MCDM-AHP and ELECTRE collaboration apps for the best vendor selection technique

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Article Info

Article history:

Received Sep 12, 2023
Revised Nov 8, 2023
Accepted Feb 12, 2024

Keywords:

Collaboration method
ELECTRE elimination
Multi-criteria decision making-analytic hierarchy process concept
Optimal eigenvector
Vendor selection

ABSTRACT

Vendor selection techniques are very important to maintain supply chain services, optimal service creates strong consistency in maintaining the continuity of supply chain business processes. The aim of this research is to provide an objective and consistent understanding of the best techniques in vendor selection which are implemented openly through the collaboration of multi-criteria decision making-analytic hierarchy process (MCDM-AHP) and ELECTRE. Empirical studies show how this approach is able to provide optimal decision-making support for the vendor selection process. Eight criteria are required which have contradictory meanings in their apps. These criteria include quality of goods (QG), payment methods (PMs), payment terms (PTs), minimum transactions (MTs), discounts (DS), delivery times (DTs), inventory (IN), and service (SV). The comparison importance value of the criteria is used as a measure of weighting the criteria through two testing approaches, namely mathematical algebra matrices and expert choice apps, through accurately assessing the optimal eigenvector from the two test approaches. Decision making support was carried out by comparison using 342 preference matrices which were developed into concordance and discordance matrices, the elimination process with threshold matrices found that the ranking results of four vendors were ranked first as worthy of being a selection priority and fifteen other vendors were ranked below.

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1. INTRODUCTION

Business processes in the supply chain are of very strong concern [1]. Sales transactions in the supply chain will be better, if supported by high consistency of soft skills, so that they are maintained throughout the supply chain business network [2]. To realize this, a vendor selection method approach is needed to carry out supply chain operations [3]. Strengthening the supply chain must be supported by strengthening financial and payment systems [4]-[6] as well as consistency in supply chain procurement to prevent critical points from occurring [7]. Maintaining a smooth vendor supply chain becomes a very difficult test when faced with all kinds of conflicting criteria presented and optimizing vendor selection becomes even more difficult [8]. To guarantee the supply chain, an appropriate analytical approach is needed to develop the smooth running of the supply chain which has the potential to maintain the stability of the vendor's supply chain efficiently [9]-[11]. Utilizing the collaborative multi-criteria decision making-analytic hierarchy process (MDCM-AHP) method is a potential approach for vendor selection solutions. The purpose of writing this paper is to provide an objective and consistent overview of the vendor selection process using the collaboration of the MCDM-AHP and ELECTRE methods through a barometer measuring contradictory criteria to achieve an optimal eigenvector which is strengthened by a preference index through threshold matrices concordance and discordance. Eight criteria are required with results that support optimal vendor selection decision making. The more criteria parameters are used in vendor selection, the more difficult the selection process will be [12], because the multi-criteria nature makes comparison considerations more complicated [13]. Furthermore, the criteria used are contradictory between one criterion and another. This means that the understanding of the use of criteria has the opposite meaning, so a slightly different normalization technique is needed as usual [14]. Understanding contradictory criteria provides two meanings of understanding, first there is a criterion that has an understanding of the smallest value is the best and the second understanding is that the largest value is the best. These two understandings provide varying assessments, so a normalization stage will be needed taking into account the importance of the multi-criteria used [15], [16].

The eight criteria that will be used in selecting the best vendor are quality of good, payment method (PM), payment term (PT), minimum transaction (MT), discount (DS), delivery time (DT), inventory (IN), and services (SV). Each vendor has a known level of service across each supply chain that has been monitored over a rolling five year period. Each vendor has been given an assessment score with its own predicate. In the assessment process for all vendors to be selected, a method is needed to handle this assessment to obtain criteria for vendors who deserve the best priority as selected vendors [17], [18].

The collaborative function-based ranking method that will be used is MCDM-AHP [19], [20] which functions as optimal weighting through optimal eigenvectors, while the ELECTRE method functions as a ranking process for the final decision of the vendor selection process. The MCDM-AHP method has been proven in other research to act as a stage for determining multi-criteria weights [21], [22] based on obtaining eigenvector values [23], [24], through questionnaire instrumentation to provide a comparative weight value for each criterion which is compared objectively. These entries came from 19 respondents through selected vendors who have long carried out business transactions in large capacities, so they can be said to be experts as entities in handling supply chain problems. The questionnaire distribution technique was carried out using the snowball sampling method. Another collaboration method is ELECTRE, this method is used for the ranking selection process [25] which is carried out independently [26] through the stages of finding concordance and discordance sets to find out alternative vendors that are tied to positive and negative value criteria and are included with the calculation of concordance matrices as values. positive and discordance matrices as negative values [27] Through this stage, the elements of the matrices will be thoroughly understood through the threshold matrices values as a measure of elimination, just like a computational process in the form of binary numbers 0 or 1, this binary concept can be developed as a control using technology in the form of internet of think as a continuation of research using apps support [28], [29]. At the aggregate dominant matrices stage, it provides a decision value for the ranking calculation using the process of multiplying threshold concordance and discordance [30].

