Data Driven Decision Analysis on the Performance of Electronic Companies with TOPSIS Model

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***Abstract*—The electrical and electronic (E&E) industry has been booming since the beginning of the 21st century and has continued to accelerate and prove its significance in the fourth industrial revolution. A strong financial performance of an E&E company is able to ensure the smooth running of daily operations, and the growth and expansion of business through extensive research and development activities. Data driven decision making allows the use of factual and verifiable metrics to help a company achieve business objectives with informed decision making through data analytics. E&E companies which adopt the data driven decision-making process will be able to understand their business performances better through business analytics while more detailed transparency in business reporting will help investors to select companies for investments. Therefore, a proposal to design a conceptual framework for the analysis and evaluation of the financial performance of E&E companies using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) model is done. This paper has found that UCHITEC is closest from the ideal solution and is the top financially performing company among the studied companies. This paper shows the significance of the evaluation, comparison and ranking of the financial statuses of E&E companies in Malaysia with TOPSIS model.**

***Index Terms*—TOPSIS model, conceptual framework, ideal solution, performance**

I. Introduction

As the world enters the fourth wave of industrialization, electronics become one of the core components in various technological advancements for the transmission of information to propel economic growth [1]. Components such as semiconductors, microprocessors and circuit boards are the enablers of modern innovations like autonomous vehicles, development of 5G connectivity and cloud computing. Data processing electronics (34.2%) is expected to contribute the highest revenue by 2022, followed by communication electronics (30.2%), industrial electronics (13.2%), automotive electronics (12%), consumer electronics (9.3%) and military aerospace electronics (1.1%) [2].

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Being one of the catalytic sub-sectors under the manufacturing sector, electrical and electronic (E&E) industry has been among the highest contributors to Malaysia's gross domestic product [3]. Ever since it has been highlighted in the 11th Malaysian Plan, the E&E industry has been showing significant increase in foreign investments and export value especially to countries such as Singapore, Japan and the Netherlands [4]. Upon realizing this outstanding achievement, the government of Malaysia rolls out several initiatives including funds and incentives to facilitate the growth of E&E industry [5].

The financial support given by the administration will definitely be an added advantage to the E&E companies as more budget allocation could be made for innovative researches and smoothen their cash flows. Financial asset is an absolute imperative for a business's initiation, sustainability and growth. Financial resources, coupled with the management financial expertise, leads to wise decision making, strategic investment and the ability to become resilient and responsive to market volatility. A healthy financial background permits an organization to acquire raw material, parts and components in a timely manner to run the production line. A company with sound financial status may also score better in risk assessments, thereby increasing the inflow of external funds and ease of obtaining business loans, strengthening its financial structure and streamline its business operations [6].

The stakeholder theory reveals that the business operation of a firm should satisfy the interests of its stakeholders through value creation. When an organization creates value, it is also fostering relationships with its stakeholders towards achieving organizational goals. This theory has identified several ways of value creation including delivering quality products and services and performing Corporate Social Responsibility (CSR) but the theory is also affirmative towards the fact that financial performance is a major determinant in the carrying out of day-to-day operations of an organization [7]. With good financial returns, an organization can pay its creditors, provide proper remuneration to employees, settle commitments with financial institutions, innovate its products and services to satisfy consumers' needs and channel additional funds for CSR activities to give back to the society. Therefore, a E&E company's financial

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performance will affect all the stakeholders. When the company manages good relationships with the stakeholders, trust in the company's brand increases, thereby making the company more successful over time [8].

As such, it is important to study the financial performances of companies in the electronics industry. Financial performance evaluation is measurable and quantifiable with the use of financial indicators from accounting documents. With values generated from financial performance evaluation, stakeholders, particularly shareholders, may be able to oversee the efficiency of an organization's operations and offer constructive feedback for corporate decision-making [9].

Multi-criteria Decision-Making (MCDM) model solves decision making problems that involve multiple criteria and alternatives. MCDM model has been applied in various fields such as fast food restaurant [10], [11], mobile phone [12], [13], financial institutions [14]-[17], job selection [18], technology companies [19], [20], education [21]-[23] and construction companies [24]. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a MCDM model determining closest path to the Positive Ideal Solution (PIS) together with the furthest separation to the Negative Ideal Solution (NIS) [25]. In data driven decision making, data is a strategic resource to replace intuitive thinking to determine "what is next" for a company using a smart business model to synergize data analysis and decision making in business strategies, technology, management and continuous improvement [26]. Data driven decision making is able to detect data anomalies, study business patterns for better decision making [27]. With the use of data driven decision making, data in an E&E company may be transformed into knowledge for business advantage which drives improvement in the company [28].

