Engineering Journal issn: 0125-8281

Article

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.

ENGINEERING JOURNAL Volume 25 Issue 1
Received 9 June 2020
Accepted 25 November 2020
Published 31 January 2021
Online at https://engj.org/
DOI:10.4186/ej.2021.25.1.297

This article is based on the presentation at the 4th International Conference on Research Methodology for Built Environment and Engineering 2019 (ICRMBEE 2019) in Bangkok, Thailand, 24th-25th April 2019.

DOI:10.4186/ej.2021.25.1.297

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	
Objective	Evaluation of construction sector companies' financial performance
Decision criteria	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 alternatives	AZRB, BENALEC, BPURI, BREM, CRESBLD, DKLS, ECONBHD, EKOVEST, FAJAR, GADANG, GAMUDA, GBGAQRS, HOHUP, HSL, IJM, IKHMAS, KERJAYA, KIMLUN, LEBTECH, MELATI, MERGE, MITRA, MLGLOBAL, MUHIBAH, PESONA, PRTASCO, PSIPTEK, PTARAS, SUNCON, SYCAL, TRC, TRIPLC, TSRCAP, VIZIONE, WCHEHB, 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.

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, i = 1, 2, ..., m, \; j = 1, 2, ..., n \quad (1)$$

Step 2: Determine the entropy "e_j" of alternative m.

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

where

$$k = \frac{1}{\ln(m)}$$

Step 3: Determine the entropy weight "w_j" of alternative m.

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n} (1 - e_j)}, \; j = 1, 2, ..., n \quad (3)$$

Step 4: Identify the worst f_j^- and the best f_j^* values for all the criterion functions, where $j = 1, ..., n$.

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

$$S_{ij} = \frac{w_j (f_j^* - f_{ij})}{(f_j^* - f_j^-)}, i = 1, ..., m, \; j = 1, ..., n \quad (4)$$

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.

$$S_i = \sum_{j=1}^{n} \frac{w_j (f_j^* - f_{ij})}{(f_j^* - f_j^-)}, i = 1, ..., m \quad (5)$$

$$R_i = \max \frac{w_j (f_j^* - f_{ij})}{(f_j^* - f_j^-)}, i = 1, ..., m \quad (6)$$

$$Q_i = v \frac{(S_i - S^*)}{(S^- - S^*)} + (1 - v) \frac{(R_i - R^*)}{(R^- - R^*)} \quad (7)$$

where

$$S^- = \max \; (S_i, i = 1, ..., m)$$
$$S^* = \min \; (S_i, i = 1, ..., m)$$
$$R^- = \max \; (R_i, i = 1, ..., m)$$
$$R^* = \min \; (R_i, i = 1, ..., m)$$

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), DER (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^* 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^* values for all the financial ratios are identified. As a result, the best f_j^* values for CR, DAR, DER, EPS, ROA, and ROE are 4.7116, 0.1799, 0.2193, 0.7971, 16.3540, and 58.0629, respectively. In contrast, the worst f_j^- values for CR, DAR, DER, EPS, ROA, and ROE are 0.1121, 0.8910, 8.1781, 0.0004, 0.0508 and 0.0962, respectively. Table 3 presents the normalized decision matrix of this study, whereas Table 4 demonstrates the scores and ranking of the construction companies.

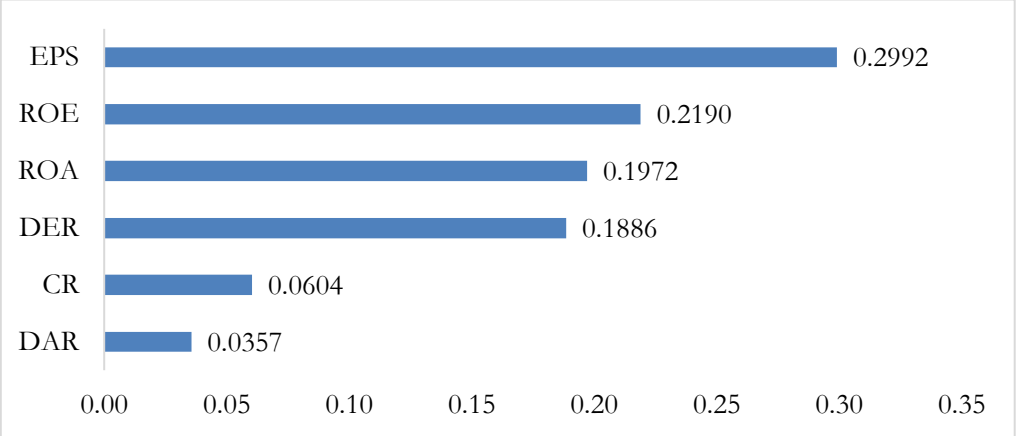

Fig. 1. Weights of the decision criteria.

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	0.0836	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

Company	CR	DAR	DER	EPS	ROA	ROE
SUNCON	0.0604	0.0256	0.0478	0.2634	0.1042	0.1248
SYCAL	0.0355	0.0181	0.0228	0.2920	0.1838	0.2098
TRC	0.0419	0.0178	0.0220	0.2775	0.1570	0.1920
TRIPLC	0.0349	0.0260	0.0496	0.1636	0.1466	0.1663
TSRCAP	0.0453	0.0213	0.0312	0.2795	0.1725	0.1993
VIZIONE	0.0256	0.0083	0.0073	0.2992	0.1923	0.2167
WCHEHB	0.0141	0.0264	0.0517	0.2889	0.1836	0.2042
WCT	0.0431	0.0220	0.0333	0.2799	0.1871	0.2105
ZECON	0.0519	0.0310	0.0880	0.0000	0.0554	0.0000

Table 4. Scores of the 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
DKLS	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
PTARAS	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

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.

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.

Acknowledgement

This study is supported by Universiti Tunku Abdul Rahman (UTAR), Malaysia.

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