SAW, TOPSIS, PROMETHEE Method as a Comparison Method in Measuring Procurement of Goods and Services Auction System

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Abstract. In the procurement of goods and services POKJA conduct auctions and decide the results of the auction. The decision taken will assist POKJA to assess and determine the winner of procurement and goods and services auction. Decision making base on some criteria and complexity in the assessment of attribute and benefit. Multi-criteria decision making helps to find best alternative base on existing data. Aim of this paper is to compare three available multi-criteria decision making (SAW, TOPSIS and PROMETHEE) for the auction application. Multi-criteria decision making is needed to calculate the strength in each stage of the procurement selection process. Where multi-criteria decision making decision support system is used in seeing the strength and rank ranking of the winning candidate for goods and services procurement. The result of the research are Promethee method that is good in performance, stability, saw, and topsis. They are good in computation and transparency base on analysis rank, reference rank and review rank. The implication is to provide alternative to select the winner of goods and services auction.

1. Introduction
Goods procurement process and services is a series of goods procurement business process where the process start from registration of auction participants up to announcement of the bidding winner. Multiple criteria decision making (MCDM) has grown as operation research method with computational and mathematical tools to support subjective evaluation of performance criteria by decision maker [1]. Lately several previous studies had used MCDM tools and applications to solve area problems such as energy, environment and sustainability, construction and project management [2,3,4,5].

Procurement of goods and services in LPSE (Electronic Procurement Service) Bandung city is a series of business process procurement of goods and services where there is a process of registration of auction participants up to the announcement of the winning bidder in the assessment process until the decision of the winning bidder handled by POKJA from City Procurement Services Unit Bandung and need a decision support system in determining the winning bidder of procurement of goods and services. In this case the Procurement Unit handles the procurement of goods and services of the city of Bandung. The need for the use of decision support system in Bandung city procurement service unit will assist the assessment of procurement of goods and services as well as the provision of alternative solutions for winning the procurement of goods and services.
State of the art of this paper focus mainly to calculate power on every step of selection process where MCDM use to determine strength and rank of every candidate of auction.

Widianta et al [6] uses AHP, TOPSIS, SAW and PROMETHEE as comparison methods for employee placement where the result are TOPSIS has 95% accuracy followed by PROMETHEE with result 93.34%, SAW 81.67% and the lowest is AHP with result 50%. In ranking TOPSIS and PROMETHEE has same rank, SAW result is 1 difference and AHP with 4 differences.

The aim of this paper is to find best alternative using three multi criteria decision making method (SAW TOPSIS and PROMETHEE). Where the data used with criteria experience, methodology and approach, qualified experts, offer price.

2. Methods
Uncertainty of goal / goal in decision-making is an important manifestation of the uncertainty associated with multi criteria decision making character of many problems encountered in complex project, planning, operation, and control systems [7]. MCDM methods use here are SAW, PROMETHEE and TOPSIS

2.1. SAW Method
The SAW method was first introduced by Harsanyi. The SAW (Simple Additive Weighted) method is probably the best known and widely used method for some of the MADM decision making attributes [8] Because of its simplicity, SAW is the most popular method in MADM problems and the best alternative can be derived by the following equation:

\[ A^* = \{ u_i(x) \mid \max_i u_i(x) \mid i = 1,2 \ldots n \} \]  

Or a gap from an alternative can be improved to build the best alternative A ^ * to achieve the desired aspiration level on each criterion.

\[ u_i(x) = \sum_{j=1}^{n} w_j r_{ij}(x), \]  

Where \( u_i(x) \) is the use of I th alternative and and = 1,2 ... n; \( w_j \) is the weight of the criterion \( j; r_{ij}(x) \) is the preferred normalization of the th th alternative by relying on the criteria for all equivalent units.

2.2. TOPSIS
Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method, initially developed by Hwang and Yoon in 1981 [9] with further developments by Yoon in 1987 [10], and Hwang, Lai and Liu in 1993 [11]. TOPSIS is based on the concept that the chosen alternative must have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the ideal solution. This is a compensatory aggregation method that compares an alternative set by identifying the weights for each criterion, scoring normalization for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best value in each criterion. The TOPSIS assumption is that monotonous criteria increase or decrease. Normalization is usually required as a parameter or criterion often an odd dimension in multi-criteria issues. Compensation methods such as TOPSIS allow trade-offs between criteria, where poor results in one criterion can be negated by good results in other criteria. This provides a more realistic form of modeling than non-compensatory methods, which include or exclude alternative solutions based on hard cut-offs.

2.3. PROMETHEE
PROMETHEE stands for Preference Ranking Organization Method for Enrichment of Evaluations. A partial preorder (PROMETHEE I) or a complete preorder (PROMETHEE II) on A can be first offered
for decision makers. PROMETHEE III provides an interval order that emphasizes ignorance. PROMETHEE IV agrees with a sustainable collection of possible alternatives [12].