A study [29] was conducted on the manufacturing companies in Romania using TOPSIS model. The study considered the important financial ratios such as Return on Assets (ROA), Return on Equities (ROE) and Earnings per Share (EPS). This study could rank the performance of companies relative to the financial ratios which then reflect their current market position. In addition, the financial performance of manufacturing firms in China was conducted using TOPSIS shown the prioritization of these manufacturing firms [30].

TOPSIS has also been applied to study the capabilities of shipping companies in Taiwan with regards to several financial indices [31]. Listed technology companies in Turkey were also being financially evaluated using TOPSIS to study the relationship between TOPSIS ranking and the companies' market value [32]. TOPSIS model has also been used to evaluate the performance of public transport [33], green suppliers [34] and risk analysis [35]. However, previous studies have shown relatively little focus to evaluate performances of E&E companies in Malaysia financially. As such, the aim of this research is to propose a conceptual framework using the TOPSIS method to analyze the financial performances of E&E companies in Malaysia. This paper will be structured with Section II containing data and methodology, Section III for the empirical results and conclusion in Section IV.

II. Data and Methodology

Financial performances of E&E companies are analyzed from 2015 to 2019. Table I presents the proposed conceptual framework for the assessment of the financial performances in listed Malaysian E&E companies using TOPSIS.

TABLE I. Proposed Conceptual Framework

Levels	Items
Objective	To assess the financial performances of electrical and electronic companies in Malaysia
Decision Criteria	Current ratio (CR)
	Debt-to-asset ratio (DAR)
	Debt-to-equity ratio (DER)
	Earnings per share (EPS)
	Return on asset (ROA)
	Return on equity (ROE)
Decision Alternatives	**Company Name**
	VS
	DUFU
	EG
	PIE
	EITA
	ATAIMS
	UCHITEC
	GUH
	UMSNGB
	AEM

Based on previous literature, the main financial ratios considered for this study are CR, DAR, DER, EPS, ROA and ROE [15], [19]. The data is analyzed and obtained from the annual financial reports of the companies. In financial analysis, both DAR and DER shall undergo minimization while CR, EPS, ROA and ROE shall undergo maximization [36].

The steps of TOPSIS model are as follows:

Step 1: Establishment of a performance matrix (x_{ij}) of size *m* x *n* as follows:

$$(x_{ij}) = \begin{bmatrix} x_{11} & x_{12} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & \cdots & x_{2n} \\ \vdots & \cdots & \ddots & \cdots & \vdots \\ \vdots & \ldots & \cdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

(x_{ij}) is a decision matrix that developed based on the financial data.

Step 2: Development of normalized decision matrix $R = (r_{ij})$ as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \qquad i = 1,2,\ldots,m, j = 1,2,\ldots,n \quad (2)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \cdots & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & \cdots & r_{2n} \\ \vdots & \ddots & \cdots & \cdots & \vdots \\ \vdots & \cdots & \ddots & \cdots & \vdots \\ \vdots & \cdots & \cdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & \cdots & r_{mn} \end{bmatrix} \quad (3)$$

Step 3: Creation of weighted normalized decision matrix (V):

$$W = (w_1, w_2, \ldots, w_n), \text{ where } \sum_{j=1}^{n} w_j = 1 \quad (4)$$

For the development of weighted normalized decision matrix, every element of the row in the R matrix shall be multiplied by w_j. The normalized matrix V is expressed in Equation (5) where $V = \lfloor v_{ij} \rfloor$.

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & \cdots & w_n r_{2n} \\ \vdots & \cdots & \ddots & \cdots & \vdots \\ \vdots & \cdots & \cdots & \cdots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & \cdots & w_n r_{mn} \end{bmatrix} \quad (5)$$

Step 4: Computation of PIS (A^+) and NIS (A^-):

$$A^+ = \{(\max V_{ij} \mid j \in J)(min\ V_{ij} \mid j \in J')\} = \{v_1^+, v_2^+, \ldots, v_n^+\} \quad (6)$$

$$A^- = \{(\min V_{ij} \mid j \in J)(max\ V_{ij} \mid j \in J')\} = \{v_1^-, v_2^-, \ldots, v_n^-\} \quad (7)$$

where J associates with the criteria that give positive impact, J' associates with the criteria that give negative impact.

