Performance Evaluation of Construction Companies in Malaysia with Entropy-VIKOR Model

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Abstract. Construction industry is an important industry that has an enormous impact on the country’s economic development. Nowadays, the government strives to encourage the construction industry to develop the advanced and modern infrastructure that related to health, transport, education, and housing. As a result, the Malaysian construction sector companies’ financial performance is studied in this paper based on the crucial financial ratios. This paper aims to assess and compare the Malaysian construction sector companies’ financial performance based on Entropy-VIKOR model. In this paper, the listed construction companies in Malaysia are investigated. The findings of this paper demonstrate that ZECON, DKLS, GADANG, TRIPLC, and MELATI are ranked as the top five construction companies based on the proposed model. The importance of this paper is to assess the construction companies’ financial performance as well as identify the weights of the financial ratios in assessing the Malaysian construction sector companies’ financial performance with the proposed Entropy-VIKOR model.

Keywords: Conceptual framework, performance assessment, VIKOR, multi-criteria decision making.
1. Introduction

Construction industry is an important industry that has an enormous impact on the economic development and national societies of any nation [1-5]. Malaysia has started to develop the construction industry since the significance of the construction sector has been realized. Construction industry plays an effective and significant role in providing great support to aggregate economy with other economy sectors [6]. In addition, it can also contribute in creating huge employment opportunities in the nation [7]. The development of the construction industry is directly proportional to the national economy [2]. As a result, the construction sector is important in providing a better life quality to the country that is crucial for the development of the country [7].

As a result, the Malaysian construction sector companies’ financial performance is studied in this paper based on the crucial financial ratios. VIKOR is a multi-criteria decision making model (MCDM) which assists the decision makers to make the selection and ranking from a number of alternatives in the presence of multiple contradictory and non-commensurable decision criteria [8-10]. The merit of the VIKOR model is to select alternatives with conflicting and inconsistent criteria [11-15]. The compromise solution in the VIKOR model is a feasible solution that is the closest to the ideal [16, 17]. Therefore, VIKOR model is proposed to assess the construction companies’ financial performance in this study. Besides that, the entropy weight method focuses to identify the weights of the decision criteria, according to Shannon and Weaver [18].

The application of Entropy-VIKOR model in various fields has been studied by the past researchers such as flood risk [19], environmental impacts [20], natural fiber reinforced brake friction material [21], Pelton turbine bucket [22], solar air flow channel [23] and environmental protection enterprises [24]. Since there is no comprehensive study on the construction companies in Malaysia, therefore this paper aims to bridge the research gap by assessing the Malaysian construction sector companies’ financial performance with the proposed Entropy-VIKOR model. This paper aims to evaluate and compare the Malaysian construction sector companies’ financial performance with Entropy-VIKOR model. This paper will highlight the significance of research by considering important financial ratios in measuring the Malaysian construction sector companies’ financial performance. The structure of this paper is organized as follows. The following section outlines the data and methodology used in detail along with procedural steps. Section 3 demonstrates the empirical results. Lastly, conclusions are drawn in the last section of this paper.

2. Data and Methodology

In this paper, the financial performance of the construction companies that listed in Malaysia stock market is analysed [25]. The data are gathered from the construction sector companies’ financial annual report in year 2016. Table 1 shows the proposed conceptual framework to assess the Malaysian construction sector companies’ financial performance with Entropy-VIKOR model.

Table 1. Proposed conceptual framework.

| Level       | Evaluation of construction sector companies’ financial performance |
|-------------|---------------------------------------------------------------|
| Objective   | Current ratio (CR), Debt to assets ratio (DAR), Debt to equity |
|             | ratio (DER), Earnings per share (EPS), Return on asset (ROA), |
|             | Return on equity (ROE)                                       |
| Decision criteria | AZRB, BENALEC, BPURI, BREM, CRESBLD, DKLS,                  |
|             | ECONBHD, EKOVEST, FAJAR, GADANG, GAMUDA, GBGAQRS, HOHUP,   |
|             | HSL, IJM, IKHMAS, KERJAYA, KIMLUN, LEBTECH, MELATTI,       |
|             | MERGE, MITRA, MLGLOBAL, MUHIBAH, PESONA, PTRASCO, PSIPTEK, |
|             | PTARAS, SUNCON, SYCAL, TRC, TRIPLC, TSRCAP, VIZIONE, WCHEHB,|
| Decision alternatives | WCT, ZECON                                                          |