From the explanation above, there are two contribution points that can be learned from writing this paper, namely; i) providing added value to new findings in the form of collaboration on vendor selection methods through the optimum eigenvector value weighting stage. The optimum eigenvector is carried out through iteration stages to reduce differences in assessments in the comparison system using the MCDM-AHP method to reach the optimum decision point, then a feasibility test process is carried out using two approaches, namely mathematical algebra matrices and expert choice apps. The accuracy of the results can be determined from obtaining the optimum eigenvector value using these two approaches. This is a clear fact that both approaches must provide the same results for the eigenvector and ii) the elimination concept apps in the ELECTRE method through the stages of obtaining threshold matrices values as a threshold measure for evaluating an alternative for each criterion used, becoming an illustration of the computational process for determining the ranking system for all alternatives, the results of which can be seen through the aggregate dominant matrices as a binary value of “0” and “1”. The ranking with the highest number of values “1” becomes the first priority in the vendor selection process.

2. RESEARCH METHOD

This section will explain the concepts that are the basis for understanding the discussion which are explained in stages to make understanding easier in order to support the research discussion process in this paper. Several eigenvector value optimization techniques are applied by proving using mathematical algebra matrices and testing through the expert choice apps. The elimination process is through a preference index which strengthens the formation of concordance and discordance matrices until the final result is formed through the threshold technique as aggregate dominant matrices. So an integrated framework is needed as a tool for selecting vendors for sustainable used [31], which can be seen in Figure 1.