Step 5: Determination of distance between every alternative and PIS (d_i^+) and NIS (d_i^-):

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, i = 1,2, \ldots, m \quad (8)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, i = 1,2, \ldots, m \quad (9)$$

where v_j^+ is the PIS for each financial ratio ($i = 1,2,...,m$), v_j^- is the NIS for each financial ratio ($i = 1,2,...,m$).

Step 6: Enumeration of the relative closeness from the ideal solution (C_i^*):

$$C_i^* = \frac{d_i^-}{d_i^- + d_i^+} \text{ where } C_i^* \in [0,1], i = 1, \ldots, m \quad (10)$$

C_i^* shall be between the values of 0 and 1 whereby when C_i^*=1, it is the closest to the PIS, making it the best performer. However, if C_i^*=0, then the alternative is closer to the NIS. As C_i^* value increases, the performance of decision alternative rises.

Step 7: Ranking of the decision alternatives with regards to the closeness to the ideal solution according to the descending order of C_i^*. The decision alternative with the largest value of C_i^* shall be the best alternative.

III. Empirical Results

Table II shows the multi criteria decision-making matrix, followed by Table III which presents the normalized decision matrix while Table IV displays the weighted normalized decision matrix.

TABLE II. Multi Criteria Decision Making Matrix

Company	CR	DAR	DER	EPS	ROA (%)	ROE (%)
VS	1.4804	0.4749	0.9208	0.1097	5.76	11.04
DUFU	3.5919	0.2368	0.3153	0.1513	15.35	19.84
EG	1.1989	0.5983	1.5731	0.1365	3.31	9.15
PIE	3.1779	0.2753	0.3996	0.2128	7.50	10.49
EITA	2.6877	0.3634	0.5821	0.1465	7.90	12.36
ATAIMS	1.2507	0.5445	1.2410	0.0271	1.99	5.21
UCHITEC	3.2271	0.2526	0.3480	0.1495	24.20	33.17
GUH	2.9010	0.2222	0.2886	0.0217	0.91	1.13
UMSNGB	7.2453	0.1442	0.1704	0.0989	7.35	8.69
AEM	1.3953	0.4337	0.7679	-1.8676	-1.54	-2.65

TABLE III. Normalized Decision Matrix

Company	CR	DAR	DER	EPS	ROA (%)	ROE (%)
VS	0.1420	0.3922	0.3673	0.0575	0.1780	0.2425
DUFU	0.3445	0.1956	0.1258	0.0793	0.4747	0.4357
EG	0.1150	0.4941	0.6276	0.0715	0.1024	0.2009
PIE	0.3048	0.2274	0.1594	0.1115	0.2320	0.2304
EITA	0.2578	0.3001	0.2322	0.0768	0.2445	0.2715
ATAIMS	0.1200	0.4497	0.4951	0.0142	0.0615	0.1144
UCHITEC	0.3095	0.2086	0.1388	0.0783	0.7485	0.7285
GUH	0.2783	0.1835	0.1151	0.0114	0.0283	0.0248
UMSNGB	0.6950	0.1191	0.0680	0.0518	0.2273	0.1908
AEM	0.1338	0.3582	0.3063	-0.9787	-0.0477	-0.0583

TABLE IV. Weighted Normalized Decision Matrix.

Company	CR	DAR	DER	EPS	ROA (%)	ROE (%)
VS	0.0237	0.0654	0.0612	0.0096	0.0297	0.0404
DUFU	0.0574	0.0326	0.0210	0.0132	0.0791	0.0726
EG	0.0192	0.0824	0.1046	0.0119	0.0171	0.0335
PIE	0.0508	0.0379	0.0266	0.0186	0.0387	0.0384
EITA	0.0430	0.0500	0.0387	0.0128	0.0407	0.0453
ATAIMS	0.0200	0.0750	0.0825	0.0024	0.0103	0.0191
UCHITEC	0.0516	0.0348	0.0231	0.0131	0.1248	0.1214
GUH	0.0464	0.0306	0.0192	0.0019	0.0047	0.0041
UMSNGB	0.1158	0.0199	0.0113	0.0086	0.0379	0.0318
AEM	0.0223	0.0597	0.0511	0.1631	0.0080	0.0097

Fig. 1 presents the PIS and NIS in terms of financial ratios.

