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Comparative method of supplier selection in ABC mining company

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ABSTRACT

Supplier selection is essential to the business. The risks faced by suppliers would have a direct effect on the success of the product. Each business has distinct supplier features to mitigate. These characteristics are divided into criteria for selection in suppliers. This research, the criteria in supplier selection will be weighted by best worst method (BWM) and comparing the three ranking methods, complex proportional assessment (COPRAS), multi-objective optimization with ratio analytic (MOORA) and technique for order preference by similarity to ideal solution (TOPSIS). The sample in this study is an ABC manufacturing company engaged in mining from Indonesia. From the results of the study, there were 16 criteria using the Delphi Method. These criteria are divided into four main criteria, namely service, quality, cost and time. From the results of weighting BWM, the price sub criteria on cost criteria have the greatest weight for ABC companies. The results of the weighting are then carried out by supplier ranking by comparing the COPRAS, MOORA and TOPSIS approaches. In comparing these three methods, approaches are used based on accuracy and complexity. The COPRAS method has the highest accuracy and lowest complexity according to the ABC company.

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1. INTRODUCTION

Organizations need to assess the output of suppliers. This calculation has become an significant part of enhancing the efficiency of companies. In certain situations, management has become valuable knowledge to support staff in the early stages of the next plan. If there is a problem, it will help with the diagnosis and minimize it [1]. The selection of suppliers thus becomes essential in the company's business processes in logistics and production management [2].

The cost of buying equipment, business competitiveness, flexibility and product quality, company performance, will be affected by selecting providers with distinct performance. Therefore, many experts and management of the company believe that the selection of suppliers is the most important activity in the procurement department. All the dangers presented by providers will also be a danger to the business when they become partners. This is an internal danger beyond the company's control [3]. Each stage has a specific model of performance evaluation and criteria [4], thus SCM has become a business practice, since 80% of the basic price is the cost of production. Including the quality of raw materials and other support materials [5].

The provider's excellent assessment must be specific to the context, content and technique. If viewed from the view point of the supply chain maturity stage, it is divided into three stages. The initial stage, called the early stages of the supply chain, focuses on the company with instant customer interactions. The second stage, called an intermediate supply chain, focuses on companies working with suppliers and retailers. The third stage is an

developed supply chain and focuses on supply chain performers and their interactions with other sides to deliver goods to customers, logistics, wholesalers, distributors and other advertising channels. Each phase has a distinct performance assessment model and criteria [6]. Because 80% of the price is a cost of manufacturing, supply chain management (SCM) has become a company approach. Includes the cost of raw materials and other materials to support them [7]. In these conditions, the division of procurement plays a main role in reducing costs and reducing risks. One of the main tasks of purchasing management and policy in the business is the supplier evaluation and selection policy. Research about choice of providers is based on product quality, distribution, history and guarantee policy. [8].

In this research, using complex proportional assessment (COPRAS), multi-objective optimization with ratio analytic (MOORA) and technique for order preference by similarity to ideal solution (TOPSIS) ranking techniques for BMW weighting. In conducting research, we use this technique to determine requirements for choosing vendors on ABC businesses. By holding a discussion, each outcome of the criteria generated will be weighted. The information acquired comes from the ABC company's inner implementation, the E-Procs application. The application is used for transactions as well as for reporting to suppliers on ABC businesses. Several people from ABC companies handle the supposition business process directly and indirectly in looking for supplier selection criteria using the Delphi Method. The resource individual then provides weight to the outcomes of the choice of these criteria after acquiring provider selection criteria. Weighting results were processed using the BWM method and then processed by comparing the results of the COPRAS, MOORA and TOPSIS methods. Suppliers are given the greatest priority from the two techniques. This evaluation will be presented to the ABC company's main individual and management concerning the suitability of the company's business management.

2. RESEARCH PROCEDURE

ABC is a corporation engaged in the mining industry in this report. All procurement details have been processed in the company's ERP program in the e-Procs application. From manufacturer data to product needs. The first move is for the writer to look for the requirements used by ABC companies to pick their suppliers. Authors shall choose the parameters using the questionnaire method which shall be distributed to the management concerned by the ABC group. After the parameters have been used, weigh each criterion. The methodology used to take the weighting is to use the BWM based on the results of the questionnaire distributed to management.