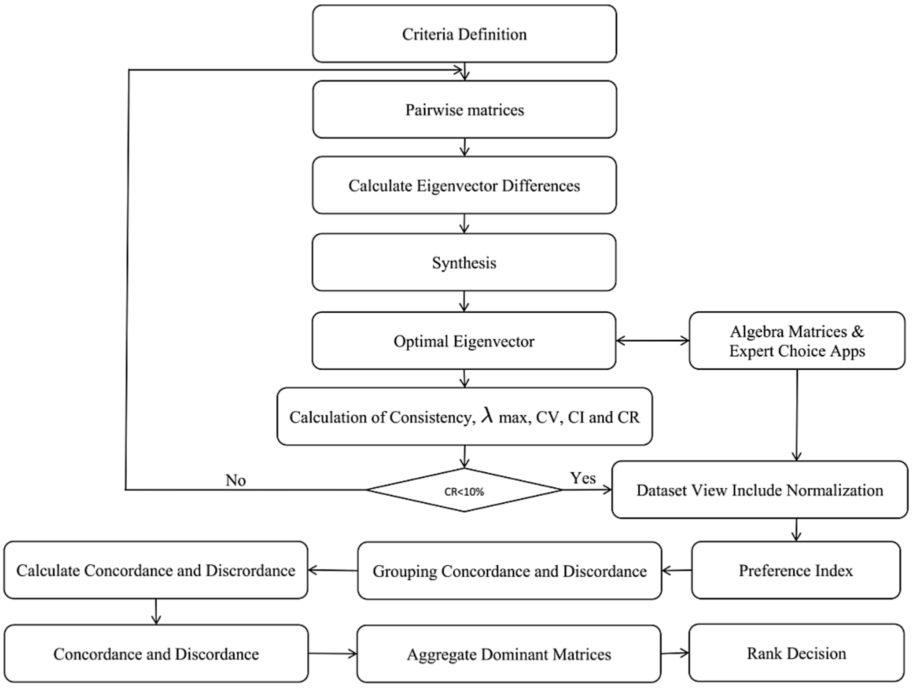

Figure 1. MCDM-AHP-ELECTRE algorithm

2.1. Multi-criteria decision making-analytic hierarchy process

Understanding MCDM provides guidance in determining the level of multi-criteria quality that reflects the experts choices [32] in assessing criteria as an assessment measure in the taxonomy of weighting criteria in normal form. AHP is a ranking method that is usually applied like the hierarchy concept to make it easier to solve problems [33], to make finding solutions simpler. Even if a very difficult problem is composed into small parts, it will be easier to see the solution to the problem hierarchically. This level of difficulty is simplified into several small parts to give a weighting of each fraction which is put back together with an eigenvector value of one, this gives an idea that the final decision is a unanimous decision that cannot be resolved against the results of the decision support. So MCDM-AHP is the best solution that can be used to solve very difficult problems in a simpler way, such as automatically [21] which is seen based on the weights measured based on the eigenvector value [34] without any difference between the last eigenvector value and the previous eigenvector value. This indicates that eigenvector value must be obtained optimally [35]. The results of obtaining optimum eigenvector values can be tested for their appropriateness to support decision making using the mathematical algebra matrices approach [36] and expert choice apps [37], [38] to prove the truth.

Through expert judgment which is previously converted into an arithmetic scale into a geometric scale and a geometric scale into an AHP scale, this becomes the best measurement for compiling pairwise matrices [39]. To support the formation of pairwise matrices, pay attention to the order size, row location, and column location correctly [40] can use (1):

$$PM_{(i,j)} = \begin{bmatrix} em_{(1,1)} & em_{(1,2)} & em_{(1,3)} & \cdots & em_{(1,j)} \\ em_{(2,1)} & em_{(2,2)} & em_{(2,3)} & \cdots & em_{(2,j)} \\ em_{(3.1)} & em_{(3,2)} & em_{(2,4)} & \cdots & em_{(3,j)} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ em_{(i,1)} & em_{(i,2)} & em_{(i,3)} & \cdots & em_{(i,j)} \end{bmatrix} \quad (1)$$

Know the number of comparison values that will be used for each criterion and alternative [40] you can use (2). This is different from vector values which must have a consistency quantity in the form of vector consistency which can be measured with (3).

$$CN = \frac{n*(n-1)}{2} \quad (2)$$

$$CV = \frac{EV}{DM} \quad (3)$$

Another consistency that must be measured when using the analytical hierarchy process is the consistency index obtained through (4), and the final point of obtaining decision support for temporary or final values requires a careful calculation process so that decisions can be accepted through (5) and the results must be tested eligibility.

$$CI = \frac{(\lambda \max - \mathrm{n})}{(n-1)} \quad (4)$$

$$CR = \frac{CI}{RI} \quad (5)$$

Obtaining CR values of course requires a table to determine the size of the order matrices used, to support CR you will need a random index (RI) in table form as shown in Table 1.

Table 1. RI [41]

Ordo matrices	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random index	0	0	0.6	0.9	1.12	1.24	1.32	1.41	1.45	1.48	1.51	1.48	1.56	1.57	1.58

2.2. ELECTRE

In solving the ELECTRE method, there are various techniques used for solving by elimination [27], [42] which is carried out thoroughly on all data elements being compared, proven one by one among the alternatives that are used as measurements for all criteria. There are several ways to obtain normalized data, this is seen in the apps of supported criteria. In this research the author tries to apply criteria that are contradictory, meaning that there are a number of criteria that are used that are not in line with their understanding, meaning that they are contradictory. What this means is that there is a general understanding that the largest value is the best value (HB), if it is said to be contradictory it means the understanding is somewhat different, namely the smallest value is the best value (LB) [43]. With conditions like this, two techniques are needed to carry out the normalization process. Pay attention to (6) which is an equation with consistent conditions. This is different from (7) which has a reverse or contradictory meaning. Conditions like those in this research use both techniques, so to handle cases of contradictory criteria like this you have to use both methods as stages of the normalization process.

$$R_{(i,j)} = \frac{(X_{(i,j)} - X'_j)}{X^*_j - X'_j)} \quad (6)$$

$$R_{(i,j)} = \frac{(X_{(i,j)} - X^*_j)}{X'_j - X^*_j)} \quad (7)$$

The results obtained from developing normalization will provide results in the form of a preference index, with the comparative value of each alternative being compared having the formation of a matrices that is arranged in two dimensions and into two groups of concordance matrices and discordance matrices. The resulting number of preference indexes can be calculated using (8). This equation will be used to form concordance matrices and discordance matrices. How many comparisons must be made to form a s of concordance matrices and discordance matrices, of course using (8):

$$PI = (Nx(N-1) \quad (8)$$

The set of concordance matrices is assessed based on the value possessed by each positive criterion and the assessment is given based on the value of the optimum criteria possessed by each criterion which is added up and can be done with the conditions as stated in (9):

$$C_{(k,l)} = \{J | V_{(k,j)} \geq V_{(i,j)}\} \; where \; j = 1,2,3, \ldots., n. \quad (9)$$

