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OPTIMIZATION OF THE PROCUREMENT PROCESS THROUGH COMPARISON OF MULTICRITERIA METHODS

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Abstract

Decision support system for procurement has an important role in maintaining the objectivity of the procurement process in an organization. This can be used as a tool in monitoring and evaluating goods procurement systems that involve many parties. Procurement of goods at the Hospital "ABC" is one of the business processes managed independently as a form of efforts to improve the quality of service to patients. A hospital must make the right decision regarding the procurement of goods carried out in collaboration with the goods provider (vendor) because it relates to the quality and budget that must be accounted for. This study tested the method of Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Both of these methods are used for multicriteria-based problem solving and careful and effective selection to determine the winner of goods procurement vendors in the "X" Hospital. Comparison of the two methods carried out in this study was tried out on data on procurement of goods at the "X" Hospital in the January 2013-September 2013 period. The results of the trials showed that both methods had the same winning vendor recommendations.

Keywords: ***procurement, vendors, AHP, TOPSIS***

Introduction

Procurement of goods in hospitals is an important factor to realize maximum service to patients. This happens because the procurement of goods has the purpose of fulfilling health facilities in hospitals. But on the internal side of the organization, procurement of goods is sensitive because it is related to the transparency system. In general, the process of procuring goods at the hospital goes through several stages, namely the submission of procurement, approval for the submission of goods procurement, to the auction of procurement projects to external parties outside the hospital. This certainly requires a long time and allows duplication of procurement data that can trigger the acquisition of the procurement budget. In addition, the number of offers submitted by external parties makes it difficult for the hospital to provide a subjective assessment of the supply of goods to the hospital. Actually, this condition can be used by external parties to bribe internal hospitals to win bids in the procurement process.

Based on these conditions, the role of information technology is expected to minimize the problems that arise related to the procurement process. One of them is the construction of a decision support system that can help internal hospitals to assess several criteria standards and provide recommendations in an objective manner about the procurement of goods. Some methods used in building multi-criteria based decision support systems include the Analytical Hierarchy Process (AHP) method and the Technique for Order of Preference by Similarity to Ideal Solution(TOPSIS).

The purpose of this research is to provide input to the internal side of the hospital through an expert system to obtain the best method that can determine the winning vendor of procurement of goods effectively, quickly and accurately. So that the risk of errors in selecting the winning vendor in the procurement process can be avoided and the creation of a culture of transparency in the procurement process in the hospital environment.

Research methods

In this research the methodology was proposed to obtain the results of comparisons of both AHP and TOPSIS methods (figure 1). The first stage in the methodology is to determine the research data to be used. Then design the algorithm for the AHP and TOPSIS methods. Finally, compare the final result of the two methods.

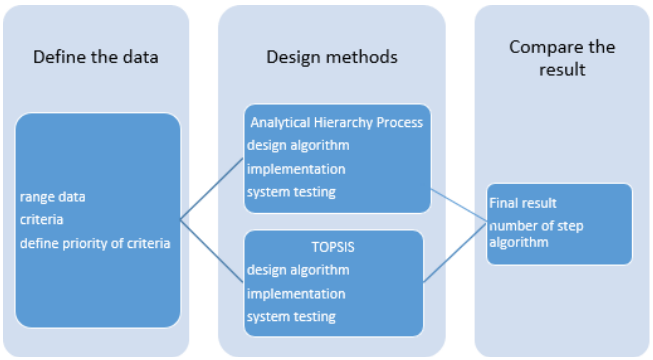

Figure 1. Research Methodology

1. Data

In this research, the data used is data on the procurement of non-medical items owned by the "X" Hospital. In selecting vendor vendors there are several assessment criteria so that the selection of vendor of goods supplier will be in accordance with the needs, influential criteria in determining the choice of vendor vendor, namely: price criteria (H), discount criteria (D), down payment criteria (U), criteria warranty (G), installment criteria (C), shipping criteria (P), vendor team presentation criteria (R), vendor profile criteria (F). The data used in this assessment is subjective data based on the experience of the expert team of procurement of goods and other supporting information.

2. Design Methods

At this stage, the two proposed methods begin with developing an algorithm design, then proceed with implementation, and finally the system test using the data defined in the previous stage.

The algorithm design for the AHP method begins by making a hierarchical structure of criteria in determining the valuation in the procurement process. Then, determining the priority scale of the eight predetermined criteria based on the knowledge of the goods procurement expert in the hospital (table 1).

