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A STUDY OF OIL AND GAS PRODUCERS SUBSECTOR PORTFOLIO USING THE TRADE-OFF RANKING METHOD

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Abstract: In the topic of stock selection, numerous multi-criteria decision-making (MCDM) techniques have been applied to handle selection difficulties. This paper proposes a compromise approach for the subsector stocks of oil and gas companies, motivated by the pandemic crisis and the political issue in Malaysia. The paper presents a novel analysis of the existing trade-off ranking (TOR) method for ranking the stocks of oil and gas producers in conflicting multi-criteria problems. As a result, the TOR technique ranks the subsector stocks effectively for two criteria weights. Comparison with TOPSIS shows that both methods exhibit similar performance.

Keywords: Trade-off ranking, MCDM, stock selection, oil and gas.

MSC: 90B50

1. INTRODUCTION

A portfolio is a set of financial assets such as stocks where the selection process depends on the return and risk of individual stocks. Portfolio selection is a process of selecting financial assets by referring to their maximized return and minimizing risk called optimal portfolio selection. Portfolio selection aims to combine stocks from a large number of available alternatives. The aim of selecting a stock portfolio is the option to distribute capital to numerous stocks to gain the most profitable returns for the investors [1].

According to [2], the return maximization and risk minimization trade-off must be considered. However, his work has a limited number of criteria for the real case problem. The limited criteria have been criticized since there are many criteria to be considered instead of the return and risk to improve the portfolio selection. It is a necessity in financial decision-making to address the problem in a wider and more realistic context by considering the factors (criteria) involved [3], not only the return and risk criteria.

Generally, the objective of the investor is to select a portfolio that can maximize its return at a certain risky condition, particularly during unstable events conditions such as political, economic, and the current pandemic coronavirus disease (COVID-19) events that affected the globe. The competitive situation of the financial markets leads investors to find a way to increase their investment gains. In real-life cases, investors should allocate their money to different stocks optimally concerning their weights to perform better in the market. However, there is a study was done by [4] with the statement that the naive diversification (1/ N) strategy always dominates some other optimal allocation strategy by allocating the portfolio weights evenly across the stocks. By considering this claim, this paper also proposes new weights that are dissimilar to naive diversification strategy for comparison.

One of the options is diversifying their stocks where more stocks are held in a portfolio. But which stocks are stable enough to be invested in? Thus, this paper answers the question by presenting a ranking that is based on the compromise solution between those stocks involved using the trade-off ranking (TOR) method [5].

The current volatility event is the pandemic COVID-19 which requires people to avoid meeting others and many businesses are shutting down. The Movement Control Order (MCO), which has been implemented to the people during the current pandemic crisis, has reduced oil usage and demand and concurrently affects oil production and price. Now, the economy has started to recover following the government's decision to reopen businesses after a few months of economic slowdown. The COVID-19 vaccination program also shows a positive signal of economic reassurance. Moreover, the changes in the Malaysian government due to the uncertain political issues during the pandemic crisis may worsen the situation, especially for the international companies that operate their business in Malaysia. Therefore, the pandemic crisis and the Malaysian political issue have been a motivation for this paper to suggest and rank the compromise oil and gas producers' subsector stocks during the Perikatan Nasional (PN) government handling the crisis.

The remainder of the paper is structured as follows. The literature on oil production and price relations to stock market return and multi-criteria decision-making (MCDM) methods on optimal portfolio selection problems are presented in sections 2 and 3 respectively. The data and methodology are briefly discussed in section 4 which following subsections are 4.1 and 4.2 respectively. In section 5, the experimental study and discussion are presented while the conclusion is discussed in section 6.

2. OIL PRODUCTION AND PRICE RELATIONS TO STOCK MARKET RETURN

Malaysia is one of the countries that are rich in energy resources, particularly oil. Oil is a major source of energy in the global economy. The energy sector in Malaysia plays an important role in achieving sustainable growth and development [6]. To obtain a sustainable oil industry, the production and price must be taken into consideration. In addition, the increment of the oil price will benefit the energy sector directly [7]. Moreover, the uncertainty in the oil price has been a motivation to many researchers to investigate the relationship between the oil price and economic events.