On the other hand, the set of discordance can be searched by obtaining a negative value for each alternative row that has a negative value and giving the value obtained for each alternative given according to its criteria, searching for the weight of the set based on the absolute minimum value divided by the maximum value of all alternatives whose weights are determined based on optimum eigenvector value, so the results are slightly different between the assessment of the concordance set and the discordance set. This is unique to the ELECTRE method. The apps of searching for discordance sets can be done using (10):

$$D_{(k,l)} = \{J|V_{(k,j)} < V_{(i,j)}\} \; where \; j = 1,2,3, \ldots., n. \tag{10}$$

Establishing the weights for each concordance can be done in a simple way using (11), while finding the weights for discordance can be done using (12). Differentiate the usage stated in determining the set and assigning weights to each alternative based on the respective criteria. This is indeed a bit difficult to understand because the more criteria used, the more complicated the solution will be.

$$C_{(k,l)} = \sum_{jC_w} W_j \tag{11}$$

$$D_{(k,l)} = \frac{\{\max\left(V_{(m,n)} - V_{(m,n)-ln}\right)\} \; where \; m,n \; \mathcal{E} \; D_{(k,l)}\}}{\{\max\left(V_{(m,n)} - V_{(m,n)-ln}\right)\}, whree \; m,n=1,2,3} \tag{12}$$

Through using (11) and (12), two-dimensional matrices will be formed from each set and the weights that have been obtained are concordance matrices and discordance matrices. Based on the findings of the two matrices, a threshold value will be searched which is known as threshold. This is done to eliminate the position of the matrices which are measured as a whole into a binary number between 0 or 1. The search for the matrices concordance threshold can be done using (13) and the search for the matrices discordance threshold can be done using (14). These two equations will give binary results on both concordance matrices and discordance matrices into decisions that are still partial and to combine them using (15) as the final decision in the alternative selection process.

$$\subseteq = \frac{\sum_{k=1}^{n}\sum_{l=1}^{n} c_{(k,l)}}{m*(m-n)} \tag{13}$$

$$\supseteq = \frac{\sum_{k=1}^{n}\sum_{l=1}^{n} c_{(k,l)}}{m*(m-n)} \tag{14}$$

$$e_{(k,l)} = f_{(k,l)} x g_{(k,l)} \tag{15}$$

Based on the findings obtained through (13) and (14), decision support for the ranking process becomes clearer. This ranking system is seen based on the highest value which is the priority to be accepted or rejected in the selection. The highest value is obtained based on the number of binaries with the value 1 owned, the more values obtained, the more likely it is to become the highest priority.

3. RESULTS AND DISCUSSION

The input received is based on expert assessments, determining criteria to provide consistent results in the selection process. 19 vendors provide 8 criteria as a barometer which is used as an objective assessment that does not favor anyone. This assessment uses the AHP method with a MCDM approach. The processed data goes through several important stages, starting from converting arithmetic to geometric scales to forming pairwise matrices which can be seen in Table 2 as shown in (1). For the large number of data matrix elements, this can be done using (2), with the number of comparison numbers totaling 28 comparisons against criteria. The process of proving the feasibility of criteria can be done using two approaches, namely the first using the mathematical algebra matrices approach and the second approach can be done with the help of the expert choice apps.

Table 2. Pairwise matrices of criterion

Criteria	QG	PM	PT	MT	DS	DT	IN	SV	Eigen vector
QG	1.000	1.453	1.943	2.923	3.349	2.683	3.295	3.272	0.251
PM	0.688	1.000	1.335	1.376	2.952	3.272	3.664	2.376	0.192
PT	0.515	0.749	1.000	1.832	1.546	2.438	2.556	2.823	0.155
MT	0.342	0.727	0.546	1.000	2.023	2.542	2.184	3.256	0.133
DS	0.299	0.339	0.647	0.494	1.000	1.336	2.223	2.286	0.089
DT	0.373	0.306	0.410	0.393	0.749	1.000	2.162	1.224	0.072
IN	0.303	0.273	0.391	0.458	0.450	0.463	1.000	1.427	0.055
SV	0.306	0.421	0.354	0.307	0.437	0.817	0.701	1.000	0.054

λ max=8.394 Consistency index (CI)=0.056 Consistency ratio (CR)=0.040 (*Acceptable*)

The calculation process in Table 2 was carried out through five iterations, until the optimum eigenvector value was found. In each iteration, the process of calculating the difference between the last eigenvector value and the previous eigenvector value must be carried out. Here we will see whether there are still differences or not. If differences are still found, then the next iteration process must be carried out. Until in the end you will find the optimum eigenvector value that has been carried out in the synthesis process for all the criteria that become the measurement barometer.