After obtaining the weight value of each criterion, the author extracts the sample data from the supplier in the application for the ABC company ERP. The sample data used is the auction process of the retailer, which is carried out at the time of the auction. Each supplier sends data from the product specifications that will take part in the auction as well as data from the supplier itself. Extraction data were calibrated for the COPRAS, MOORA and TOPSIS calculations. Using these measurements, the weighting effects of the BWM are used for each criterion. The winner of the auction will emerge from the results of the calculations for each process. Such results are compared to the original winner's data to determine the accuracy of the COPRAS, MOORA and TOPSIS calculation.

3. METHOD

Research in weighting vendor criteria has previously been examined by Setyono et al that research on supplier selection with BWM [9]. Cengiz et al also performed studies to determine the provider choice using the fuzzy analytic hierarchy process (FAHP) method [10]. Taguchi Loss Function and analytical hierarchy process (AHP), Pi and Low introduced the hybrid method in the selection of suppliers [11]. Mananawigapol et al. sustainability literacy for selecting suppliers based using AHP and TOPSIS techniques [12]. There is also quite a lot of studies that combines two or more techniques in his studies. Singer selection using Analytic Hierarchy Process (AHP) and simple additive weighting (SAW) techniques also uses specific weight requirements [13]. By merging the genetic algorithm with that of AHP, Rao conducted studies using supplier selection techniques [14]. The synthesis of the two strategies of FAHP and Promethee was also used by Wiguna et al., [15]. Work with several standards, such as website evaluation, where Setiawan et al had fulfilled the relation specifications and had their own weight with AHP [16]. Yudatama et al merged two strategies, Fuzzy AHP and Fuzzy TOPSIS, to assess the maturity index and risk control of IT governance in the bank [17]. A further study was conducted which paired between FAHP and TOPSIS to emphasize strategic planning [18]. Based on previous research, this study compares some of the appropriate methods for ABC companies. By comparing COPRAS, MOORA and TOPSIS methods with BWM weighting, in order to obtain the correct method for ABC companies. Here are the steps of this research.

3.1. Preparation of the questionnaire

A studies conducted by Dickson et al in 1966 following a study of 273 companies in the United States and Canada identified 23 requirements for the choice of suppliers [19]. All the parameters contained conditions that were both measurable and straightforward. But as time went on, Dickson's suggested criteria in today's age were not enacted. Cheraghi, et al., in Table 1 conducted a research with Dickson's criteria with that conducted between 1966 and 2001 [8]. Several of Dickson's suggested criteria met a change in value due to market changes and time shifts. The geographical position is no longer the focus of the criteria because transportation technology continues to grow. Warranty and claims policy criteria are no longer regarded as providers now have an obligation to provide them in the world SCM. Even Training Aids is no longer a problem in the development of SCM because the tools used have developed more universally. From 1966 to 2001, technical capacity stayed constant as the capacity of the company to manage orders was sufficiently essential to mitigate risk. For most research, quality and delivery criteria are still the main criteria because companies need commodities that are not faulty and mitigate hazards that may arise. The outcome of the Cheragi et al research based on the criteria in Dickson's research is presented in Table 1. It is used as a basis obtain the requirements that ABC businesses will use. Not all of the criteria in Table 1 are selected for ABC businesses for suppliers choice.

Table 1. Criteria and sub criteria used

No	Criteria	Σ '66-'90	Σ '90-'01	Σ All
1	Price	55	26	81
2	Delivery	45	30	75
3	Quality	40	31	71
4	Production Facilities and Capacity	25	10	35
5	Technical Capability	19	11	30
6	Repair Service	7	11	18
7	Management and Organization	10	7	17
8	Geographical Places	15	2	17
9	Financial Position	8	7	15
10	Attitude	9	5	14
11	Performance History	7	4	11
12	Reputation and Position in Industry	9	1	10
13	Communication Systems	3	4	7
14	Impression	4	2	6
15	Operating Controls	5	0	5
16	Packaging Ability	5	0	5
17	Reciprocal Arrangements	3	2	5
18	Procedural Compliance	2	2	4
19	Labor Relations Record	3	1	4
20	Training Aids	3	0	3
21	Desire to Business	2	0	2
22	Warranties & Claims Policies	1	0	1
23	Amount of Past Business	1	0	1

From the results of Dickson's research, it became the foundation for forming a questionnaire to be distributed to ABC. The questionnaire was created with blended issues, closed and open questions from the literature research outcomes. Because the questionnaire findings will be reprocessed and the investigator will need feedback to consider the questionnaire outcomes. ABC Procurement Department will distribute the questionnaire.