The important criteria in oil issues are oil production and oil prices during the pandemic COVID-19. The limited oil production affects the oil price globally. The changes in oil prices affect the return of the Malaysian market such as the return of the KLCI index [7], [8] and the EMAS index [8]. Jafarian and Safari [7] investigated the relationship between the changes in crude oil and the return of KLCI. The result showed a significant impact specifically on the return of consumers and the energy indices. Moreover, they found that the energy sector including the oil and gas companies is significantly affected by the oil price changes. Therefore, there is a relation between the oil price and the Malaysia energy sector's return.

A study involving oil prices and Malaysia index prices was done by [8]. They investigated the oil price effect on the two different Malaysian indices prices, namely KLCI and EMAS. The result showed that the oil prices and stock prices are cointegrated. They found that there is a long-term relationship between the oil price with the two indices. They claimed their findings are consistent with the theory of the higher the crude oil prices, the lower the stock price. Furthermore, Al-hajj et al. [9] found that the stock market returns in most cases have been adversely affected as a result of oil price shocks, regardless of whether oil price shocks are in the direction of upside or downside. This indicates that the Malaysian market is sensitive to the volatility in the oil price.

Lee et al. [10] found that the increase in COVID-19 cases in Malaysia brought an adverse effect on the performance of the KLCI and all sectoral indices, not including the Real Estate Investment Trusts (REITs) index. Also, Malaysian stock market performance is affected by the Brent oil price and fluctuation index. This includes the energy sector index as the highest volatile index among others based on the coefficient of variation. Besides that, Hoque et al. [11] revealed that the price of oil and gas, and the exchange rate had a significant impact on the stock returns to all oil and gas subindustries, but the negative effect on the stock returns of the gas utility sub-industry. Nikolaichuk, L. et. al. [12] proposed asset diversification using cluster analysis to form an investment portfolio of oil and gas assets.

To conclude this section, this study will be focusing on the oil price issue in the stock market in Malaysia. To the best of our knowledge, no study has taken into consideration the oil production criteria during the pandemic crisis. Hence, this paper adds oil production as a criterion to the conflicting problem since it is also affected during the pandemic. Oil production is one of the main factors in the oil price volatility, particularly during this pandemic crisis. Besides, other criteria such as earnings per share, return on equity, return on assets, debt-to-equity, and total debt ratio criteria that relate to the equity market and financial indicators from each stock are also considered. According to Vuković et al. [13], it is important when choosing and analyzing stocks to take into account the equity market and financial indicators together. Besides that, the reason for selecting the energy sector is because oil is usually used in investment assets and the portfolio investment will directly impact the stock market, and also oil and gas contributed 30% to the Malaysian government revenue [8].

3. MULTI-CRITERIA DECISION-MAKING METHODS ON OPTIMAL PORTFOLIO SELECTION

Markowitz [2] developed the first portfolio optimization model in 1952, known as a basis for modern portfolio theory. However, the limited criteria have been criticized since there are many criteria to be considered instead of the return and risk to improve the portfolio selection. Hence, it seems not sufficient to use the classical approach for effective portfolio selection. The problem of choosing an effective portfolio is a multi-criteria issue that can be aided using a suitable technique [14]. Thus, the MCDM method is suitable to be used for choosing the alternatives associated with numerous criteria. Moreover, several stocks with more than one criterion in the decision-making process can be implemented as MCDM problems [15].

Many MCDM methods have been implemented to solve selection problems and different uses in the stock selection field. Xidonas et al. [14] studied the MCDM approach for choosing stocks in the Athens Stock Exchange (ASE) market. The MCDM method used was the Elimination and Choice Expressing the Reality (ELECTRE) Tri method. There are 66 stocks from the ASE that were chosen as a sample in the study that used the weekly closing prices between 1 January 2004 and 31 June 2007.

Poklepović and Babić [15] used five MCDM methods which are Complex Proportional Assessment (COPRAS), Linear Assignment, Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), Simple Additive Weighting (SAW) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as the divergent results since integrating numerous MCDM methods often bring to the divergent rankings. This study used Spearman's rank correlation coefficient to solve this problem. The data used in this study included stock returns and traded volumes of nineteen stocks from the Croatian capital market, beginning from March 2012 till March 2014. This study takes into consideration the companies' fundamental and stock market indicators of the selected stocks.