To obtain the eigenvector value in Table 2, consistency testing must be carried out to determine the feasibility of obtaining the eigenvector value. This stage requires knowing the vector length (λ max) through the average of the consistency vector matrices obtained through (3) and the consistency index (CI) using (4), Meanwhile, the consistency ratio (CR) can be proven using (5). The CR value must meet certain rules, where the CR value must be less than or equal to 0.1; This means that the decision determined in terms of the eigenvector value can be accepted and continued. The resulting CR value is 0.014 with order 8. To find the CR value, a measurement standard is needed whose value is known based on order matrices. This can be seen in Table 1 as a reference for its use. Proving the test to obtain eigenvector values can be done in a second way with the help of tools in the form of an expert choice application which has the advantage of being able to determine the magnitude of the inconsistency value. This is known by looking at the level of calculation errors that have been made using the expert choice application. The test is very simple, entering the upper triangular matrix as a pair matrix. The calculation process is the same as using a mathematical algebra matrix. The registration form can be seen in Table 3.

Table 3. Pairwise matrices using expert choice apps

	QG	PM	PT	MT	DS	DT	IN	SV
QG		1.453	1.943	2.923	3.349	2.683	3.295	3.272
PM			1.335	1.376	2.953	3.272	3.664	2.376
PT				1.832	1.546	2.438	2.556	2.823
MT					2.023	2.542	2.184	3.256
DS						1.336	2.223	2.286
DT							2.162	1.224
IN								1.427
SV	Incon: 0.03							

According to Table 3, it can be seen that the entry process was not carried out according to the mathematical algebra matrices approach, but rather all the data was obtained through a questionnaire after the conversion process was carried out. The reciprocal data that forms the matrices is not displayed, because it will be done through calculations in the apps program. The inconsistency value obtained is 0.03, this means that the error rate for pairwise data entry matrices is said to be very good and with results less than 0.1 which is standardized. Continuing with the search stage of the synthesis process from pairwise matrices with the help of the expert choice apps, this can be done via the expert choice apps menu, which can be seen in Figure 2.

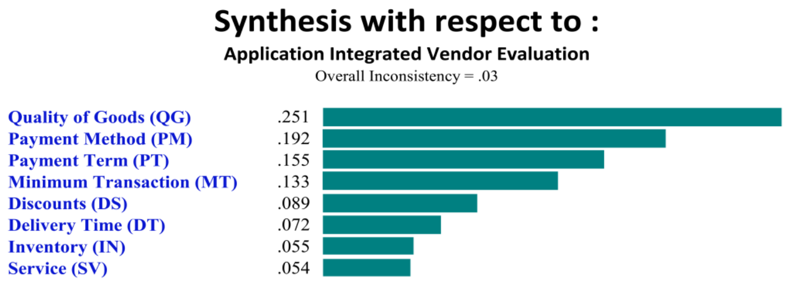

Figure 2. Synthesis of eigenvector using expert choice apps

The finding of optimum criteria which have been proven to have a level of accuracy by testing mathematical algebra matrices and with expert choice apps gives confidence to carry out collaboration tests using the ELECTRE method. All provisions obtained through the assessment of each vendor are directly carried out in a normalization process on the dataset view using (6) and (7) with the results which can be seen in Table 4 which is included with the type criteria used for the biggest is the best (HB) or the lowest is the best (LB). Table 4 can be used to find the preference index for each alternative which is compared with one another to find out which alternatives can be eliminated to form a concordance set and a discordance set. Each set is obtained based on the smallest value which is compared via index preference, the sum of which can be used using (8). Through index preference, positive values will become concordance matrices which can be done using (9), while negative values will become discordance matrices which can be done using (10). The layout of element concordance matrices must be in accordance with the alternatives being compared, this also applies to the layout of element discordance matrices.