According to past studies, the six important financial ratios such as CR, EPS, ROA, ROE, DAR, and DER are considered in this study [26-33]. In this study, CR, EPS, ROA, and ROE are required to be maximized whereas the financial ratios that needed to be minimized are DAR and DER.
The Entropy-VIKOR model consists of seven steps [34-37].

Step 1: Calculate the weight of the decision criteria by using entropy weight method. Calculate the proportion \( p_{ij} \) of alternative \( m \) under criteria \( n \).

\[
p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, \quad i=1,2,...,m, \quad j=1,2,...,n
\]  

(1)

Step 2: Determine the entropy “\( e_j \)” of alternative \( m \).

\[
e_j = -k \sum_{i=1}^{m} p_{ij} \ln(p_{ij}), \quad j=1,2,...,n
\]  

(2)

where

\[
k = \frac{1}{\ln(m)}
\]

Step 3: Determine the entropy weight “\( w_j \)” of alternative \( m \).

\[
w_j = \frac{1-e_j}{\sum_{j=1}^{n} (1-e_j)}, \quad j=1,2,...,n
\]  

(3)

Step 4: Identify the worst \( f_j^- \) and the best \( f_j^\ast \) values for all the criterion functions, where \( j=1,...,n \).

Step 5: Compute \( S_j \) for \( i=1,...,m, \quad j=1,...,n \) where \( n \) is the number of criteria and \( m \) is the number of alternatives. \( f_{ij} \) refer to the score for alternative \( i \) with criterion \( j \).

\[
S_{ij} = \frac{w_j(f_{ij}^\ast - f_{ij}^-)}{(f_{j}^\ast - f_j^-)}, \quad i=1,...,m, \quad j=1,...,n
\]  

(4)

Step 6: Determine the \( S_i, R_i \) and \( Q_i \) values, \( i=1,...,m \). \( v \) is referring to the maximum group utility’s strategy weight. \( v \) is equal to 0.5.

\[
S_i = \sum_{j=1}^{n} w_j(f_{ij}^\ast - f_{ij}^-), \quad i=1,...,m
\]  

(5)

\[
R_i = \max \left( \frac{w_j(f_{ij}^\ast - f_{ij}^-)}{(f_{j}^\ast - f_j^-)}, i=1,...,m \right)
\]  

(6)

\[
Q_i = v \left( \frac{S_i - S^\ast}{S^\ast - S^-} + (1-v) \frac{R_i - R^\ast}{R^\ast - R^-} \right)
\]  

(7)

where

\[
S^\ast = \max (S_i, i=1,...,m)
\]

\[
S^- = \min (S_i, i=1,...,m)
\]

\[
R^\ast = \max (R_i, i=1,...,m)
\]

\[
R^- = \min (R_i, i=1,...,m)
\]

Step 7: Give the ranking of the alternatives based on the \( Q \) values [14, 38]. Select the best alternative by choosing the smallest \( Q \) value.

3. Empirical Results

Figure 1 presents the weights of the decision criteria. As displayed in Fig. 1, the weights of the decision criteria have been determined by the entropy weight method. The EPS gives the highest weights of 0.2992 followed by ROE (0.2190), ROA (0.1972), DAR (0.1886), CR (0.0604), and lastly DAR (0.0357). According to the weights of each financial ratio, CR and DAR are less important compared to EPS, ROE, ROA, and DER. On the other hand, it also indicates that EPS, ROE, ROA, and DER are the most crucial decision criteria in assessing the construction sector companies’ financial performance in this study. Table 2 presents the best \( f_j^\ast \) and the worst \( f_j^- \) values for all the financial ratios.