Xidonas et al. [14] used the Python programming language to solve an integrated multi-criteria portfolio selection decision support system to incorporate investors' preferences. There are four multi-criteria methods used which were PROMETHEE II, ELECTRE III, Multi-Attribute Utility Theory (MAUT), and TOPSIS. Then, the mathematical programming models were used which were mixed-integer quadratic programming (MIQP), goal programming (GP), genetic algorithm (GA), and multi-objective PROMETHEE models. Data used in this study were from four stock exchanges, the New York Stock Exchange (NYSE), the National Association of Securities Dealers Automated Quotations (NASDAQ), Paris, and Tokyo consist of technological, energy, and financial sectors. The study period from January 2016 to December 2018 uses daily closing prices.

Vuković et al. [13] used hybrid MCDM methods and modern portfolio theory to compare the stock selection which consists of the equity market indicators only. The methods used were Linear Assignment, TOPSIS, SAW, COPRAS, and PROMETHEE. There are some financial indicators used which are earnings per share, return on equity, return on assets, price-to-book value ratio, and price-to-sales ratio. The result showed that there was a significant difference in the ranking of the stocks. Since the equity market and financial indicators showed the performance difference among the companies ranking, therefore, it is important to take both equity market and financial indicators into account when choosing stocks.

Fazli and Jafari [16] proposed a hybrid MCDM model that involved Analytical Network Process (ANP), Decision Making Trial and Evaluation Laboratory (DEMATEL) and VlseKriterijuska Optimizacija I Komoromisno Resenje (VIKOR). The DEMATEL method was used to construct the interrelation among criteria. Then, the weights of all criteria were determined using the ANP method and lastly, the VIKOR method was used to rank and select the best alternatives for investment. The data used from the year 2006 to the year 2010 from the Iran stock exchange using fifty stocks. This study used financial ratios which were profitability ratios, liquidity ratios, financial leverage ratios, growth ratios, and activity ratios. Besides that, Chen and Hung [1] presented the different types of linguistic variables to represent experts' opinions by combining the linguistic ELECTRE and linguistic TOPSIS methods to get the final investment ratio. They used ten stocks from the semiconductor industry of Taiwan with six criteria. The criteria were profitability, asset utilization, liquidity, leverage, valuation, and growth. The qualitative and quantitative factors in financial decision-making have been assessed in the study.

Casado, R. S. et. al. [17] proposed a multidimensional risk evaluation with an implicit enumeration algorithm to overcome bias in Multi-Attribute Utility Method (MAUT) for the portfolio selection problem. They considered potential environmental, financial, and human losses as criteria.

Applying MCDM methods to stock selection during the pandemic crisis and political issues in Malaysia can have significant implications for investors. The pandemic situation has introduced unprecedented levels of uncertainty in financial markets. MCDM methods can help investors identify stocks that offer better risk-adjusted returns by considering multiple criteria. In such turbulent times, traditional stock selection methods may fall short of capturing the dynamic nature of the risks. MCDM approaches enable a more comprehensive analysis by considering various factors, allowing investors to make more informed and robust decisions.

To the best of our knowledge, there is no study involving the trade-off concept to the stock market regarding the return and risk value in Malaysia particularly for the oil and gas producers' subsector in Malaysia. Thus, this study uses his study provides numerous criteria that are related to the current pandemic situation whereas oil production and price data are used in the decision-making process. Many studies [1], [13], [14], [15], [16], [18] have been done on how to distribute stocks to get a better return at a certain level of risk. Hence, in summary of the previous literature works, this study considers the revenue, sales volume, oil production, average return, return risk, earnings per share, return on equity, return on assets criteria, debt-to-equity, and total debt ratio criteria. They are the criteria in which the data is available in the Malaysia database. The objective of the study is to show which stocks were the most compromised in the oil and gas subsector during the ruling of the PN government in Malaysia.

The use of the TOR method as compared to other MCDM methods lies in the fact that TOR is efficient in ranking a conflicting MCDM problem [19]. TOR can give a compromise solution for this problem which considers a return higher than the "low return-low risk" stocks and a risk lower than the "high return-high risk" stocks. Here, the investor is the decision-maker (DM) who wants a high return at a low-risk condition. However, as mentioned earlier, such a condition is almost unrealistic since there are more criteria to be considered, especially during volatility events. Even though fulfilling all criteria at once seems impossible when there are numerous goals [18], but TOR method can give a solution that would satisfy DM preference with respective objectives.

4. DATA AND METHODOLOGY

In this section, subsection 4.1 explains the data of this study. Later, the methodology of this study is elaborated in subsection 4.2.