Table 4. Normalization dataset

Criteria (Alt)\Type	QG HB	PM HB	PT HB	MT LB	DS HB	DT LB	IV HB	SV HB
SP01	0.601	1.000	0.194	0.301	0.908	0.409	0.535	0.018
SP02	0.609	0.562	0.341	0.555	0.428	0.633	0.481	0.548
SP03	0.469	0.408	0.357	1.000	0.464	0.242	0.456	0.221
SP04	0.796	0.545	0.199	0.417	0.482	0.321	0.346	0
SP05	0.19898	0.567	0.286	0.488	0.433	0.597	0.103	1.000
SP06	0.986	0.296	0	0.29	0.277	0.277	0.401	0.505
SP07	1.000	0.33	0.157	0.549	0.25	0.524	1.000	0.265
SP08	0.589	0.017	0.49	0.048	0.204	0	0	0.667
SP09	0.355	0.595	0.449	0.055	0	0.361	0.459	0.213
SP10	0.797	0.566	0.295	0	1.000	0.401	0.152	0.187
SP11	0.581	0	0.663	0.288	0.421	0.474	0.393	0.347
SP12	0.569	0.592	0.756	0.439	0.329	0.922	0.394	0.226
SP13	0	0.029	0.8	0.484	0.145	1.000	0.455	0.356
SP14	0.436	0.415	0.24	0.068	0.217	0.513	0.538	0.347
SP15	0.469	0.063	0.244	0.055	0.262	0.552	0.18	0.754
SP16	0.585	0.029	0.603	0.16	0.755	0.471	0.159	0.665
SP17	0.686	0.497	0.307	0.625	0.213	0.961	0.101	0.263
SP18	0.458	0.438	1.000	0.733	0.354	0.647	0.346	0.262
SP19	0.297	0.651	0.501	0.055	0.427	0.409	0.293	0.109

The formation of element concordance matrices and element discordance matrices is a reference for assigning weights to both, both for concordance matrices which can be done using (11) where elements with positive values automatically belong to concordance matrices, while element matrices with negative values automatically belong to discordance matrices which can be done using (12). The two matrices can be shown in Table 5 as concordance matrices.

Table 5. Concordance matrices

	SP01	SP02	SP03	SP04	SP05	SP06	SP07	SP08	SP09	SP10	SP11	SP12	SP13	SP14	SP15	SP16	SP17	SP18	SP19
SP01		0.34	0.66	0.46	0.59	0.7	0.44	0.79	0.79	0.45	0.72	0.59	0.59	0.66	0.72	0.72	0.34	0.59	0.72
SP02	0.66		0.62	0.66	0.67	0.75	0.69	0.79	0.65	0.47	0.85	0.58	0.77	0.94	0.95	0.7	0.54	0.64	0.65
SP03	0.41	0.45		0.4	0.68	0.62	0.64	0.47	0.6	0.4	0.47	0.28	0.72	0.7	0.87	0.38	0.43	0.53	0.58
SP04	0.61	0.41	0.6		0.34	0.7	0.56	0.66	0.6	0.13	0.79	0.47	0.66	0.79	0.66	0.58	0.53	0.66	0.47
SP05	0.47	0.46	0.37	0.66		0.75	0.62	0.47	0.4	0.51	0.59	0.4	0.85	0.75	0.75	0.51	0.33	0.46	0.4
SP06	0.43	0.38	0.43	0.3	0.25		0.27	0.66	0.65	0.44	0.63	0.3	0.71	0.65	0.66	0.58	0.39	0.3	0.44
SP07	0.44	0.25	0.3	0.44	0.38	0.73		0.66	0.53	0.44	0.58	0.44	0.66	0.47	0.58	0.58	0.39	0.3	0.44
SP08	0.34	0.34	0.59	0.34	0.53	0.34	0.75		0.67	0.47	0.62	0.43	0.52	0.59	0.53	0.43	0.34	0.43	0.43
SP09	0.28	0.47	0.46	0.46	0.65	0.46	0.47	0.43		0.53	0.19	0.19	0.44	0.47	0.35	0.35	0.35	0.19	0.3
SP10	0.67	0.66	0.66	0.87	0.49	0.56	0.56	0.53	0.47		0.66	0.47	0.66	0.81	0.81	0.66	0.53	0.66	0.52
SP11	0.34	0.28	0.59	0.21	0.41	0.37	0.42	0.38	0.81	0.34		0.52	0.47	0.75	0.63	0.29	0.3	0.39	0.59
SP12	0.41	0.42	0.72	0.53	0.6	0.64	0.51	0.57	0.75	0.53	0.48		0.66	0.95	0.82	0.48	0.44	0.44	0.59
SP13	0.47	0.28	0.34	0.34	0.15	0.29	0.34	0.48	0.56	0.34	0.53	0.34		0.47	0.29	0.48	0.21	0.13	0.34
SP14	0.21	0	0.25	0.21	0.25	0.35	0.53	0.41	0.53	0.19	0.19	0.05	0.53		0.33	0.19	0.14	0.05	0.44
SP15	0.34	0.18	0.18	0.34	0.25	0.34	0.42	0.47	0.52	0.19	0.37	0.18	0.71	0.67		0.25	0.14	0.43	0.43
SP16	0.34	0.42	0.67	0.42	0.49	0.42	0.42	0.57	0.81	0.34	0.71	0.52	0.52	0.81	0.75		0.3	0.52	0.81
SP17	0.72	0.51	0.62	0.47	0.67	0.61	0.61	0.66	0.65	0.47	0.7	0.56	0.79	0.86	0.86	0.7		0.62	0.56
SP18	0.47	0.41	0.53	0.34	0.54	0.7	0.7	0.57	0.81	0.34	0.61	0.56	0.95	0.95	0.57	0.48	0.38		0.59
SP19	0.34	0.47	0.47	0.53	0.6	0.56	0.56	0.57	0.56	0.48	0.41	0.41	0.66	0.56	0.44	0.19	0.44	0.41	