As shown in Table 2, the worst \( f_j^- \) and the best \( f_j^\ast \) values for all the financial ratios are identified. As a result, the best \( f_j^\ast \) values for CR, DAR, DER, EPS, ROA, and ROE are 4.7116, 0.1799, 0.2, 16.3540, 58.0629, respectively. In contrast, the worst \( f_j^- \) values for CR, DAR, DER, EPS, ROA, and ROE are 0.1121, 0.8910, 0.2193, 0.7971, 0.1972, and 0.0604, respectively. Table 3 presents the normalized decision matrix of this study, whereas Table 4 demonstrates the scores and ranking of the construction companies.
Fig. 1. Weights of the decision criteria.

Table 2. The worst $f_j^-$ and the best $f_j^*$ values for all the financial ratios.

| Criteria | Worst ($f_j^-$) | Best ($f_j^*$) |
|----------|----------------|----------------|
| CR       | 0.1121         | 4.7116         |
| DAR      | 0.8910         | 0.1799         |
| DER      | 8.1781         | 0.2193         |
| EPS      | 0.0004         | 0.7971         |
| ROA      | 0.0508         | 16.3540        |
| ROE      | 0.0962         | 58.0629        |

Table 3. Normalized decision matrix.

| Company | CR   | DAR   | DER   | EPS   | ROA   | ROE   |
|---------|------|-------|-------|-------|-------|-------|
| AZRB    | 0.0386 | 0.0357 | 0.1886 | 0.2802 | 0.1894 | 0.1954 |
| BENALEC | 0.0357 | 0.0181 | 0.0228 | 0.2910 | 0.1817 | 0.2084 |
| BPURI   | 0.0475 | 0.0321 | 0.1030 | 0.2787 | 0.1883 | 0.2028 |
| BREM    | 0.0199 | 0.0007 | 0.0005 | 0.2701 | 0.1572 | 0.2036 |
| CRESBLD | 0.0414 | 0.0256 | 0.0475 | 0.2675 | 0.1843 | 0.2058 |
| DKLS    | 0.0412 | 0.0100 | 0.0093 | 0.0959 | 0.1047 | 0.1724 |
| ECONBHD | 0.0329 | 0.0111 | 0.0107 | 0.2519 | 0.0000 | 0.1161 |
| EKOVEST | 0.0377 | 0.0246 | 0.0429 | 0.2310 | 0.1506 | 0.1747 |
| FAJAR   | 0.0355 | 0.0171 | 0.0206 | 0.2667 | 0.1263 | 0.1727 |
| GADANG  | 0.0265 | 0.0191 | 0.0251 | 0.1618 | 0.1041 | 0.1526 |
| GAMUDA  | 0.0307 | 0.0156 | 0.0176 | 0.1955 | 0.1407 | 0.1843 |
| GBGAQRS | 0.0421 | 0.0231 | 0.0371 | 0.2722 | 0.1628 | 0.1889 |
| HOHUP   | 0.0399 | 0.0182 | 0.0230 | 0.2341 | 0.0826 | 0.1405 |
| HSL     | 0.0153 | 0.0007 | 0.0005 | 0.2630 | 0.1196 | 0.1890 |
| IJM     | 0.0228 | 0.0153 | 0.0170 | 0.1986 | 0.1440 | 0.1868 |
| IKHMAS  | 0.0419 | 0.0195 | 0.0259 | 0.2919 | 0.1701 | 0.1994 |
| KERJAYA | 0.0357 | 0.0050 | 0.0040 | 0.2257 | 0.0856 | 0.1699 |
| KIMLUN  | 0.0355 | 0.0137 | 0.0144 | 0.2002 | 0.0972 | 0.1620 |
| LEBTECH | 0.0192 | 0.0048 | 0.0038 | 0.2973 | 0.1927 | 0.2171 |
| MELATI  | 0.0240 | 0.0044 | 0.0035 | 0.2049 | 0.0705 | 0.1650 |
| MERGE   | 0.0429 | 0.0153 | 0.0171 | 0.2887 | 0.1785 | 0.2076 |
| MITRA   | 0.0399 | 0.0161 | 0.0186 | 0.2313 | 0.0792 | 0.1451 |
| MLGLOBAL | 0.0485 | 0.0147 | 0.0160 | 0.2990 | 0.1972 | 0.2190 |
| MUHIBAH | 0.0475 | 0.0243 | 0.0415 | 0.1740 | 0.1503 | 0.1753 |
| PESONA  | 0.0428 | 0.0205 | 0.0287 | 0.2878 | 0.1283 | 0.1666 |
| PRTASCO | 0.0460 | 0.0264 | 0.0519 | 0.2529 | 0.1521 | 0.1707 |
| PSIPTEK | 0.0366 | 0.0162 | 0.0188 | 0.2934 | 0.1816 | 0.2092 |
| PTARAS  | 0.0000 | 0.0000 | 0.0000 | 0.2585 | 0.1446 | 0.1991 |
As presented in step 6, the $S^-$, $S^+$, $R^-$ and $R^+$ have been determined in this study, $S^- = 0.2262$, $S^+ = 0.9279$, $R^- = 0.0880$, $R^+ = 0.2992$ and $v = 0.5$. In this study, there are total of 37 construction companies evaluated based on important financial ratios such as CR, EPS, ROA, ROE, DAR, and DER.