4.1. Data of Oil Production and Price

This subsection discusses the data of this study. There are four categories of criteria involved in this study. The categories are oil production, oil price, profitability ratio, and leverage ratio. For the oil production category, the criteria are revenue, sales production, and oil production per day. The criteria for the oil price category are average return and return risk. The criteria for profitability ratio are earnings per share, return on equity, and return on assets. The last category consists of debt-to-equity and total debt ratio criteria. Among these four categories, the criteria for oil production are obtained from the quarterly and annual reports, without calculation. Next, the criteria for the oil price category retrieve data from the Datastream database for daily stock prices of the oil and gas subsector listed in Bursa Malaysia (BM). The companies from the oil and gas subsector listed in BM are shown in Table 1.

Table 1: The companies from the oil and gas subsector listed in BM

Alternative	Stock Name
A1	Hengyuan Refining Company Bhd
A2	Hibiscus Petroleum Bhd
A3	Petron Malaysia Refining & Marketing Bhd
A4	Reach Energy Bhd

The analysis was done for 18 months during the ruling of the PN government from 10th Mac 2020 to 16th August 2021 with 352 trading days. The study period during the ruling is chosen based on two reasons. The first reason is the pandemic cases are still at an early stage in Malaysia around the formation of the PN government. In addition, the PN government succeeded in decreasing the daily COVID-19 cases of the affected people, however, the cases started to increase one week after the state election in Sabah which was held on 26 September 2020. Next, the second reason to choose the study period during the PN government is the only government that has long experience in solving this pandemic crisis in Malaysia. Besides, Malaysia's vaccination rate is one of the best countries in the world per hundred people at 1.65 [20], and this achievement happened during PN as the ruler. Regarding the oil and gas subsector, in particular, the closure of sectors due to COVID-19 led to a decline in oil demand, further lowering oil prices and oil company stock prices.

After that, the criteria for profitability ratio and leverage ratio are shown in Table 2 with the simple mathematical formula and goal columns. The methodology of this study is shown in the next subsection.

Table 2: The criteria for financial indicators of the oil and gas subsector stocks

Category	Criterion	Mathematical Formula	Goal
Profitability Ration	Earnings per share (RM)	$\frac{\text{Net Income}}{\text{Average Outstanding Shares}}$	Max
	Return on equity	$\frac{\text{Net Income}}{\text{Total Equity}}$	Max
	Return on assets	$\frac{\text{Net Income}}{\text{Total Assets}}$	Max
Leverage Ratio	Debt-to-equity	$\frac{\text{Total Liability}}{\text{Total Equity}}$	Min
	Total debt ratio	$\frac{\text{Total Liability}}{\text{Total Assets}}$	Min

4.2. Methodology

Next, this subsection discusses the methodology of this study. The methodology of this study is divided into two parts. The first part is the calculation of the average return and return risk from the oil prices and the calculation of the financial indicators for profitability and leverage ratios. While the second part of the calculation is the TOR method algorithm. The TOR method was previously applied to numerous areas including car selection, personnel selection, and vehicle routing problems [5], [21], [22]. Fig. 1 shows the flowchart of this study.