Tabel 1 Criteria Weighting of AHP Method

Criteria	Priority	Weight
Price (H)	1	9
Discount (D)	2	8
Done Payment (U)	3	7
Warranty (G)	4	6
Credit (C)	5	5
Delivery (P)	6	4
Presentasion team (R)	7	3
Vendor profile (F)	8	2

In this case the first priority is price, the weight given is nine because the highest weight in AHP is number nine. Furthermore, the second priority is discount given the weight of eight, the third priority is the down payment given weight 7, the fourth priority warranty is given weight 6, the fifth priority installments are weighted 5, the priority of the six shipments is given a weight of four, the priority of the seven presentations is given a weight of three, and the last priority profile given a weight of two. If there are priorities of equal importance, the weight given must also be the same. Furthermore, the eight criteria are arranged in a pairwise comparison matrix to calculate the eigen vector value. The results of the matrix will be calculated CR and CI values to determine the value of the consistency of a criterion.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \text{.....(1)} \qquad CR = \frac{CI}{RI} \quad \text{.....(2)}$$

Whereas the design of the TOPSIS method has the same initialization as the AHP method. In this study, the criteria used in the TOPSIS method are the same as the criteria used in the AHP method, namely 9 criteria with

3 alternative vendor choices. The main point that distinguishes the design of the TOPSIS method is the steps in manual calculation and preparation of program pieces. The stages in the TOPSIS method include making normalized decision matrices, weighted decision matrices, determining the positive and negative ideal solution matrix, determining the distance between each alternative with a matrix of positive and negative ideal solutions, and determining preference values.

3. Compare The Result

In this study the comparison of results was carried out in order to find out the method that has the most rapid and accurate trial results. Comparison of the results of the trial will be displayed in the form of a comparison matrix between the actual conditions of the procurement of goods that have been done, the results of the AHP method, and the results of the TOPSIS method.

Research Results and Discussion

AHP Method

The hierarchy of criteria for evaluating product procurement is the first step in the design of the AHP method. In this study 8 criteria were used that must be owned by each vendor of goods procurement. Each criterion has different weights depending on each priority scale, then the criteria are arranged in a paired matrix (matrix pairwise comparison). The eigen vector value is obtained from the division of weights in the matrix pairwise comparison with the total matrix value of a criterion (table 2). Then the eigen vector value is normalized by calculating the average weight of a criterion.

Table 2 Value of eigen vetor

Criteria	H	D	U	G	C	P	R	F	Sum	*Eigen*
H	0,2045	0,2045	0,2045	0,2045	0,2045	0,2045	0,2045	0,2045	**1,636**	0,2045
D	0,1818	0,1818	0,1818	0,1818	0,1818	0,1818	0,1818	0,1818	1,4544	0,1818
U	0,1591	0,1591	0,1591	0,1591	0,1591	0,1591	0,1591	0,1591	1,2728	0,1591
G	0,1364	0,1364	0,1364	0,1364	0,1364	0,1364	0,1364	0,1364	1,0912	0,1364
C	0,1136	0,1136	0,1136	0,1136	0,1136	0,1136	0,1136	0,1136	0,9088	0,1136
P	0,0909	0,0909	0,0909	0,0909	0,0909	0,0909	0,0909	0,0909	0,7272	0,0909
R	0,0682	0,0682	0,0682	0,0682	0,0682	0,0682	0,0682	0,0682	0,5456	0,0682
F	0,0454	0,0454	0,0454	0,0454	0,0454	0,0454	0,0454	0,0454	0,3632	0,0454

To assess the objectivity of a criterion used the calculation of consistency ratio (CR) and consistency index (CI) with formulas 1 and 2. If the CR value is <0.1, the criteria are objectively stated otherwise the criteria are declared not objective so they are not worthy of consideration. The results of the eight criteria used in the case study in hospital X showed a value of <0.1 so that the eight criteria were stated objectively.

This reasearch, as many as 3 vendors of procurement providers were tested using the AHP method. First, the pairwise matrix of the three vendors is compiled to obtain the eigenvalue vector and normalized weights. The pairwise matrix of 3 procurement vendor vendors is made a number of predetermined criteria. The results of the calculation of CI and CR values of the three vendors against the 8 criteria show below 0.1, that means the 8 criteria are objective for all vendors. Second, the results of the normalization weight of all vendors on the 8 criteria are included in the merger matrix. This is done to get the results of global priority from the three vendors of goods differentiation. The matrix combining the weight of each criterion with the vendor of goods procurement is shown in table 3. The vendor who gets the highest number of weight is the vendor recommended to be the winner in the tender for procurement of goods at the hospital.