The PROMETHEE method requests additional information but only on few parameters to be fixed and all have real economic significance. 6 possible types of generalizable criteria that can be considered in the PROMETHEE method and as shown in table 3.1. Each type can be easily defined because only one or two parameters need to be fixed.

Let A a finite set of alternatives to the MCDM problem, and suppose the function of preference, \( f_j \) has been defined for each \( g_j \) for each pair of alternate \( a, b \in A \) when \( a \succ b \) in \( j \) criteria. \( f_j(a, b) = f_j(d_\text{(ab | j)}) \) indicates that the degree of alternative prefers alternative \( b \) (a over b) to a distance different from the performance value \( d_\text{(ab | j)} = g_j(a) - g_j(b) \) in \( j \) criteria, and \( \pi(a, b) \) is the index preference through all criteria defined by

\[
\pi(a, b) = \sum_{j=1}^{n} w_j f_j(a, b)
\]

3. Results
Development of the system through the process of system design that will be developed to meet the needs of the system. Here are the modules for the system to be developed:

1. The registration process of the project will be auction based on the procurement plan from various agencies where in this process is done data collection project.
2. Data collection of project requirements that have been registered in the procurement project that has been entered which in this process checklist of project requirements and enter the data requirements project
3. The process of entering the procurement schedule of a project that is auctioned with several stages of the schedule where in this process input is done in the start date of the procurement stage activities and the end date of the procurement stage
4. The process of entering the minutes according to the stage of the schedule that has been done in the procurement process where at this stage made the making of events and documentation of the minutes of the event according to the project schedule
5. The process of entering procurement documents from procurement projects to be tendered which in this process documentation of procurement documents as reference procurement project auction
6. The process of entering the data of the auctioneer's request for procurement project which is followed by the participant where in this process the registration of the request from the participant who will follow the procurement of a procurement project
7. The process of entering the application requirements data for the procurement project followed by the participant where in this process carried out the process of entering the application requirements data such as document offerings and technical documents
8. Process of administrative evaluation of application requirements data from participant of project procurement where in this process verifier does checklist checking of bidding document and technical document to be adjusted to procurement requirement of project
9. The technical evaluation process and the bid price of the applicant for the procurement project where in this process the assessor performs a technical evaluation in accordance with the predetermined value system for the project
10. Qualification proofing process from the applicant of the procurement project where in this process the participants bring the original documents to be shown to the committee / verifier and check the conformity with the administrative documents and technical documents that have been entered during the bidding
11. The process of calculating the decision support system of multicriteria decision making using SAW, TOPSIS, PROMETHEE method to calculate based on the assessment that has been done in providing decision support to the winning bidder of procurement of goods and services
12. The process of determining the winning bidder for procurement of goods and services where in this process the winner of tender auction of procurement of goods and services based on alternative solution given decision support system.

13. Procurement reporting process whereby in this process ulp head can make procurement report of goods and services.

Through comparative analysis conducted where there are several criteria assessed where the criteria are sorted by the following rank where analysis result shown at table 1.

| Method  | Algorithm | Performance | Scale | Sign | Result | Sensitivity Analysis | Coefficient Sensitivity Analysis | History | Classification | Total | Rank |
|---------|-----------|-------------|-------|------|--------|----------------------|-------------------------------|---------|----------------|-------|------|
| SAW     | 1         | 1           | 3     | 1    | 2      | 2                    | 1                             | 3       | 18             | 1     | 1    |
| TOPSIS  | 1         | 3           | 2     | 1    | 5      | 4                    | 6                             | 3       | 2              | 33    | 3    |
| PROMETHEE | 3      | 2           | 6     | 1    | 1      | 3                    | 4                             | 1       | 1              | 26    | 2    |

Table 2. showing result of reference base analysis. Base on journal reference analysis method where measurement on MCDM method had done then the result shown at table 2.

| Method  | Method Classification | Result Classification | Transparency | Computation | Cost | Total | Rank |
|---------|-----------------------|-----------------------|--------------|-------------|------|-------|------|
| SAW     | 5                     | 3                     | 5            | 5           | 1    | 19    | 1    |
| TOPSIS  | 5                     | 4                     | 3            | 5           | 1    | 18    | 2    |
| PROMETHEE | 5                | 3                     | 1            | 1           | 3    | 12    | 3    |

Table 3. Review Base Result.

| Method   | Popularity | Easy | Stability | Total | Rank |
|----------|------------|------|-----------|-------|------|
| SAW      | 4          | 5    | 3         | 12    | 1    |
| TOPSIS   | 3          | 4    | 3         | 10    | 2    |
| PROMETHEE | 2        | 2    | 5         | 9     | 3    |

4. Conclusion

Based on the results of the analysis, it can be concluded that the PROMETHEE method is superior in terms of accuracy, while SAW excels as a point of comparison in seeing the overall results whereas TOPSIS excels in viewing the ideal point of all alternatives. This paper did not use may attributes as measurement variable, for further research can use hierarchical decision support with deeper attribute analysis.

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