According to Table 5, it can be seen that the location of the element matrices has a number according to (8) as well as the discordance matrices which are arranged identically to the concordance matrices with the same number of elements, namely 342 element data matrices. The results of forming discordance matrices can be seen in Table 6 with the position of the data elements in accordance with the preference index.

Table 6. Discordance matrices

	SP01	SP02	SP03	SP04	SP05	SP06	SP07	SP08	SP09	SP10	SP11	SP12	SP13	SP14	SP15	SP16	SP17	SP18	SP19
SP01		1.1	1.18	0.43	2.07	0.69	0.69	0.66	0.28	0.45	0.47	0.97	0.62	0.48	0.79	0.67	0.79	1.43	0.64
SP02	0.91		1.14	0.34	1.1	1.06	1.83	0.23	0.22	1.03	0.57	1.29	0.75	0.12	0.41	0.61	0.86	2.3	0.32
SP03	2.55	1.04		1.7	1.81	1.93	0.7	1.63	0.57	1.28	0.57	1.63	0.71	0.19	1.12	1.09	2.81	5.5	0.77
SP04	1.71	1.33	0.59		0.76	0.93	0.22	0.92	0.43	2.64	0.64	1.84	0.57	0.44	0.72	0.59	1.8	1.78	0.45
SP05	0.71	0.78	0.55	1.31		1.9	0.64	0.72	0.32	1.61	0.68	0.92	0.72	0.39	0.54	0.73	1.45	1.59	0.4
SP06	1.82	0.7	0.52	1.07	0.53		0.14	1.4	0.53	2.68	1.23	1.36	0.61	0.33	0.59	1.13	1.39	1.42	0.55
SP07	1.67	1.84	1.43	4.47	1.55	7.07		3.38	1.17	5.81	2.02	1.96	0.76	1.14	2.15	2.82	3.98	1.68	1.4
SP08	1.31	0.81	0.61	1.09	1.39	0.71	0.18		0.9	2.54	0.28	1.04	0.37	0.53	0.18	1.74	2.58	0.87	1.54
SP09	3.32	3.68	1.75	2.34	3.14	1.87	0.86	1.11		6.07	0.5	75.12	0.47	0.85	0.73	0.94	4.65	2.65	5.13
SP10	0.81	0.4	0.78	0.38	0.62	0.37	0.17	0.39	0.16		0.49	0.74	0.48	0.13	0.5	0.43	0.37	1.17	0.31
SP11	2.82	2.31	1.76	1.55	1.47	0.81	0.5	3.59	2	2.04		0.18	1.3	0.94	0.94	7.24	1.85	3.52	2.27
SP12	2.75	3.96	4.24	3.41	4.75	2.38	0.61	3.34	5.5	4.89	2.31		0.1	0.14	0.56	0.58	1.2	1.2	0.51
SP13	2.12	1.76	1.41	1.76	1.38	1.64	1.32	2.71	2.13	2.1	5.63	9.57		1.04	1.19	3.95	1.85	1.34	2.75
SP14	3.85	-2.29	5.33	2.27	2.55	3.05	0.88	1.9	1.18	7.49	0.77	6.97	0.97		1.42	1.37	15.68	14.58	2.46
SP15	1.88	1.18	0.89	1.39	1.84	1.69	0.47	5.53	1.36	1.99	1.06	1.77	0.89	0.7		8.48	1.92	2.47	1.98
SP16	1.84	1.18	0.91	1.69	1.38	0.88	0.35	0.57	1.06	2.31	0.14	1.72	0.25	0.73	0.12		1.23	1.45	2.14
SP17	0.83	0.28	0.36	0.55	0.69	0.72	0.25	0.39	0.22	2.68	0.54	0.83	0.54	0.06	0.52	0.82		1.53	0.39
SP18	0.92	0.3	0.18	0.56	0.63	0.7	0.6	1.15	0.38	0.86	0.28	0.84	0.09	0.07	0.41	0.69	0.65		0.56
SP19	1.03	1.19	1.29	2.2	2.52	1.83	0.72	0.65	0.19	3.24	0.44	1.95	0.36	0.41	0.51	0.47	2.55	1.77	

