| | A4 | VP (1,1,3) | F (3,5,7) | F (3,5,7) |
| | A5 | VP (1,1,3) | VG (7,9,9) | F (3,5,7) |
| | A6 | VG (7,9,9) | G (5,7,9) | F (3,5,7) |
| C4 | A1 | G (5,7,9) | VG (7,9,9) | F (3,5,7) |
| | A2 | G (5,7,9) | VG (7,9,9) | F (3,5,7) |
| | A3 | VG (7,9,9) | P (1,3,5) | F (3,5,7) |
| | A4 | G (5,7,9) | F (3,5,7) | F (3,5,7) |
| | A5 | VG (7,9,9) | G (5,7,9) | F (3,5,7) |
| | A6 | VG (7,9,9) | G (5,7,9) | F (3,5,7) |

The results were generated from the method of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) using the steps given in methodology. There are six steps in this method. The steps and results are expressed in Tables 4 until Tables 13.

Step 1: The aggregated fuzzy weight of each criterion and fuzzy rating of alternative.

The aggregated fuzzy weight of each criterion in Table 4 was obtained by using Equation (3). Meanwhile, the aggregated fuzzy rating of alternative in Table 5 was obtained by using Equation (4).

Table 4: The aggregated fuzzy weight for criteria

| Criteria | Aggregated Fuzzy Weight |
|----------|-------------------------|
| C1 | (1.000, 3.000, 5.000) |
| C2 | (3.000, 5.667, 9.000) |
| C3 | (1.000, 3.667, 7.000) |
| C4 | (1.000, 5.000, 9.000) |

Table 5: The aggregated fuzzy rating for alternative

| Criteria | Alternative | | | | | |
|----------|---------------|---------------|---------------|---------------|---------------|---------------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | (3, 5.000, 7) | (3, 6.333, 9) | (1, 3.667, 9) | (1, 5.000, 9) | (1, 5.000, 9) | (3, 7.000, 9) |
| C2 | (5, 7.000, 9) | (3, 6.333, 9) | (1, 5.000, 9) | (1, 3.667, 7) | (1, 5.667, 9) | (1, 6.333, 9) |
| C3 | (1, 5.000, 9) | (3, 5.667, 9) | (1, 3.000, 9) | (1, 3.667, 7) | (1, 5.000, 9) | (3, 7.000, 9) |
| C4 | (3, 7.000, 9) | (3, 7.000, 9) | (1, 5.667, 9) | (3, 5.667, 9) | (3, 7.000, 9) | (3, 7.000, 9) |

Step 2: The normalised fuzzy decision matrix for benefit criteria and cost criteria

The values for the normalised decision matrix of benefit criteria were calculated using Equation (5). The value for the normalised decision matrix of cost criteria was computed using Equation (6). Table 6 and Table 7 show the results of the calculation criteria matrix obtained in normalisation respectively.

Table 6: The normalised fuzzy decision matrix (benefit criteria) for alternatives

| Criteria | Alternative | | | | | |
|----------|-----------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | (0.333, 0.556, 0.778) | (0.333, 0.704, 1) | (0.111, 0.407, 1) | (0.111, 0.556, 1) | (0.111, 0.556, 1) | (0.333, 0.778, 1) |
| C2 | (0.556, 0.778, 1) | (0.333, 0.704, 1) | (0.111, 0.556, 1) | (0.111, 0.407, 0.778) | (0.111, 0.630, 1) | (0.111, 0.704, 1) |
| C3 | (0.111, 0.556, 1) | (0.333, 0.630, 1) | (0.111, 0.333, 1) | (0.111, 0.407, 0.778) | (0.111, 0.556, 1) | (0.333, 0.778, 1) |
| C4 | (0.333, 0.778, 1) | (0.333, 0.778, 1) | (0.111, 0.630, 1) | (0.333, 0.630, 1) | (0.333, 0.778, 1) | (0.333, 0.778, 1) |

