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Performance Ranking of Construction Companies using Data Envelopment Analysis Model

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ABSTRACT

Construction sector is an important industry in contribution economy growth of Malaysia. At this presence time, inflation cost is the critical issue that facing by construction sector companies which impacting the financial performance. The purpose of this study is to investigate the performance of 42 construction companies listed in main market of Bursa Malaysia by Data Envelopment Analysis (DEA) model and super-efficiency DEA with duration from year 2013 until 2022. The analysis measurement uses an output-oriented approach which contains the six key financial ratios to identify the most efficient companies. The data that obtained from financial reports through Bursa Malaysia are utilized. The finding of this paper reveals various in efficiency score among the construction sector companies which underscoring the notability of employing the operational efficiency, enhancing construction sector performance for sustainability as well as the ability of competitiveness significantly. This research delivers the valuable findings to the literature on evaluation of efficiency performance within the construction sector, which hold the significant implications for various stakeholders and improvement on their strategic decision making. The future research of this study can be extended to further examine other sector companies such as agricultural product sector, food and beverage sector and etc. through examining efficiency.

1. Introduction

The construction sector is one of the largest sectors in Malaysia. Although construction sector in Malaysia was facing a big challenge in year 2020 due to the pandemic of Covid-19, but it still apportions an increment of Gross Domestic Product (GDP) in year 2021 and followed by year 2022 with the value of -5.1 to 5.0 [1]. Construction sector is an important industry in contribution economy growth of Malaysia although the contribution of, GDP lesser than services, manufacturing and agriculture sector. On 24th February 2023, the Budget Malaysia 2023 was announced which expected Malaysia GDP to be growth approximately 4.5% [2].

For the meantime, the construction sector's GDP in Malaysia was expected to rise by 6.1 per year based on the data that shown in Department of Statistics Malaysia [3]. Through the Malaysia Digital

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Economy Blueprint, the Construction 4.0 Strategic Plan (2021-2025) is aligned with it to modernise the construction sector by employing the advance technologies in order to develop a system that is more effective, sustainable and integrated [4]. It is obvious that the construction sector not only one of the important contributors to economic growth in Malaysia through Malaysia's GDP significantly, but it also creates a lot of employment opportunities, boosting the tourism sector, human development as well as enhancing investment sector [5].

Several large-scale construction projects in Malaysia have been completed in recent year, such as The MRT Putrajaya Line, The Exchange 106 Tower, Merdeka 118, and so on. It is emphasised throughout these development projects how the construction industry significantly affects Malaysia's economy. Nevertheless, to achieve the efficiency performance of a company always being a challenging part as involving the complication of the projects, the limitation of resources as well as constantly changing depends on the market conditions. Data Envelopment Analysis (DEA) serve as is a powerful measurement tool that able to evaluate the efficiency and performance of numerous sectors companies, counting construction sector companies. Although DEA is widely applied to many disciplines of areas, but it is still lacking of studies that analysing on construction sector companies in Malaysia applying DEA.

At this presence time, inflation cost is the critical issue that facing by construction sector companies which impacting the financial performance [6]. Construction sector companies may struggle in how to identify on the part that should be improved and how to reallocate or redistribute the existing resources effectively. For that reason, this study will focus on the ranking performance on through the measurement of efficiency by DEA model. Besides, by examining the efficiency and performance on construction companies, this study not only able to robust the construction sector competitiveness, it also contributing to the understanding on theoreticality and practicality of DEA model.

Efficiency is explained by the relationship between the resources and outcome of the process that resulting by the combination from the resources from a company [7]. Alternatively, when individuals in a society optimise their utility in association with the existing resources, the efficiency is essentially achieved [8]. Efficiency is a crucial measurement on the optimal performance which usually determined through the measurement of a production with cost [9]. Generally, efficiency can be evaluated by a non-parameter linear programming method, namely Data Envelopment Analysis (DEA). It was first introduced by three researchers who made significant contribution in the area of operations research. In Charnes *et al.,* [10] seminar paper publication, they provided the methodology on measuring the efficiency for non-profit decision-making unit (DMU). According to Hatami-Marbini and Toloo [11] and Ganesh *et al.,* [12], DEA is a set of measurements which is the ratio of total outputs to total inputs; various inputs and outputs are combined into a single measurement of efficiency.