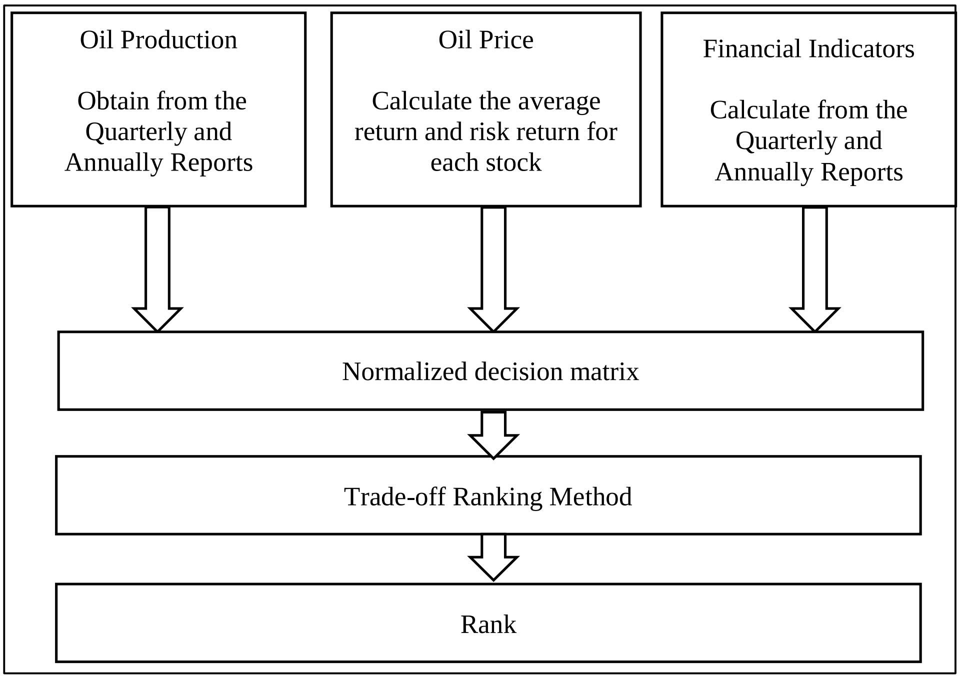

Figure 1: Flowchart of the study

The daily prices of each oil and gas producer's stocks are used to calculate the return prices. The return and average prices for each oil and gas producer stock are calculated by using equations (1) and (2), respectively. The return prices are expressed in logarithmic form as follows:

$$R_t = \ln(P_t) - \ln(P_{t-1}) \tag{1}$$

where,

R_t is the daily return of the stock at the time t,

P_t is the daily stock price at the time t,

P_{t-1} is the daily stock price at time $t-1$.

The average return prices of each stock, $\overline{R}$ are calculated as follows:

$$\overline{R} = \frac{\sum_{t=1}^{n} R_t}{n} \tag{2}$$

where n is the number of trading days.

Next, the risk for each stock is measured using the standard deviation (SD) formula. The SD is calculated by using equation (3). SD is a risk measurement in the financial field that be used to calculate the volatility between the stocks. The smaller the SD value, the less volatile it is, and vice versa. This study uses actual data (stock price) to evaluate the return risk criteria, as opposed to expert evaluations that typically use a fuzzy number system, so this study is more applicable to real-world cases. The risk calculation is based on the daily return prices of each oil and gas producer’s stocks using the SD formula as follows:

$$SD = \sqrt{\frac{\sum (r_i - \overline{r})^2}{n-1}} \tag{3}$$

where,

r_i is the return of the stock i,

$\overline{r}$ is the average return,

n is the number of trading days.

After the average return and return risk calculation, the TOR method is used. TOR method uses the distance from an alternative to the other alternatives to decide the ranking. The determination of the ranking in the TOR method depends on the total distances between those alternatives. The distance reflects the degree of trade-off between the solutions. To make the methodology clearer to the readers, the decision matrix for the MCDM problem is shown in Table 3. Assuming that there are A alternatives, C criteria and P_{ij} denotes the performance of criterion j in terms of alternative i and w_i denotes the weight of the criterion, where $i = 1, 2, ..., a; j = 1, 2, ..., c$.

Table 3: The decision matrix

	Criterion				
Alternative	C_1	C_2	C_3	$\cdots$	C_c
A_1	P_{11}	P_{12}	P_{13}	$\cdots$	P_{1c}
A_2	P_{21}	P_{22}	P_{23}	$\cdots$	P_{2c}
A_3	P_{31}	P_{32}	P_{33}	$\cdots$	P_{3c}
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
A_a	P_{a1}	P_{a2}	P_{a3}	$\cdots$	P_{ac}

The TOR method algorithm to calculate the distance between points (stocks as alternatives) is as follows:

Step 1: The calculation starts with the normalization of the criteria value, P_{ij} (return and risk). The normalization of the performance of criterion j in the alternative i, P_{ij} using the equation:

$$f_{ij} = \frac{P_{ij} - \min_j P_{ij}}{\max_j P_{ij} - \min_j P_{ij}}, i = 1, 2, ..., a, j = 1, 2, ..., c. \tag{4}$$

Step 2. Determination of the objective of every criterion either maximum or minimum cases.