Matrices findings in Tables 5 and 6 will make it easier to find the threshold value that is used as a measure for eliminating all elements of data matrices, both in the concordance matrices and in the discordance discordance matrices. The threshold value can be found using (13) and (14), namely finding the threshold value first to be used as an elimination process for all elements of the data matrices. The end of the elimination process that has been carried out is followed by the multiplication of the two matrices using (15). According to Table 7 as a determinant in supporting decision making to find out which is worthy of being the best priority. Based on (13), the threshold value for the concordance matrices obtained a value of 0.51; while the threshold for discordance matrices is 1.75, this is a selection measure for concordance matrices and discordance matrices. The output results from the multiplication of the two through (15) can be seen in Table 7.

According to Table 7 which is a ranking process of a number of stages according to the problem-solving algorithm that has been sorted from 19 alternatives. In first place with the number of aggregate dominant matrices obtained with a score of 18 consisting of 4 alternatives which really deserve first priority and followed by the next alternative by paying attention to the size of the aggregate dominant matrices with smaller scores decreasing downwards. This selection can support decisions about how many alternatives to choose according to their needs.

Table 7. Aggregate dominant matrices

	SP 01	SP 02	SP 03	SP 04	SP 05	SP 06	SP 07	SP 08	SP 09	SP 10	SP 11	SP 12	SP 13	SP 14	SP 15	SP 16	SP 17	SP 18	SP 19	Rank
SP 09	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
SP 10	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
SP 11	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
SP 12	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
SP 07	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	2
SP 14	1	0	1	0	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	3
SP 17	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1	0	0	1	1	4
SP 18	0	1	1	0	0	0	0	1	1	0	1	1	1	0	1	1	1	0	1	5
SP 15	1	1	1	0	0	1	0	1	0	0	0	1	1	0	0	0	1	1	1	6
SP 16	1	1	1	0	0	0	1	1	0	0	1	0	1	0	1	0	1	1	0	7
SP 19	1	1	1	0	0	0	0	1	1	1	1	0	1	0	0	0	1	1	0	8
SP 08	1	1	1	0	1	0	0	0	0	1	0	1	0	0	0	1	1	0	1	9
SP 06	1	1	1	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1	0	10
SP 03	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	11
SP 04	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	12
SP 05	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	13
SP 13	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
SP 01	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	15
SP 02	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	16

The important thing to pay attention to in the collaborative apps of the MCDM-AHP method and ELECTRE method lies in the two sides of the method. On MCDM-AHP side, determining the eigenvector value is of course centered on determining accurate questionnaire filling, otherwise it would not be possible to proceed to the next stage of the method, because the obtained eigenvector value must first be proven consistently through mathematical algebra matrices tests and expert choice apps. The results of obtaining the eigenvector values will be accepted with optimal conditions by proving the difference in values in the last iteration with the previous iteration. This proves that this research uses the MCDM-AHP approach as a characteristic of this method. The second reason on the ELECTRE side is that the process of determining the concordance set and discordance set must really meet accurate rules, so that the weighting of alternatives can be measured as a whole, concordance matrix elements and discordance element matrices with a comprehensive threshold value, an elimination process can occur. accurately according to aggregate dominant matrices. The collaboration of these two methods can be aligned to obtain optimal decision support.

4. CONCLUSION

The resulting collaboration method provides an answer to complete vendor selection by building a framework to handle critical points in the supply chain resulting from contradictory types of a number of multi-criteria. Both methods carry out a normalization process to obtain weighting optimization and ranking optimization to achieve optimal decision results. Through a very long process stage, the results obtained from the selection process for 19 vendors gave the decision that the ranking was determined based on the aggregate dominant matrix which had the highest weighted score. There are 4 vendors who have the highest ranking as the best vendors with a weight of 18 points, followed by rankings with increasingly smaller point weights. Selection of the best vendor for quality procurement and capable of maintaining the supply chain can be adjusted to the need for decision-making support as an alternative.

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