Table 7: The normalized fuzzy decision matrix (cost criteria) for alternatives

| Criteria | Alternative | | | | | |
|----------|-----------------------|-----------------------|-------------------|-----------------------|-----------------------|-----------------------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | (0.143, 0.200, 0.333) | (0.111, 0.158, 0.333) | (0.111, 0.273, 1) | (0.111, 0.200, 1) | (0.111, 0.200, 1) | (0.111, 0.143, 0.333) |
| C2 | (0.111, 0.143, 0.200) | (0.111, 0.158, 0.333) | (0.111, 0.200, 1) | (0.143, 0.273, 1) | (0.111, 0.176, 1) | (0.111, 0.158, 1) |
| C3 | (0.111, 0.200, 1) | (0.111, 0.176, 0.333) | (0.111, 0.333, 1) | (0.143, 0.273, 1) | (0.111, 0.200, 1) | (0.111, 0.143, 0.333) |
| C4 | (0.111, 0.143, 0.333) | (0.111, 0.143, 0.333) | (0.111, 0.176, 1) | (0.111, 0.176, 0.333) | (0.111, 0.143, 0.333) | (0.111, 0.143, 0.333) |

Step 3: The weighted normalized fuzzy decision matrix for benefit criteria and cost criteria

Equation (7) was used to generate the weighted normal matrix, which is presented in Table 8 for benefit cost and Table 9 for criteria cost. Each element of the normalized matrix would be multiplied by the weightage determined by the fuzzy set theory, which allocated weight to each criteria based on linguistic variables.

Table 8: The weighted normalized fuzzy decision matrix (benefit criteria) for alternatives

| Criteria | Alternative | | | | | |
|----------|-----------------------|-------------------|-------------------|-----------------------|-------------------|-------------------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | (0.333, 1.668, 3.890) | (0.333, 2.112, 5) | (0.111, 1.221, 5) | (0.111, 1.668, 5) | (0.111, 1.668, 5) | (0.333, 2.334, 5) |
| C2 | (1.668, 4.409, 9) | (0.999, 3.990, 9) | (0.333, 3.151, 9) | (0.333, 2.306, 7.002) | (0.333, 3.570, 9) | (0.333, 3.990, 9) |
| C3 | (0.111, 2.039, 7) | (0.333, 2.310, 7) | (0.111, 1.221, 7) | (0.111, 1.492, 5.446) | (0.111, 2.039, 7) | (0.333, 2.853, 7) |
| C4 | (0.333, 3.890, 9) | (0.333, 3.890, 9) | (0.111, 3.150, 9) | (0.333, 3.150, 9) | (0.333, 3.890, 9) | (0.333, 3.890, 9) |

Table 9: The weighted normalized fuzzy decision matrix (cost criteria) for alternatives

| Criteria | Alternative | | | | | |
|----------|-----------------------|-----------------------|-------------------|-----------------------|-----------------------|-----------------------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | (0.143, 0.600, 1.665) | (0.111, 0.474, 1.665) | (0.111, 0.819, 5) | (0.111, 0.600, 5) | (0.111, 0.600, 5) | (0.111, 0.429, 1.665) |
| C2 | (0.333, 0.810, 1.800) | (0.333, 0.895, 2.997) | (0.333, 1.133, 9) | (0.429, 1.547, 9) | (0.333, 0.997, 9) | (0.333, 0.895, 9) |
| C3 | (0.111, 0.733, 7) | (0.111, 0.645, 2.331) | (0.111, 1.221, 7) | (0.143, 1.001, 7) | (0.111, 0.733, 7) | (0.111, 0.524, 2.331) |
| C4 | (0.111, 0.715, 2.997) | (0.111, 0.715, 2.997) | (0.111, 0.880, 9) | (0.111, 0.880, 2.997) | (0.111, 0.715, 2.997) | (0.111, 0.715, 2.997) |

Step 4: The fuzzy distance of each alternative from fuzzy positive, d_x^+ and fuzzy negative ideals solution, d_x^-

The fuzzy distance of each alternative was computed by using Equation (2), (10) and (11). FPIS and FNIS values had been set to (1, 1, 1) and (0, 0, 0), respectively. This value is known as the perfect value according to Chen's method. The result is shown in Table 10 and Table 11.