The comprehensive of the financial analysis through the financial ratios on the construction companies in Malaysia offer important information which able to bring advantageous to decision makers, investors, policymakers and other stakeholders. Tsolas [13] utilized the financial ratios such as current ratio, quick ratio, gross margin, net margin, return on equity (ROE), return on assets (ROA), debt to equity ratio, and equity to assets ratio on Greek construction firms. Based on the study that conducted by Reza Alfianto Siregar and Pardomuan Sihombing [14], the financial ratios such as ROE, DER, CR, Price-to-Book Value (PBV) and Total Asset Turnover (TATO) were analysed that give the effect on stock returns under the construction companies listed on the IDX from year 2015 to 2019. The result shows that ROE, DER, CR, PBV and TATO simultaneously have a significant effect on stock returns.

Gjoni *et al.*, [15] examined the financial performance of 100 construction companies in Albania using the debt ratio, the liquidity ratio and the profitability ratio which covered the year 2018 to 2020. They found that the liquidity ratio and profitability indicator with the ROA indicator has effect positively. To ensure long-term sustainability, therefore the financial ratio analysis need to be prioritized so that it can overcome the challenges that facing by construction companies in Malaysia. Yu *et al.*, [16] studied the green financing efficiency of listed construction companies from 2019 to 2020 using four-stage of DEA model. This study extracted data such as green debt financing cost, green equity financing capacity, green financing scale and green financing structure as input indicators while the return on net assets, earnings per share, total asset turnover and operating income are used as output indicators.

Key performance measurement provides useful significant details of a construction company's financial conditions and stability [17]. The assessment on financial performance of construction companies such a crucial step before embarking new collaboration, partnership or massive projects with other companies [18,19]. Throughout the assessment, the financial analysis such as liquidity, profitability, current ratio, earning per share and so on can help both parties to build up confidence of each other [20,21] as well as can be more understanding on their own firm's capabilities and limitations. Consequently, in order to make sure that construction companies in Malaysia remain resilient, they must watch over on their financial performance. Besides, DEA also serves as a benchmarking tool which is frequently used in Decision Making Unit (DMU) for examples hospitals sector reviewed by Campisi *et al.,* [22], university organizations studied by Peixoto *et al.,* [23], Kaffash *et al.,* [24] studied on bank sector, Daultani *et al.,* [25] investigated on insurance sector, while Mosbah *et al.*, [26] explored on agriculture and Maity *et al.,* [27] looked into service industries and so on which employed DEA as an assessment performance of efficiency analysis. The DEA model as a tool for multi-criteria decision making (MCDM) is investigated for studying various management strategies [28]. In MCDM problems, the decision alternatives are assessed and ranked by considering various decision criteria [29,30].

According to the review of previous studies, there are no comprehensive research that actively examine the efficiency on construction companies in Malaysia. Hence, this current research will fill this gap by using DEA model along with financial ratios. In the view context, this research delivers the valuable findings which hold the significant implications for various stakeholders within the construction sector as well as other related industries. The financial ratios that will be utilized in this research are earnings per share (EPS), ROA and ROE serve as output indicators, while current ratio, debt to assets ratio and debt to equity ratio are used as input indicators. Moreover, the super efficiency in DEA will be employed in this research for further ranking between the efficient companies.