3.2. Distribution of questionnaires and processing the result

ABC Procurement Department received the prepared questionnaire. The questionnaire findings have been processed and compared. The investigator prepares the questionnaire again on the basis of the outcomes of the earlier questionnaire if there is still no agreement. This iteration is repeated until the questionnaire gives the researcher the consensus outcome.

The repetition of the questionnaire is based on the Delphi method. Questionnaires are used to obtain the most credible consensus from a group of professionals. The process of completing the questionnaire in the Delphi method is constantly carried out and can consist of several review rounds or rounds until a mutual agreement is lastly reached [20]. Each specialist fills out a questionnaire with each one's opinions and ideas in its execution. After completion, the investigator will review the questionnaire to become a summary report. To find a mutual agreement, this iteration was performed.

3.3. Questionnaires weighting criteria with BWM

Upon receiving the assessment criteria, the next step is to return the questionnaire so that each criterion can be weighted. The structure of the questionnaire was modified to the Best Worst Method and the estimates. BWM technique compares the criteria used. Best Worst Approach uses a tiny volume of data on its studies, generates coherent information and does not involve a complete matrix for pair comparison [21].

Calculation of the Best Worst Form by comparing each of the best conditions, called Best, and the most ugliest, called Worst, with the others. The calculation uses a 9-integer scale measure. In the sense of the equation, the value of the best criteria (1) with BJ, the significance of the criteria is more important than the other criteria with 1 compared to the criteria and 9 compared to the criteria. Priority for equation is the worst existing criteria (2) with a1w1 being more negligible than other criteria. The cost of 1 being the most meaningless rules relative to the other requirements and the importance of 9 being the law is very low compared to other requirements.

$$A_B = (a_{B1}, a_{B2}, a_{B3}, \dots, a_{Bn}) \quad (1)$$

$$A_w = (a_{1w}, a_{2w}, a_{3w}, \dots, a_{nw})^T \quad (2)$$

In addition, the ideal value weighting value is sought after all the evaluation criteria $(w1*, w2*, \dots wn*)$. Equation for optimum weighting (3) it is necessary to calculate all j minimized (4) in linear (5) for the best criteria and (1.6) for the worst criteria. With an optimum value ξ^L as an index of consistency if it is nearer to zero.

$$\{|W_B - a_{Bj}W_j|, |W_j - a_{jw}W_W|\} \quad (3)$$

$$\sum_j wj = 1wj \geq 0, for\ all\ j \quad (4)$$

$$|W_B - a_{bj}W_j| \leq \xi^L, for\ all\ j \quad (5)$$

$$|W_j - a_{jw}W_w| \leq \xi^L, for\ all\ j \quad (6)$$

The findings of the evaluation criteria for ABC firms are acquired from the outcomes of the Delphi technique. The investigator then obtained information on ABC businesses from ERP apps based on the criteria. The information obtained is adapted to the data and criteria characteristics.

3.4. Supplier sample data collection

Test Data Collection Supplier Sampling from procurement auction data in ERP systems. The purpose of the auction data collection is to obtain results from the precision of the COPRAS, MOORA and TOPSIS methods. The data taken is adjusted to the results of the selection criteria. Raw ERP information is streamlined to make it simple to handle and comprehend. Mathematical calculations from the information spectrum accessible in ERP apps are used to process.

3.5. Ranking process with COPRAS, MOORA and TOPSIS

The required ERP encoding data is made available in the e-Procs application. The next move is to measure COPRAS, MOORA and TOPSIS after collecting and modifying auction data from e-Procs. At the time of calculation, all parameters were taken from the results of the BWM. Each approach has a different kind of data processing.