Step 3. Determination of the extreme solutions, $ES_k^*, k = 1, 2, ..., \mathrm{c},$ using the formula as follows:

$$ES_k^* = \left\{\min_{1 \le i \le a} f_{ij}\right\}, j = 1, 2, ..., c, \text{ for the cost criteria, or}$$

$$ES_k^* = \left\{\max_{1 \le i \le a} f_{ij}\right\}, j = 1, 2, ..., c, \text{ for the benefit criteria.} \tag{5}$$

Step 4. The TOR method has two selection levels. The first level is the calculation of the distance between an alternative to an extreme solution while the second level is the calculation between an alternative with other alternatives if the degree of trade-off, DT^1 value is the same.

i. The first level of TOR method selection:

- Calculate the distance between an alternative, A to an extreme solution ES_k^* denoted as $d_{TOR}\left(ES_k^*, A^\alpha\right)$, using the equation as follows:

$$d_{TOR1}\left(ES_k^*, A^\alpha\right) = \left[\sum_{j=1}^{c}\left(f_{kj}, f_{\alpha j}\right)^2\right]^{1/2}, \alpha = 1,2,...,a, k = 1,2,...,c. \tag{6}$$

- Calculate the degree of trade-off, DT between all extreme solutions with an alternative using the formula as follows,

$$DT_{A^\alpha}^1 = \sum_{j=1}^{c}\left[w_j \times d_{TOR1}\left(ES_k^*, A^\alpha\right)\right], \alpha = 1,2,...,a, k = 1,2,...,c. \tag{7}$$

where w_j is the weight or importance of the j^{th} criterion.

ii. The second level of TOR method selection:

- Calculate the distance between the alternatives denoted $d_{TOR2}\left(A^\alpha, A^\beta\right)$, using the equation as follows:

$$d_{TOR2}\left(A^\alpha, A^\beta\right) = \left[\sum_{j=1}^{c}\left(\overline{P}_{\alpha j} - \overline{P}_{\beta j}\right)^2\right]^{1/2}, \alpha, \beta = 1,2,...,a, \tag{8}$$

where the weighted performance of an alternative i in criterion j.

$$\overline{P_{ij}} = w_j \times f_{ij}, i = 1,2,...,a, j = 1,2,...,c. \tag{9}$$

- Calculate the degree of trade-off, DT between the alternatives using the formula as follows,

$$DT_{A_\alpha}^2 = \sum_{i=1}^{a}\left[d_{TOR2}\left(A_\alpha, A_i\right)\right], \alpha = 1,2,...,a. \tag{10}$$

Step 5. Rank the best alternative with the lowest value of DT^1. If the values DT^1 are the same, then rank the best alternatives with the lowest value of DT^2.

5. EXPERIMENTAL STUDY AND DISCUSSION

This section shows the experimental part and discussion of the study. After obtaining all the initial data to be used for this study, the initial table for subsector oil and gas producers' stocks' data is shown in Table 4. This study selected four alternatives which are Hengyuan Refining Company Bhd (A1), Hibiscus Petroleum Bhd (A2), Petron Malaysia Refining & Marketing Bhd (A3) and Reach Energy Bhd (A4). While there are ten criteria (C1 to C10) involved in this study. There are seven maximize criteria which are revenue, sales volume, oil production, average return, earnings per share, return on equity, and return on assets criteria. Meanwhile, there are three minimize criteria which are return risk, debt-to-equity, and total debt ratio. In this study, average weights are used for all criteria since the return and risk are as important as oil production, profitability, and leverage ratios during this pandemic crisis. This may be used to evaluate the companies' strength to face the pandemic crisis.

Table 4: The initial table for subsector oil and gas producers' stocks' data

Criterion	Goal	Hengyuan Refining Company Bhd (A1)	Hibiscus Petroleum Bhd (A2)	Petron Malaysia Refining & Marketing Bhd (A3)	Reach Energy Bhd (A4)
Revenue (C1)	Max	9,326,202,000	1,739,196,000	8,250,642,000	111,019,000
Sales Volume (barrels) (C2)	Max	41,000,000	2,630,000	33,600,000	601,250
Oil production (barrels per day) (C3)	Max	156,000	32,696	88,000	8,187
Average Return (%) (C4)	Max	0.093%	0.120%	0.026%	0.076%
Return Risk (%) (C5)	Min	3.553%	3.819%	2.981%	6.501%
Earnings per share (RM) (C6)	Max	22.14	-0.70	15.96	-0.02
Return on equity (%) (C7)	Max	-1.91%	-1.56%	2.35%	-7.39%
Return on assets (%) (C8)	Max	-0.82%	-0.73%	1.34%	-2.89%
Debt-to-Equity (C9)	Min	1.19	1.00	0.78	1.58
Total debt ratio (C10)	Min	0.54	0.50	0.44	0.61

(Sources: Authors' calculation based on the Quarterly Reports of each company starting from the second quarter 2020 till second quarter 2021 and data from Annual Report 2020)

This section highlights two cases for this study. The first case uses the TOR method with average weights while the second case uses the TOR method with different weights. Both cases are chosen to reflect the different level in TOR calculation, as in formula (6) – (7) for the first level (different weights) and formula (8) – (10) for the second level (average weights).