2. Methodology

In this section, the methodology designed to analyse the ranking performance on efficient construction companies by DEA Model will be described. The process of extracting the data, duration to be included, as well as the DEA model employed for this study are explained under this section. Bursa Malaysia [31] is the main stock market in Malaysia which previously name as Kuala Lumpur Stock Exchange (KLSE) that established in 1973. It is one of the largest stock exchange markets in Southeast Asia, which serves as a platform that provides a fully integrated exchange for companies, government and related group by offering a wide variety of exchange-related facilities such as listing, trading of securities, derivatives, settlement and depository services. According to Bursa Malaysia website, currently there are 795 listed companies under main market which include 52 construction

companies. In this research, the data consist of construction companies from construction sector which listed in Bursa Malaysia thru main market. The duration of this study covers from year 2013 until 2022. Although currently there are 52 construction companies that listed in main market of Bursa Malaysia, as some of the annual reports of the construction companies are not completely available. The required criteria for selection are that the annual reports of each company have been publicly and available which covering the entire 2013-2022 period, for ensuring a consistent and reliable dataset for the analysis. By filtering out the information that cannot be obtained through financial statement, hence in this research, the final sample was narrow down to 42 construction companies.

Ratio analysis is a commonly used management tool that provides insights into a company's financial performance and trends over time. In this research, six key financial ratios were selected to evaluate the operational efficiency of construction companies listed on the Bursa Malaysia. The six key financial ratios that utilized as the weighted inputs and weighted outputs which are DAR, DER, CR, EPS, ROE and ROA can be referred to previous studies [29-32]. Table 1 below shows that the six key financial ratios as input and output indicators. Table 2 displays the 42 construction companies listed in Main Market of Bursa Malaysia for evaluation on efficiency applying DEA model.

Table 1
Six key financial ratios as input and output indicators

Input Indicators
DEBT TO ASSETS RATIO (DAR)= (total liabilities)/(total assets)
DEPT TO EQUITY RATIO (DER)= (total liabilities)/(Total Shareholders' Equity)
CURRENT RATIO (CR= (current assets)/(current liabilities)
Output Indicators
EARNING PER SHARE (EPS)= (net profit)/(numbers of shares)
RETURN ON EQUITY (ROE)= (Net Profit)/(Total Shareholders' Equity)
RETURN ON ASSET (ROA) = (Net Profit)/(total assets)

Table 2
The 42 construction companies listed in main market of Bursa Malaysia

AGESON	IJM	PEB
AZRB	IREKA	PESONA
BENALEC	JAKS	PRTASCO
BINAPURI	KERJAYA	PTARAS
CRESBLD	KIMLUN	PUNCAK
DKLS	LEBTECH	SENDAI
EKOVEST	MELATI	SYCAL
FAJAR	MERCURY	TRC
GADANG	MERGE	TSRCAP
GBGAQRS	MGB	VIZIONE
GAMUDA	MITRA	WCHEHB
GKENT	MUDAJYA	WCT
HOHUP	MUHIBAH	ZECON
IHB	OCR	ZELAN

Based on the studies from [36,37], DEA is set of measurement that is generally refer to proportion of weighted total outputs to weighted total inputs, through combination of multiple outputs and

inputs into a single measurement efficiency. The efficiency score that computed through DEA is attain within the range 0 to 1, if a DMU have an efficiency score which is equal 1, then a DMU considered as efficiency; else a DMU is categories as an inefficiency when having the efficiency score that less than one [38,39]. The DEA model output maximization is mathematically expressed [40,41] as follows in Eqs. (1) to (3):

$$\text{Maximize } \theta_k = \sum_{r=1}^{s} u_r y_{rk} \tag{1}$$

Subject to

$$-\sum_{r=1}^{s} u_r y_{rj} + \sum_{i=1}^{m} v_i x_{ij} \geq 0; j = 1,2,3,\dots,n \tag{2}$$

$$\sum_{i=1}^{m} v_i x_{ik} = 1 \tag{3}$$

$$u_r, v_i \geq \varepsilon; r = 1,\cdots,s; i = 1,\cdots,m.$$

Where,

θ_k is relative efficiency of DMU$_k$
s is the number of outputs
u_r is the weights to be determined for output r
m is the number of inputs
$v_i$is the weights to be determined for input i
n is the number of companies
ε is the small positive value