First method is use multi-objective optimization with ratio analytic (MOORA). It's a multi-purpose scheme in which each reaction is an alternative to the general objective option. This denomination is the square root of each selected alternative's amount of squares [22]. In this research, vendors were ranked on the basis of parameters. MOORA comprises between components, the approach to the system ratio and the approach to the scale point on the basis of the same standardization form. The first phase before optimization the requirements is to modify the Decision Matrix by using vector standardization processes to become a standardized matrix, overriding the conversion of price type parameters into advantages. The outcomes of each supplier's evaluation and weighting will be calculated using formula (7). Depending on the needs and results of the criteria, certain criteria are maximized or minimized in each case. Calculations are performed using formula (8).

$$r_{ij} = \frac{x_{ij}}{(\sum_{i=1}^{n} x_{ij})^{\frac{1}{2}}} \quad (7)$$

$$Q_i = \sum_{j\epsilon\Omega max} w_j r_{ij} - \sum_{j\epsilon\Omega min} w_j r_{ij} \quad (8)$$

Second method is complex proportional assessment (COPRAS). A technique in which alternative comparisons and other priorities are below the competing criteria, taking into account the weight of every requirement [23]. Considering the dependence is strictly proportional to the alternatives meaning and priority level. Evaluation that is standardized in the MOORA technique and then used with formula (9).

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (9)$$

Each alternative's general evaluation index is calculated using formula (10) with a maximum (11) and minimization (12).

$$Q_i = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{-=1}^{m} \frac{1}{S_{-i}}} \quad (10)$$

which,

$$S_{+i} = \sum_{j\epsilon\Omega max} w_j r_{ij} \quad (11)$$

$$S_{-i} = \sum_{j\epsilon\Omega min} w_j r_{ij} \quad (12)$$

Last method is technique for order preference by similarity to ideal solution (TOPSIS). Designed to rank various alternatives with the closest distance to the ideal positive solution and the distance from the farthest distance to the ideal alternative negative [24]. As in (13), the first stage of the TOPSIS technique is to normalize the matrix.

$$R = \begin{bmatrix} r_{11} & r_{12} & r_{1j} \\ r_{21} & r_{22} & r_{2j} \\ r_{i1} & r_{i2} & r_{ij} \end{bmatrix} \quad (13)$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (14)$$

It can be simplified from matrix (13) and (14) to (15) with rij as an component of the centralized matrix R.

$$r_{11} = \frac{x_{11}}{\sqrt{{x_{11}}^2 + {x_{21}}^2 + \ldots + {x_{m1}}^2}} \quad (15)$$

The next step is to weigh the standardized matrix. The calculation is similar to formula (16).

$$Y = \begin{bmatrix} W_1 r_{11} & W_2 r_{12} & W_j r_{1j} \\ W_1 r_{21} & \ldots & \ldots \\ W_1 r_{i1} & W_2 r_{i1} & W_j r_{ij} \end{bmatrix} \quad (16)$$

The next stage after obtaining a matrix with a weighted value is to calculate the matrix of the optimal positive solution (A+) and the optimal matrix adverse solution (A-) based on the weighting of matrix (16) outcomes. If the lowest (such as expenses) or if the highest (such as quality) is selected as in formulas (17) and (18), the solution is chosen to differentiate the solution.

$$A^+ = (y_1^+, y_2^+, \ldots, y_n^+) \quad (17)$$

with A_j^+,

- Max Yij, if j is the selected criteria, the better the larger.
- Min Yij, if j is the selected criteria, the better the smaller.

$$A^- = (y_1^-, y_2^-, \ldots, y_n^-) \quad (18)$$

with A_j^-,

a) Max Yij, if j is the selected criteria, the better the smaller.
b) Min Yij, if j is the selected criteria, the better the larger.