Firstly, the TOR method with average weights is used in this study. The TOR method starts with the normalization of the initial decision matrix by using Table 4 and the formula (4). The normalized initial decision matrix is shown in Table 5 with average weights for all criteria.

Table 5: The normalized initial decision matrix with average weights

Category	Oil Production			Oil Price		Profitability Ratio			Leverage Ratio	
Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Goal	Max	Max	Max	Max	Min	Max	Max	Max	Min	Min
Weight	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
A1	1	1	1	0.714	0.162	1	0.563	0.488	0.510	0.604
A2	0.177	0.050	0.166	1	0.238	0	0.599	0.510	0.266	0.345
A3	0.883	0.817	0.540	0	0	0.7296	1	1	0	0
A4	0	0	0	0.534	1	0.030	0	0	1	1

Next, the extreme solutions of the TOR method are obtained using formula (5) after the determination of the objective of every criterion either maximum or minimum cases. Then the extreme solution values are used to calculate the distance between an alternative to the extreme solution d_{TOR} and the degree of trade-off DT by using formulas (6) - (10) respectively. The result of the TOR method with average weights is given in Table 6. While the ranking for the case is given in Table 7.

Table 6: The TOR method with average weights result

Trade-off	A1	A2	A3	A4
DT^1	0.884	1.670	0.743	2.476

Referring to Table 6, the smallest DT^1 value is A3, followed by A1, A2, and A4. The smaller the value of the d_{TOR}, the lesser difference in the criterion value for the alternative with the extreme solution (best value in one criterion). That means the closer to the best value of the criterion. Therefore, an alternative that has many of the lowest d_{TOR} values is the best solution in the TOR method. The distance represents the difference, and the less the difference the better the alternative. In conclusion, it can be said that an alternative is becoming more stable. The average weights used in this study can show which alternative is more stable compared to others.

Now, this paper considers another type of criteria weight for the second case by considering higher weights for oil price and profitability ratio categories than the lower weights for oil production and leverage ratio categories. For this new weight assumption, the oil production criteria would be less preferred since the oil production is lower during the pandemic crisis and the stock market is volatile. Also, the leverage ratio has lower weights since the profitability ratio category is assumed high. The new weights for average return and return risk from the oil price category are higher compared to other criteria.

During this pandemic, investors are avoiding the risky market, therefore high weight for return risk is used in this study. Note that, there is no general benchmark to consider either good or bad SD since it depends on the decision makers' investing goals. Some investor wants to be a less risky portfolio, a high SD would be considered as bad. Meanwhile, investors who seek more aggressive decisions for taking riskier portfolios would consider it a good decision. But this paper believes the investors are more careful on riskier stocks during risky situations. In addition, the energy sector is most affected during this pandemic phase. This paper shows the most stable oil and gas producers' stocks that still can be considered to invest in especially after the pandemic becomes endemic. It is reasonable to buy at good stock performance even though the sector is affected badly yet they can survive.

Assume that the new weights of C1 to C10 are 0.02, 0.02, 0.02, 0.30, 0.30, 0.10, 0.10, 0.10, 0.02 and 0.02, respectively. By using the same calculation process as the first case, the result is shown in Table 7. Table 7 shows the comparison results between the TOR method with average weights and the TOR method with different weights for first and second cases respectively.

Table 7: The comparison results between the TOR method with average weights and the TOR method with different weights

Rank	First case: TOR method with average weights	Second case: TOR method with different weights
1	A3	A3
2	A1	A2
3	A2	A1
4	A4	A4

For the first case, A3 (Petron Malaysia Refining & Marketing Bhd) is the best stock followed by the second, third and fourth ranks which are stocks A1 (Hengyuan Refining Company Bhd), A2 (Hibiscus Petroleum Bhd) and A4 (Reach Energy Bhd) respectively. The criteria weights are equal in this case. Note that, by referring to Table 5, A3 has the highest value for maximizing criteria (C6-C8) and also has the lowest value for minimizing criteria (C5, C9-C10). These values are used as extreme solutions to calculate the trade-off distance between each alternative to their respective extreme solution. Thus, Petron Malaysia Refining & Marketing Bhd is the best alternative since it has the most balanced traits.