The data that extracted from annual report under financial statement of each construction company were gathered in Microsoft Excel. The LINGO software which can use to solve for linear or non-linear programming models as well as mixed integer programming models was utilized to perform computational work. Then, the super-efficiency DEA model will further compute for efficient companies. The greatest strength of super-efficiency DEA model able to determine the difference between efficient companies. This model is able to distinguish between the companies that are efficient and recalculate their efficiency scores. Following that, a ranking based on the chosen companies' ultimate efficiency scores are attainable. Qiu *et al.,* [42] stated that a super-efficiency score of a DMU must be equal to or greater than one; alternatively, the decision-making unit will be considered invalid. Several published studies on super-efficiency DEA model in various context can be referred to [43-45].

3. Results and Discussions

The efficiency score for construction companies' year 2013 until 2022 have been computed as shown in Table 3. The construction companies which obtained efficiency score of 1 are categorized as efficient companies that stand at the highest ranking. Through the optimal solution of DEA model, a total 9 out of 42 construction companies have been sorted as efficient companies which achieve efficiency score at 1 that consists of DKLS, GAMUDA, GKENT, HOHUP, KERJAYA, MUHIBBAH, PTARAS, MERCURY and ZECON. This shows that the 9 efficient companies have fully utilized their resources to achieve the greatest possible outputs.

Table 3
Efficiency score for construction companies

DMU	Efficiency Score	Rank	DMU	Efficiency Score	Rank	DMU	Efficiency Score	Rank
DKLS	1	1	MERGE	0.8273	15	AGESON	0.6798	29
ZECON	1	1	TRC	0.8248	16	CRESBLD	0.6772	30
GAMUDA	1	1	IJM	0.8099	17	BINAPURI	0.5856	31
GKENT	1	1	PRTASCO	0.8063	18	PUNCAK	0.5782	32
HOHUP	1	1	PEB	0.8053	19	BENALEC	0.5755	33
KERJAYA	1	1	JAKS	0.8003	20	ZELAN	0.5505	34
MERCURY	1	1	TSRCAP	0.8000	21	OCR	0.4849	35
MUHIBAH	1	1	PESONA	0.7610	22	EKOVEST	0.4634	36
PTARAS	1	1	GBGAQRS	0.7584	23	SENDAI	0.4522	37
MGB	0.9692	10	WCT	0.7551	24	AZRB	0.4487	38
MITRA	0.9021	11	VIZIONE	0.7520	25	IHB	0.4303	39
FAJAR	0.8627	12	SYCAL	0.7065	26	WCHEHB	0.3965	40
MELATI	0.8614	13	GADANG	0.6967	27	MUDAJYA	0.3187	41
KIMLUN	0.8595	14	LEBTECH	0.6967	28	IREKA	0.0461	42

Meanwhile the other 33 companies are grouped in inefficient companies as obtained the efficiency score less than 1. MGB(0.9692), MITRA(0.9021), FAJAR(0.8627), MELATI(0.8614), KIMLUN(0.8595), MERGE (0.8273), TRC(0.8248), IJM(0.8099), PRTASCO(0.8063), PEB(0.8053), JAKS(0.8003) and TSRCAP (0.8000) are the inefficient companies which obtained the efficiency score that close to 1 but lesser than 1. PESONA (0.7610), GBGAQRS(0.7584), WCT(0.7551), VIZIONE(0.7520), SYCAL(0.7065), GADANG(0.6967), LEBTECH(0.6967), AGESON(0.6798) and CRESBLD(0.6772) achieved the efficiency score with the 0.6 to 0.79 with the rank from 22 until 30. PUNCAK(0.5782), BENALEC(0.5755), ZELAN(0.5505), OCR(0.4849), EKOVEST(0.4634), SENDAI (0.4522), AZRB(0.4487), IHB(0.4303), WCHEHB(0.3965), MUDAJYA(0.3187) and IREKA(0.0461) with the efficiency score within the range of 0.01 to 0.59 also consider as inefficient companies which in the position of 31 until 42. Table 4 shows the summary of efficiency score for the construction companies.