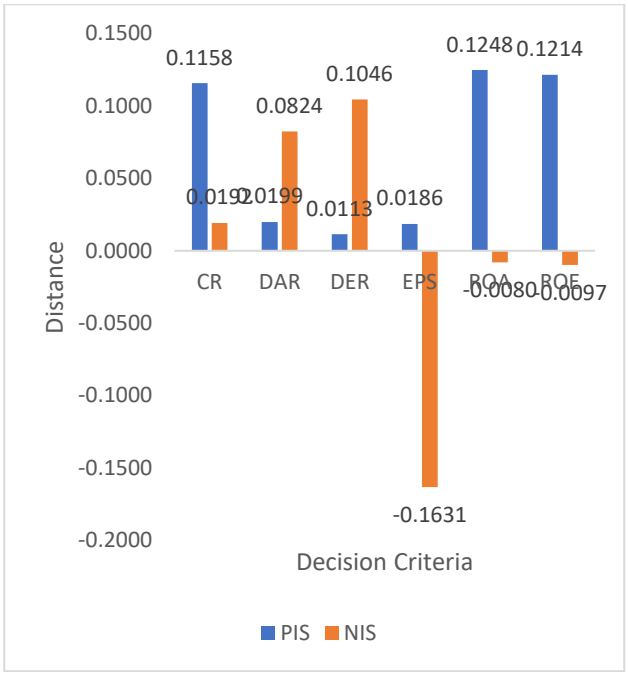

Figure 1. PIS and NIS in terms of financial ratio.

Based on Fig. 1, the NIS are 0.0192, 0.0824, 0.1046, -0.1631, -0.0080 and -0.0097 for CR, DAR, DER, EPS, ROA and ROE respectively as provided by the TOPSIS model. In reverse, the PIS for CR, DAR, DER, EPS, ROA and ROE are 0.1158, 0.0199, 0.0113, 0.0186, 0.1248 and 0.1214 respectively. The PIS and NIS of each respective financial ratio signifies the benchmark to these E&E companies for their ongoing continuous improvement processes.

The distance between the PIS and NIS of the decision alternatives, are computed using Equations (8) and (9) respectively. Fig. 2 displays the distance of every decision alternative to the NIS while the distance of every decision alternative to PIS is depicted in Fig. 3.

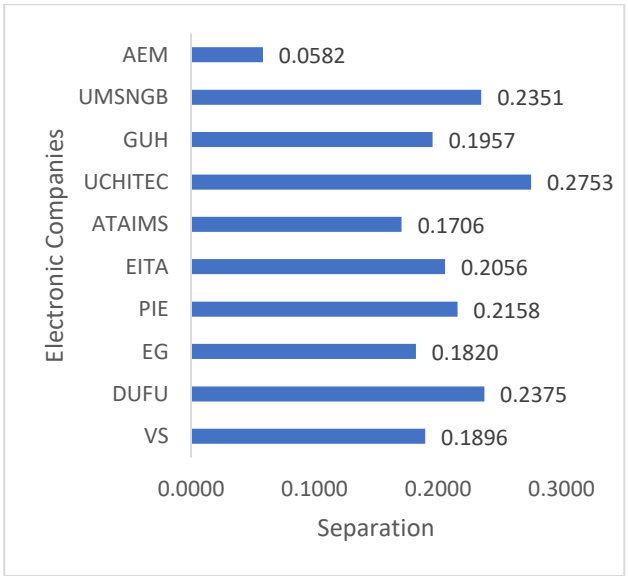

Figure 2. Separation of every decision alternative to the NIS.