The next stage is to use formula (19) to calculate the distance between options using a favorable perfect matrix for adverse ideal using formula (20).

$$S_i^+ = \sqrt{\sum_{j=1}^{n}(Y_j^+ - Y_{ij})^2} \quad (19)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}(Y_{ij} - Y_j^-)^2} \quad (20)$$

The final step is to use formula (21) to obtain preferential values. Ranking ratings are acquired by sorting the outcomes from the highest to the smallest preference values.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (21)$$

The outcomes can be contrasted after acquiring the two alternative sequences using both the techniques of COPRAS, MOORA and TOPSIS. Considering the complexity of the technique, the flexibility of the technique and the precision of the final outcomes, weights are used in making comparisons. The complexity of the technique is seen from the number of steps and techniques that are implemented in the form of programming code. Researchers will undertake conversations with the e-Procs software development team, system analyzes and programmers to evaluate complexity. Discuss how heavy the system is going to be and how complicated the code is going to be written. For the method's flexibility, the method can still support if there is a policy change in the e-Procs implementation to alter the requirements or flow process. Is the code still usable without changing the majority of the current code.

Accuracy of the method is seen from the two methods final outcomes. The Procurement Department will conduct a subjective rating evaluation and will be contrasted with the two methods final outcomes. According to the Procurement Department, the findings with the least distinction are the most precise results. In the future, ranking methods will be selected and applied in the e-Proc program after being measured by these three measurements.

4. RESULTS AND ANALYSIS

The findings and debate of the techniques used in this research will be described in Chapter 4. Determination of criteria and questionnaire using the Delphi method. The questionnaire findings are criteria for the choice of suppliers for ABC businesses. The weighting criteria questionnaire is allocated, resulting in the weight of the criteria. Vendor ratings are calculated using COPRAS, MOORA and TOPSIS based on these weights, which are then compared to the outcomes. Comparison of the techniques of COPRAS, MOORA and TOPSIS is contrasted on the basis of the precision of the inner classification outcomes of ABC company and the specialist judgment process complexity.

4.1. Determination of criteria

Based on the Dickson criteria from Table 1 where in the E-Procs implementation not all information criteria are accessible. The questionnaire does not include criteria that do not have information accessibility. The questionnaire's correspondents were four members of the ABC company's procurement department. Delphi method is used to select requirements. Each iteration is performed using the discussion technique and the questionnaire is completed. The findings of the four-stage questionnaire are based on 16 criteria. These criteria become sub-criteria to simplify the weighting evaluation, which will be divided into several primary criteria. The primary aim of grouping criteria into four primary criteria is to promote weight determination and the outcomes of sub-criteria criteria.

Zolfani and others. Revealed that the key to obtaining the best provider was four primary variables, namely Quality, Cost, Time and Services [25]. The criteria of all these variables are tangible and intangible. With many sub-criteria following it, the suggested factor may be the primary criterion. The criteria put forward by Zolfani et al are the primary criteria in the situation of ABC businesses, and the sub-criteria are the outcomes of the assessment of the fourth phase questionnaire. Table 2 shows the grouping.

Table 2. Criteria and sub criteria used

Criteria	Sub Criteria
Services	Communication
	Packing
	Shipment
	Return
Quality	Warranty
	Specification
	Certification
Cost	Discount
	Price
	Payment Terms
	Penalty
	Delivery Cost
Time	Claim and Services Procedure
	Delivery Time
	Respond Time
	Purchasing Procedure

4.2. Weighting criteria and sub criteria

The expected correspondent is the correspondent who, in determining the requirements, earlier filled out the questionnaire. In each column "Best" and "Worst," where the price of one is the value for the best and worst criteria, fill in by providing a scale value of 1 to 9. When the questionnaire is completed, support is given to enable the weighting of Best Worst Method to provide answers in accordance with the award. The prepared questionnaire was distributed to the ABC Procurement Department. The results of the questionnaire were processed and compared

For the primary criteria, the weighting findings in Table 3 'Cost' are the top priority. It can not be rejected that prices, including ABC businesses, are still prioritized by the supply chain climate circumstances in Indonesia. Next, after 'Cost,' there is 'Service' that is a problem. It refers to how to ship products in the 'Service' criteria, because some business places are hard to achieve. In addition, there are 'Quality' criteria for products, where the product specification is more essential than the warranty and vendor certification sub-criteria. The truth of the matter is the time requirement, according to the leadership of the procurement division, time is crucial, but because the agreement is adequately bound and there were no major obstacles that existed too least. For a moment, most of them were bound by a long contract and procurement time based on the exposure of the correspondent. That's why the time criteria aren't too much a problem.