Table 4
Summary of efficiency score for the construction companies

Description	Result
Average efficiency score	0.7367
Maximum efficiency score	1.0000
Minimum efficiency score	0.0461
Percentage of efficient companies	21.43%
Percentage of inefficient companies	78.57%

The percentage of efficient companies of this study is 21.43%, which is calculated by 9 efficient companies divided by overall companies, that is 42 companies and multiply by 100%. This is consistent with previous investigation, which reported efficiency rates ranging from 10.00% to 40.00% [46]. As reported by Yildirim *et al*., [47], approximately 31.25% of the DMUs is categorized as efficient companies. Another study assessed 24.2% of efficient public hospitals in Saudi Arabia using DEA model [48].

Throughout the result that obtained for DEA analysis, total 9 construction companies are under efficient company. In order to differentiate these 9 companies that fully utilize their resources to generate maximum outputs, the further step such as super-efficiency DEA model was employed. The super-efficiency DEA model allows efficient DMUs to achieve score greater than 1 [49]. Table 5 displays the ranking of the 9 efficient construction companies. ZECON is the most efficient company as getting the highest super-efficiency score at 2.6754. PTARAS(1.3786), MUHIBAH(1.1353), GKENT(1.1220), DKLS(1.0913), HOHUP(1.0673), KERJAYA(1.0432), GAMUDA(1.0222) and MERCURY(1.0167) ranked in 2, 3, 4, 5, 6 ,7, 8 and 9 respectively. It is significant to observe that the super-efficiency DEA model ranks each company uniquely than Table 5.

Table 5
The Ranking of efficient construction companies by super-efficiency DEA

Companies	Super-efficiency score	Ranking
ZECON	2.6754	1
PTARAS	1.3786	2
MUHIBAH	1.1353	3
GKENT	1.1220	4
DKLS	1.0913	5
HOHUP	1.0673	6
KERJAYA	1.0432	7
GAMUDA	1.0222	8
MERCURY	1.0167	9

4. Conclusions

This paper presented a study on DEA model that can identified the efficiency of DMUs simultaneously. The evaluation of efficiency can be assessed by a well-known technique that is Data Envelopment Analysis (DEA). DEA is one of the techniques to solve the linear programming problem and it is categorized as non-parametric method which served as a benchmarking tool that is frequently used in Decision Making Unit (DMU) such as hospitals, university organizations, bank sector, insurance sector, agriculture, service industries and so on that are employed as an assessment performance of efficiency analysis. The efficient companies have been determined in this study. Additionally, the ranking for efficient companies also had been figured out by using super-efficiency DEA model. This study is significant because it provides meaningful information and insights for the decision-making of construction companies by analyzing their financial performance using the DEA model. The future research of this study can be extended to further examine other sector companies such as agricultural product sector, food and beverage sector, and etc. through examining efficiency. This might provoke the golden bullets to various sectors in Malaysia. Besides, in order to strengthen the effectiveness and bolster competitiveness under the construction sector Malaysia, the companies should take into account on the investment in technological innovation, in accordance with the Industry Revolution 4.0 as well as addressing mental health factors that influence efficiency. [50]. Throughout this perception, the construction companies able to improve resource utilization as well as engage in the performance benchmarking regularly either is in the project-based outcome or restructure company's capital, by embarking the latest innovation technologies such Building Information Modeling (BIM), Internet of Thing (IoT) and Artificial Intelligence (AI). Other methods, such as the Fuzzy Delphi Method (FDM), can be integrated with the DEA model to achieve a more

accurate and comprehensive evaluation of company efficiency and rankings [51]. Additionally, it is suggested that the DEA model could incorporate the Multi-Objective Economic Dispatch (MOED) framework [52] to assess and rank construction companies based on cost-effectiveness and resource utilization. This combined approach is capable of providing a more holistic evaluation of the performance of construction companies.

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