Besides that, for the second case, A3 (Petron Malaysia Refining & Marketing Bhd) is the best stock followed by the second, third and fourth ranks which are stocks A2 (Hibiscus Petroleum Bhd), A1 (Hengyuan Refining Company Bhd) and A4 (Reach Energy Bhd). The new weights are assumed for this case whereas average return, return risk, earnings per share, return on equity and return on assets are higher in weights than the others. Note that, Petron Malaysia Refining & Marketing Bhd has a balancing characteristic that shows its least compromise to all criteria compared to Hibiscus Petroleum Bhd, Hengyuan Refining Company Bhd and Reach Energy Bhd.

In this case, the most important criteria are C4 and C5 with the highest weights among others. The second highest criteria weights are C6, C7 and C8. Note that, even though A3 has the lowest average return (C4) among other stocks, but A3 has the best value for C5 to C10 with higher weights for C5 to C8. Hence, Petron Malaysia Refining & Marketing Bhd holds the best rank as it has the best value in most criteria, even though it has the worst value in one criterion with higher weights.

Note that, Petron Malaysia Refining & Marketing Bhd is ranked first while Reach Energy Bhd is ranked fourth for both average weights and new weights cases. For both types of cases, the distance position of the Petron Malaysia Refining & Marketing Bhd among all other stocks is consistent in all criteria between average or new weights. Therefore, Petron Malaysia Refining & Marketing Bhd is the least compromise solution using the TOR method. Meanwhile, referring to Table 5, Reach Energy Bhd is the worst alternative for both cases as it has the lowest value for maximizing criteria (C1-C3 and C7-C8) and the highest value for minimizing criteria (C5, C9-C10). Therefore, Reach Energy Bhd is the most compromised solution for both cases in this study.

To validate the methodology, a comparison of TOR with the renowned MCDM method, TOPSIS is done [23], [24]. The TOPSIS method as explained in Xuan, H. et. al. [25] is employed. Table 8 shows the results of the methods' comparison.

Table 8: The comparison results between the TOR method with TOPSIS.

Rank	First case: TOR method with average weights	First case: TOPSIS method with average weights	Second case: TOR method with different weights	Second case: TOPSIS method with different weights
1	A3	A1	A3	A2
2	A1	A3	A2	A1
3	A2	A2	A1	A3
4	A4	A4	A4	A4

From Table 8, the TOR method is on par with TOPSIS in comparison. The high-ranking portfolios (first and second) are between two similar options, interchangeably. Also, in both methods, A4 (Reach Energy Bhd) holds the lowest ranking in both weight cases. Note that, the TOR method chooses the most compromised option as its first choice, while TOPSIS selects alternatives based on their similarity to the ideal and anti-ideal solutions.

5. CONCLUSION

In this research, a TOR method has been tested to solve the stock selection problem. Stock selection is a problem with the conflicting multi-criteria. This study provides some criteria that are related to the current pandemic situation whereas oil production and price data are used in the decision-making process. Apart from those, the study also considers return and risk as compromise criteria to show which stocks are the least compromised in the oil and gas subsector. The study timeframe is during the pandemic and the PN ruling in Malaysia. The cases considered MCDM problems with average and different weights. As a comparison, the TOR method performs a ranking analysis in par with TOPSIS. The further potential research for this study is expanding the criteria set and increasing the number of stocks (alternatives) into consideration, especially from other sectors or other asset classes. Furthermore, a fuzzy set to represent qualitative data and experts' evaluations may be considered. Qualitative factors, such as expert opinions, textual data, or subjective judgments, can add valuable insights to decision-making processes. However, different experts may have varying biases, making it challenging to quantify and compare them. To overcome the challenge, fuzzy logic, and linguistic variables can be employed to represent and manage imprecise qualitative information, allowing for more flexible and nuanced modeling. Qualitative data can be converted into linguistic variables with fuzzy membership functions, e.g. excellent, average, poor. Fuzzy logic accommodates uncertainty and vagueness in the qualitative data. It allows for a more accurate reflection of real-world ambiguity, where data is seldom completely precise.

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