Table 3 Global Priority Merge Matrix

Vendors	H	D	U	G	C	P	R	F	Sum	Ranking
	0,2045	0,1818	0,1591	0,1250	0,1364	0,0909	0,0682	0,0454		
Vendor A	0,3206	0,3465	0,333	0,2	0,5	0,4	0,375	0,3333	**0,3421**	**2**
Vendor B	0,2716	0,099	0,333	0,4	0,25	0,2	0,375	0,3333	**0,2677**	**3**
Vendor C	0,4079	0,5544	0,333	0,4	0,25	0,4	0,25	0,3333	**0,3880**	**1**

TOPSIS Method

The trial implementation with the TOPSIS method uses the same procurement criteria and vendor data as the previous method. If the AHP method needs to be calculated to ensure the value of objectivity, it is different from the TOPSIS method which does not use the approach. Regarding the calculation of the TOPSIS method, the compatibility rating of each criterion varies, with varying levels of importance. Criteria for prices are assessed by (1) expensive, (2) standard, (3) cheap; discount criteria are rated with (1) a little, (2) a lot; the criteria for advances are assessed by (1) large, (2) small; warranty criteria are assessed by (1) less than 1 year, (2) more than equal to 1 year; Installment criteria are assessed by (1) Less than 2 installments, (2) More than 2 installments; shipping criteria are assessed by (1) more than 1 month, (2) less than 1 month; Presentation criteria and vendor profiles are assessed by the assessment matrix as follows (1) very bad, (2) bad, (3) sufficient, (4) good, (5) very good.
The results of the three procurement vendor evaluations are transformed into a kariteria and alternative match matrix shown in table 4.

Tabel 4 Criteria Compatibility Matrix and Alternative Vendors

Vendors	Criteria							
	H	D	U	G	C	P	R	F
Vendor A	2	2	1	1	2	2	4	5
Vendor B	1	1	1	2	1	1	4	4
Vendor C	3	2	1	2	1	2	4	4

After a match matrix has been made, the calculation of value weights can be done. Normalization of the weight of each procurement vendor is calculated according to the specified criteria (formula 2). So that the normalization matrix results in figure 2.

$$\begin{bmatrix} 0{,}5346 & 0{,}666 & 0{,}5773 & 0{,}333 & 0{,}666 & 0{,}666 & 0{,}5773 & 0{,}6622 \\ 0{,}2673 & 0{,}333 & 0{,}5773 & 0{,}666 & 0{,}333 & 0{,}333 & 0{,}5773 & 0{,}5298 \\ 0{,}8019 & 0{,}333 & 0{,}5773 & 0{,}666 & 0{,}333 & 0{,}666 & 0{,}5773 & 0{,}5298 \end{bmatrix}$$

Figure 2. Normalization Matrix TOPSIS

The normalization matrix is calculated by multiplying the results of normalization with the previously entered assessment, so that the normalization matrix of the new merger is obtained as shown in figure 3.

$$\begin{bmatrix} 1{,}0692 & 1{,}332 & 0{,}5773 & 0{,}333 & 1{,}332 & 1{,}332 & 2{,}309 & 3{,}11 \\ 0{,}2673 & 0{,}333 & 0{,}5773 & 1{,}332 & 0{,}333 & 0{,}333 & 2{,}309 & 2{,}1192 \\ 2{,}4057 & 0{,}333 & 0{,}5773 & 1{,}332 & 0{,}333 & 1{,}332 & 2{,}309 & 2{,}1192 \end{bmatrix}$$

Figure 2. Weighted Matrix TOPSIS

Then from the weight matrix, each criterion looks for the ideal positive (A +) and negative (A-) values. This is done to calculate the distance between the weighted value of each vendor to a positive solution and a negative solution. Based on the calculation results for 3 vendors of procurement of goods against 8 criteria, the results obtained in table 5.

Table 5. Positive and Negative Weighted Value Results

Vendors	Value weighted positive solution	Value weighted negative solution
Vendor A	2,3344	2,149
Vendor B	2,7477	0.9989
Vendor C	1,7255	2,7477

Preference values are needed to calculate the final weight of each vendor procuring goods. This value is obtained by dividing the weight value of the negative ideal solution by the number of ideal positive and negative distances. The results show vendor A preference value of 0.4793, vendor B 0.2666, and vendor C of 0.6142. So based on the calculation of the recommended TOPSIS method to be the winner in the tender for procurement of goods at the hospital.

Conclusions and recommendations

The process of procurement of goods, especially in a hospital requires transparency and objective assessment of the vendors of procurement of goods. In the assessment process, of course, use several criteria to determine the right vendor winner. The criteria used in the case study of this study are the price of the item offer, the discount given, the advance payment for goods, the warranty of goods, the installments that are permitted, the time of delivery of goods, the vendor presentation, and the profile of the vendor offering the goods. To solve the multicriteria problem, several methods are proposed including Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). This research is proposed to test both methods in solving the problem of the process of procuring goods in hospital X. The results of the trial show the final results of the AHP method recommending vendor C as the winner with the final weight of 8 criteria amounting to 0.3880. While the TOPSIS method shows the largest preference value is 0.6142 owned by vendor C. This shows that the results of the two methods recommend the same winner results of the vendor. Even though through different mathematical calculations, the AHP method goes through several stages which are more than the TOPSIS method. This is interesting for system development in the future. There needs to be an increase in the amount of data and sub-criteria for assessment to determine the resilience of the two methods to solve the problems.

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