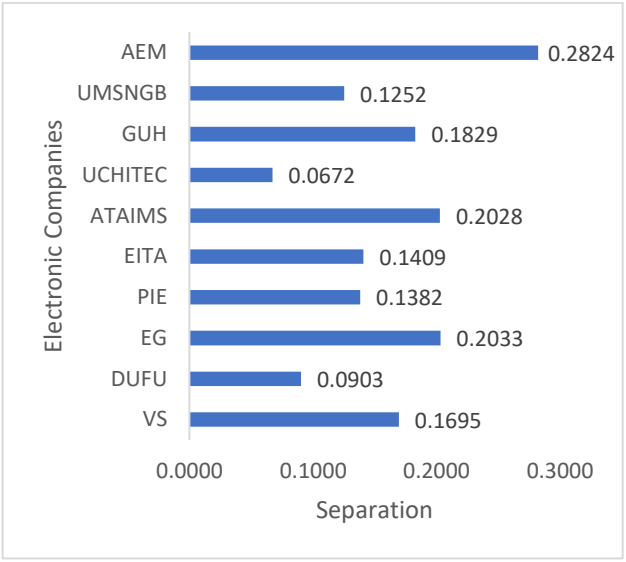

Figure 3. Separation of every decision alternative to the PIS.

From Fig. 2 and Fig. 3, the distances of the firms to the NIS and PIS are obtained from the comparison of weighted normalized decision criteria of a particular company with the NIS and PIS respectively. The comparison of the weighted normalized decision criteria of a company to the NIS generates the separation of the company to the NIS. AEM has the shortest distance of 0.0582 to the NIS, making the company the nearest to the NIS. The second company with the shortest distance to the NIS is ATAIMS at 0.1706, followed by EG (0.1820), VS (0.1896), GUH (0.1957), EITA (0.2056), PIE (0.2158), UMSNGB (0.2351), DUFU (0.2375) and finally UCHITEC (0.2753).

On the other hand, the comparison of the weighted normalized decision criteria of an E&E company to the PIS generates the distance of the company to the PIS. UCHITEC has the shortest distance of 0.0672 to the PIS, making the company closest to the PIS, followed by DUFU (0.0903), UMSNGB (0.1252), PIE (0.1382), EITA (0.1409), VS (0.1695), GUH (0.1829), ATAIMS (0.2028), EG (0.2033) and AEM (0.2824).

Finally, the optimal solution C_i^*, for the entire financial performance can be found by calculating the relative closeness of the distances of decision alternatives to the ideal solutions respectively and depicted in Table V. The greater the relative closeness of the decision alternative to the ideal solution indicates stronger financial assessments of the firm.

TABLE V. FINANCIAL PERFORMANCE OF E&E COMPANIES IN MALAYSIA.

Company	Relative Closeness to the Ideal Solution, C_i^*	Ranks
UCHITEC	0.8037	1
DUFU	0.7244	2
UMSNGB	0.6525	3
PIE	0.6097	4
EITA	0.5934	5
VS	0.5279	6
GUH	0.5169	7
EG	0.4724	8
ATAIMS	0.4568	9
AEM	0.1709	10

As seen in Table V, UCHITEC scored the largest relative closeness to the ideal solution (0.8037) among all the studied E&E companies, thereby achieving the first ranking in this study. DUFU, UMSNGB, PIE, EITA, VS, GUH, EG, ATAIMS and AEM obtained 0.7244, 0.6525, 0.6079, 0.5934, 0.5279, 0.4724, 0.4569 and 0.1709 respectively. TOPSIS model has successfully ranked the financial performances of listed Malaysian E&E companies according to the proposal of conceptual framework.

IV. Conclusion

A conceptual framework is introduced to assess the financial performances of the listed Malaysian E&E companies using TOPSIS model. UCHITEC is the first among the studied companies, followed by DUFU, UMSNGB, PIE, EITA, VS, GUH, EG, ATAIMS and AEM. This paper has helped in the evaluation, comparison and ranking of the financial performances of listed Malaysian E&E companies using the important financial ratios with TOPSIS model. Both the PIS and NIS for the respective financial ratio may then be used as benchmarking for the E&E companies for continuous development. Future studies may explore the effects of Covid-19 to the financial performance of E&E companies. This study may be applied to study the financial performance of E&E industry in other countries.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Lam Weng Siew took responsibility in the construction of the proposed conceptual framework and supervised the research; Lam Weng Hoe took responsibility in the construction of the manuscript; Lam Weng Siew, Lam Weng Hoe, Mohd Abidin Bakar and Lee Pei Fun wrote the paper; Lee Pei Fun did the data collection; all authors discussed the progress and results of the research and had approved the final version.

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