Table 3. Weighting result

Criteria	Sub-Criteria	Weight of Criteria	Sub-Criteria Weight
Services	Communication	0.26829	0.21359
	Packing		0.16019
	Shipment		0.53883
	Return		0.08738
Quality	Warranty	0.17886	0.23529
	Specification		0.64706
	Certification		0.11765
Cost	Discount	0.47154	0.04865
	Price		0.44595
	Payment Terms		0.27568
	Penalty		0.09189
	Delivery Cost		0.13784
Time	Claim and Services Procedure	0.0813	0.07194
	Delivery Time		0.46043
	Respond Time		0.28058
	Purchasing Procedure		0.18705

4.3. Supplier evaluation

Recovering information from ABC's inner business apps by taking provider evaluations, e-Procs with a sample of 8 tender papers. For the procurement of products, each tenderer may have more than one item. And each product, invited by many vendors, but not all vendors invited to participate in the tender. So with 146 rankings, there are a total of 35 items.

Results of different criteria are acquired from information withdrawal in the e-Procs implementation, technical specifications records and supply of supplier and provider master data catalogue records. In addition,

the findings of this evaluation are used as a 5-scale evaluation. Scale 5 assessment is based on the outcomes of debates with the ABC Department of Business Procurement. The simplification aim is to promote calculation on a scale of 5. So every evaluation has no extreme value. Each criterion has a value that is maximized with this scale of 5. The following is the result of an agreement to evaluate each of the criteria from the discussion with representatives from the procurement department. Table 4 shows the outcomes of the evaluation for each criteria and each tender every supplier.

Table 5 contains some examples of rankings from 146 procurement lists from ABC company. The NN column is a list of ABC corporations' historic procurement. Column C is the ranking of the results of the COPRAS method; column M is the ranking of the results of the MOORA method; and column T is the ranking of the results of the TOPSIS method. Green when all ranks are right, yellow when some of the other ranks are correct, and red for incorrect rankings.

Table 4. Vendor rating for each criteria
S1: return, S2: shipment, S3: packing, S4: com., Q1: warranty, Q2: specification, Q3: certification, C1: delivery cost, C2: payment terms, C3: price, C4: penalty, C5: discount, T1: delivery time, T2: purchasing procedure, T3: respond time, T4: claim and service procedure

No	Tender Code	No Item	No Vendor	S1	S2	S3	S4	Q1	Q2	Q3	C1	C2	C3	C4	C5	T1	T2	T3	T4
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
2	DX714291	10	110660	5	5	5	3	2	5	3	3	3	2	3	2	5	5	4	4
			111156	5	5	5	5	2	5	2	5	3	2	3	4	5	5	5	5
			110354	5	3	4	3	2	5	2	5	1	2	3	1	5	4	5	4
			114020	3	5	4	5	2	5	2	5	1	4	4	1	5	4	5	4
			112828	2	5	5	5	2	2	3	3	1	3	3	2	5	4	5	2
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
22	DX713957	10	114202	5	5	5	5	4	4	3	5	1	5	4	2	3	5	5	5
			110070	5	5	5	5	4	4	2	5	3	5	1	1	3	5	5	5
			113767	5	5	5	5	4	3	3	5	1	3	4	4	5	5	5	5
			113554	5	5	5	5	2	2	2	5	1	3	3	1	4	5	5	5
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
34	DX714295	110	110456	5	3	5	5	2	5	3	3	1	5	2	4	5	2	5	5
			110138	2	3	5	3	2	5	2	3	1	5	2	4	4	2	4	5
			111462	5	3	5	5	2	5	2	1	1	5	3	2	5	2	5	2
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…