Table 5 presents the performance ranking of construction companies.

| Company  | Values $S$ | Values $R$ | Values $Q$ |
|----------|------------|------------|------------|
| AZRB     | 0.9279     | 0.2802     | 0.9551     |
| BENALEC  | 0.7577     | 0.2910     | 0.8593     |
| BPURI    | 0.8524     | 0.2787     | 0.8977     |
| BREM     | 0.6520     | 0.2701     | 0.7345     |
| CRESBLD  | 0.7721     | 0.2675     | 0.8140     |
| DKL      | 0.4336     | 0.1724     | 0.3477     |
| ECONBHD  | 0.4228     | 0.2519     | 0.5282     |
| EKOVEST  | 0.6616     | 0.2310     | 0.6489     |
| FAJAR    | 0.6389     | 0.2667     | 0.7171     |
| GADANG   | 0.4894     | 0.1618     | 0.3624     |
| GAMUDA   | 0.5845     | 0.1955     | 0.5099     |
| GBGAQRS  | 0.7262     | 0.2722     | 0.7923     |
| HOHUP    | 0.5384     | 0.2341     | 0.5685     |
| HSL      | 0.5880     | 0.2630     | 0.6720     |
| IJM      | 0.5845     | 0.1986     | 0.5171     |
| IKHMAS   | 0.7488     | 0.2919     | 0.8552     |
| KERJAYA  | 0.5239     | 0.2257     | 0.5381     |
| KIMLUN   | 0.5230     | 0.2002     | 0.4771     |
| LEBTECH  | 0.7348     | 0.2973     | 0.8578     |
| MELATI   | 0.4723     | 0.2049     | 0.4522     |
| MERGE    | 0.7503     | 0.2887     | 0.8486     |
| MITRA    | 0.5302     | 0.2313     | 0.5560     |
| MLGLOBAL | 0.7943     | 0.2990     | 0.9043     |
| MUHIBAH  | 0.6129     | 0.1753     | 0.4823     |
| PESONA   | 0.6748     | 0.2878     | 0.7928     |
| PRTASCO  | 0.7000     | 0.2529     | 0.7281     |
| PSIPTEK  | 0.7557     | 0.2934     | 0.8635     |
| PTRAS    | 0.6021     | 0.2585     | 0.6715     |
| SUNCON   | 0.6261     | 0.2634     | 0.7003     |
| SYCAL    | 0.7619     | 0.2920     | 0.8647     |
| TRC      | 0.7083     | 0.2775     | 0.7923     |
| TRIPLC   | 0.5870     | 0.1663     | 0.4427     |
| TSRCAP   | 0.7492     | 0.2795     | 0.8261     |
| VIZIONE  | 0.7493     | 0.2992     | 0.8727     |
| WCHEHB   | 0.7690     | 0.2889     | 0.8625     |
| WCT      | 0.7759     | 0.2799     | 0.8461     |
| ZECON    | 0.2262     | 0.0880     | 0.0000     |