Table 10: The distances of alternative from FPIS

| Criteria | Alternative | | | | | |
|---------------|-------------|--------|--------|--------|--------|--------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | 1.755 | 2.428 | 2.369 | 2.397 | 2.397 | 2.465 |
| C2 | 5.035 | 4.931 | 4.798 | 3.567 | 4.867 | 4.946 |
| C3 | 3.553 | 3.567 | 3.504 | 2.633 | 3.553 | 3.646 |
| C4 | 4.926 | 4.926 | 4.81 | 4.798 | 4.926 | 4.926 |
| Total d_x^+ | 15.269 | 15.852 | 15.481 | 13.395 | 15.743 | 15.983 |

Table 11: The distances of alternative from FNIS

| Criteria | Alternative | | | | | |
|---------------|-------------|-------|--------|--------|--------|-------|
| | A1 | A2 | A3 | A4 | A5 | A6 |
| C1 | 1.025 | 1.002 | 2.926 | 2.908 | 2.908 | 0.995 |
| C2 | 1.156 | 1.816 | 5.241 | 5.278 | 5.231 | 5.225 |
| C3 | 4.064 | 1.398 | 4.103 | 4.083 | 4.064 | 1.381 |
| C4 | 1.780 | 1.780 | 5.221 | 1.805 | 1.780 | 1.780 |
| Total d_x^- | 8.025 | 5.996 | 17.491 | 14.074 | 13.983 | 9.381 |

Step 5: The fuzzy closeness coefficient, \tilde{CC}_x

Based on Table 12, the closeness coefficient was calculated by using Equation (12). The closeness coefficient may be computed by dividing the value of distance for each alternative from FNIS by the total value of distance for each alternative from both FPIS and FNIS.

Table 12: The closeness coefficient for six alternatives

| Alternative | d_x^+ | d_x^- | \tilde{CC}_x |
|-------------|---------|---------|----------------|
| A1 | 15.269 | 8.025 | 0.3445 |
| A2 | 15.852 | 5.996 | 0.2744 |
| A3 | 15.481 | 17.491 | 0.5305 |
| A4 | 13.395 | 14.074 | 0.5124 |
| A5 | 15.743 | 13.983 | 0.4704 |
| A6 | 15.983 | 9.381 | 0.3699 |

Step 6: The ranking of six alternatives

According to Table 13, the ranking order of these six alternatives is wage discrimination (A3), fraud by employment agents (A4), alcohol and drug abuse (A5), poor education level (A6), lack of facilities (A1) and poverty (A2) respectively.

Table 13: The ranking of alternatives

| Rank | $\tilde{C}C_x$ | Alternative |
|------|----------------|-------------|
| 1 | 0.5305 | A3 |
| 2 | 0.5124 | A4 |
| 3 | 0.4704 | A5 |
| 4 | 0.3699 | A6 |
| 5 | 0.3445 | A1 |
| 6 | 0.2744 | A2 |

CONCLUSION AND RECOMMENDATIONS

The present study was designed to determine the factors of committing a crime by foreign workers using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) under a fuzzy environment based on linguistic variables. The finding emerged from this study is wage discrimination is the main factor of committing crime by foreign workers with the most significant closeness coefficient, which is 0.5305. Meanwhile, the least contributing factor of committing crime is poverty, with a closeness coefficient of 0.2744. In addition, the study by Mahmud et al. (2018) on factors of committing crime also shows that the minor contributing factor is poverty. This shows that poverty does not affect the factor of committing crime either for immigrants, youth, unemployed, ex-criminal, or desperate individuals. Therefore, this study demonstrates that the findings may be accurately acquired using this method. The current study is limited to only two types of method, which are Fuzzy Set Theory and Fuzzy TOPSIS. Future researcher might include other multi-criteria decision-making methods such as the analytic hierarchal process (AHP), the analytic network process (ANP) and data envelopment analysis (DEA). Besides, this research paper is limited with six alternatives only which are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level. Further work needs to be done to establish whether wage discrimination is still the highest closeness coefficient by adding more alternatives such as peer pressure and family condition. Furthermore, the scope of this study is limited in terms of foreign workers. Other scopes that can be studied further are adolescents and children. Hence, further research in this field would be of great help in decreasing criminal cases.

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CONFLICT OF INTEREST DISCLOSURE

All authors declare that they have no conflicts of interest to disclose.

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