Table 5. Ranking of each method

N.	Tender Code	Item	Vendor Code	NN	C	M	T	COPRAS Value	MOORA Value	TOPSIS Value
…	…	…	…	…	…	…	…	…	…	…
			110660	1	3	3	3	0.2084550	0.4444661	0.6755867
			111156	2	1	1	2	0.2241956	0.4777708	0.6910267
2	DX714291	10	110354	3	5	5	4	0.1675298	0.3616044	0.5493465
			114020	4	2	2	1	0.2182736	0.4713343	0.7517633
			112828	x	4	4	5	0.1815460	0.3918928	0.6470388
…	…	…	…	…	…	…	…	…	…	…
			114202	1	2	2	2	0.2632813	0.5094893	0.7011278
			110070	2	1	1	1	0.2908079	0.5554649	0.8841349
22	DX713957	10	113767	x	3	3	3	0.2388194	0.4607639	0.6062623
			113554	x	4	4	4	0.2070914	0.4014801	0.5702205
…	…	…	…	…	…	…	…	…	…	…
			110456	1	1	1	1	0.3478076	0.5953024	0.9490918
34	DX714295	110	110138	2	3	3	2	0.3258214	0.5582916	0.8976274
			111462	3	2	2	3	0.3263710	0.5608511	0.8597995
…	…	…	…	…	…	…	…	…	…	…

4.4. Performance of method comparison

Comparison with precision and complexity of the classification outcomes of the COPRAS, MOORA and TOPSIS techniques. Calculated accurately by comparing the COPRAS, MOORA and TOPSIS ranking outcomes with the e-Procs application ranking outcomes. The method's precision can be acquired from the variations in ranking outcomes. Complexity, acquired in the creation of e-Procs from the outcomes of questionnaires with the development team of e-Procs together with the System Analyst. What is their opinion of the algorithm to be implemented in the ABC company's e-Procs implementation. How are the technical aspects impacts and how are the barriers in their growth.

4.4.1. Accurately

Supplier ranking outcomes for each technique are contained in Appendix 10. Compared to the outcomes of the present e-Procs ranking, the classification findings are based on the COPRAS, MOORA and TOPSIS techniques in the appendix. With the outcomes of the e-Procs application ranking, you can see the distinction in the ranking of each technique from Table 5. The precision findings for all three techniques are as follows:

a) COPRAS has 12 different branches with the e-Procs application ranking of 146 items, so the accuracy of the ranking of COPRAS is equal to, $\frac{134}{146}$ 100% = **91**, **78**%.
b) MOORA has 14 different ranks with the e-Procs application ranking of 146 items, so the accuracy of MOORA ranking is, $\frac{132}{146}$ 100% = **90**, **41**%.
c) TOPSIS has 29 different ranks with the e-Procs application ranking of 146 items, so the accuracy of the TOPSIS ranking is as big as, $\frac{117}{146}$ 100% = **80**, **14**%.

4.4.2. In complexity

A questionnaire was developed and presented on the ABC business to the development team and the System Analyst e-Procs application in evaluating the complexity of the technique. The questionnaire included the COPRAS, MOORA and TOPSIS algorithm content. Correspondents will select what they believe can be applied easily and how to react. The outcomes of the evaluation of the complexity of each technique can be achieved from the outcomes of this questionnaire. Respondents were given the option to select one of the three available techniques. Respondents also provided evaluations and reactions as to why they chose the technique to assist answer why the technique was selected. They chose the COPRAS technique from the two e-Procs software designers and one Systems Analyst correspondents. According to them, the creation of the COPRAS technique was simple. If applied, such as the other two techniques, the algorithm does not overload the system. And in terms of coding, it's also quite easy.

5. CONCLUSION

Based on the research outcomes, a total of 16 criteria were acquired using the Delphi Method from four iterations. Each criteria split into four primary criteria All criteria is weighted using the BWM. The criteria with the highest weight to select ABC vendors are the "Cost" criteria with the "Price" sub-criteria. Table 3 shows all criteria and sub-criteria and weighting.

Comparing COPRAS, MOORA and TOPSIS based on the accuracy approach using past data in ABC company. COPRAS method has the highest precision rate at 91,78%, followed by MOORA 90,41% and TOPSIS 80,14%. Approach to the complexity of the method, obtained from the results of discussions and questionnaires. From the results of discussions and questionnaires, COPRAS is the simplest method to be applied to procurement applications on ABC companies.

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