Table 4. Scores of the construction companies.
Table 5. Performance ranking of construction companies.

| Company     | Ranking |
|-------------|---------|
| AZRB        | 37      |
| BENALEC     | 30      |
| BPURI       | 35      |
| BREM        | 20      |
| CRESBLD     | 24      |
| DKLS        | 2       |
| ECONBHD     | 10      |
| EKOVEST     | 14      |
| FAJAR       | 18      |
| GADANG      | 3       |
| GAMUDA      | 8       |
| GBGAQRS     | 22      |
| HOHUP       | 13      |
| HSL         | 16      |
| IJM         | 9       |
| IKHMAS      | 28      |
| KERJAYA     | 11      |
| KIMLUN      | 6       |
| LEBTECH     | 29      |
| MELATI      | 5       |
| MERGE       | 27      |
| MITRA       | 12      |
| MLGLOBAL    | 36      |
| MUHIBAH     | 7       |
| PESONA      | 23      |
| PRTASCO     | 19      |
| PSIPTEK     | 32      |
| PTARAS      | 15      |
| SUNCON      | 17      |
| SYCAL       | 33      |
| TRC         | 21      |
| TRIPLC      | 4       |
| TSRCAP      | 25      |
| VIZIONE     | 34      |
| WCHEHB      | 31      |
| WCT         | 26      |
| ZECON       | 1       |

Based on the proposed conceptual framework with Entropy-VIKOR model, the decision alternative with the lowest value of $Q$ will be classified as the best alternative among the number of alternatives under consideration. Therefore, ZACON has been identified as the best construction company with $S$, $R$, and $Q$ of 0.2262, 0.0880, and 0.0000, respectively. On the other hand, AZRB is ranked as the lowest position based on $S$, $R$, and $Q$ of 0.9279, 0.2802, and 0.9551, respectively. In this study, ZECON gives the lowest value of $Q$, therefore ZECON achieves the first ranking among the construction companies, followed by DKLS, GADANG, TRIPLC, MELATI, KIMLUN, MUHIBAH, GAMUDA, IJM, ECONBHD, KERJAYA, MITRA, HOHUP, EKOVEST, PTARAS, HSL, SUNCON, FAJAR, PRTASCO, BREM, TRC, GBGAQRS, PESONA, CRESBLD, TSRCAP, WCT, MERGE, IKHMAS, LEBTECH, BENALEC, WCHEHB, PSIPTEK, SYCAL, VIZIONE, BPURI, MLGLOBAL and finally AZRB. In summary, ZECON has been identified as the best construction company in terms of financial performance among the listed construction companies in Malaysia. The contribution of this study is to provide a reference to those investors who are interested to make an investment in the field of construction.

4. Conclusion

In this study, the Entropy-VIKOR model is proposed in measuring the Malaysian construction sector companies’ financial performance. This study demonstrates the successful implementation of Entropy-VIKOR model. The results of this study show that ZECON, DKLS, GADANG, TRIPLC, and MELATI are the top five construction companies based on the proposed model. Moreover, the findings demonstrate
that the most crucial financial ratio in assessing the financial performance of the construction companies is EPS, followed by ROE, ROA, DER, CR, and lastly DAR. The importance of this paper is to help determine the construction sector companies' financial performance as well as determine the weights of the decision criteria in measuring the Malaysian construction sector companies’ financial performance with the proposed Entropy-VIKOR model. For future study, the Entropy-VIKOR model can be extended and applied to other fields by considering the important attributes and criteria.

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