Decision Support System for Evaluation Procurement of Goods with Simple Additive Weighting Method (SAW)

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Abstract—**Procurement of goods through the provision requiring a decision support in selecting the winner of the procurement decision-making in order to vote and determine the winner of the procurement . This research aims to build a Decision Support System (DSS), which serves as a tool in decision-making on procurement evaluation process. For the purpose of DSS can be achieved with both the aided by using one of the methods in decision-making that is the method of Simple Additive Weighting Method (SAW) to evaluate alternatives in the procurement of goods based on the criteria for decision-making. This method has the benefits criteria and cost criteria. Benefit criteria is use when making decisions that take into account the maximum profit. When the cost criteria is the inverse of the attribute gains, in this draft decision will be search for a minimum cost. The results may support the decision on the evaluation of alternative procurement election winners based on predetermined criteria.**

Keywords-Procurement; Decision Support Systems; Simple Additive Weighting

I. Introduction

Procurement of goods through the auction either done conventionally require a support procurement decisions in choosing a winner. System running during this limited participant noted procurement and files are requiring, so that decision-making should still work in selecting and determining the winner.

The way they often cause problems such as the emergence of the objection from the procurement was not satisfied with the results of procurement decisions winner. The number of participants attend so it takes a long time to evaluated all required documents and bidding documents . Qualification evaluating process conducted by asking and checking all bidding documents.

This research aims to build a Decision Support System (DSS), which serves as a tool in decision-making in the procurement process. The purpose of DSS can be achieve with both the aided by using one of the methods in decision-making that is the method of Simple Additive Weighting Method (SAW) Method to evaluate alternatives in the procurement of goods based on the criteria for decision-making.

II. Framework of Theory

A. Procurement of Goods

Government procurement of goods or services, and then referred to as the procurement of goods or services is activity to acquire goods or services by the ministry or agency or work unit or other institution that started the process of planning needs until completion of all activities to obtain goods or services [4].

Procurement of goods and services can be only done, if the goods and services listed in the Program Plan and Budget unit which has been approved by the leadership. In this contents are all activities that will be undertaken in outline, including the amount and source of the budget, spending plan also including details of goods start from specification, to estimate the amount of the cost.

B. Evaluation of Procurement

Procurement services unit to evaluated offered include:

- *Administration evaluation*
  Administrative evaluations conducted on the completeness and validity of the administrative requirements specified in procurement documents.
- *Technical evaluation*
  Technical evaluation carried out on the technical requirements set out in the procurement documents. When used the pass threshold, the technical evaluation can be done by providing assessment (score) of the technical elements in accordance with establishing criteria.
- *Price evaluation*
  Based on the results of the price evaluation, procurement services unit lists the starting bid cost of the order of the lowest bidder [4].

C. Decision Support Systems

Decision support systems (DSS) are using as a tool for decision makers to expand the capabilities of decision-making, but not to replace the judgment of the decision-making. DSS is intending for decisions that require judgment or for decisions that can be supporting at all by the algorithm. DSS expanded rapidly, from just a personal tool to support a shared commodity [5].

The issue of decision-making, in the selection, essence is of a variety of alternative forms of action that may be selected which process a particular mechanism, in hopes of producing a best decision.

- *Phase of the decision-making process*
  Phase of the decision-making process consists of the following steps:
  1) *Intellegence phase*
     This phase is the process of tracking, the detection of the scope of the problems and the process of recognition of the problem. The data obtained was processed and tested in order to identify the problem.
  2) *Design phase*
     This phase is the process of discovering, developing and analyzing possible courses of action. This includes an understanding of the problems and test the solutions are feasible.
  3) *Choice phase*
     In this phase, a decision is made real and take a commitment to follow a particular action.
  4) *Implementation phase*

In this phase, made a recommended solution that can be work or implementation of a proposed solution to a problem.

- *Characteristics of Decision Support Systems*
  Characteristics of the decision support system are as follows:
  1) Decision support to discuss issues of structured, semi-structured, and unstructured.
  2) Output is intended for personnel in all levels of the organization.
  3) Support in all phases of the decision-making process: intelligence, design, choice.
  4) The presence of human or machine interface, where human (user) keep control of the decision making process.
  5) Using mathematical models and statistics in accordance with the discussion.
  6) Dialog has the ability to obtain information in accordance with the requirements.
  7) Have integrated subsystems such that it can be serve as a unified system.
  8) Requires a comprehensive data structure that can serve the needs of all levels of management information.
  9) Approach is easy to use. Characteristics of an effective decision support system is its simplicity to use and allows the user the flexibility to choose or develop new approaches in addressing the problems that exist.
  10) System's ability to adapt quickly, where decision-making can be take on new problems and at the same time be able to handle it in a way adapted to the system conditions change happens [5].

D. Simple Additive Weighting (SAW)

Is a weighting sum method. The basic concept is the SAW method for weighting sum of rating the performance of each alternative on all criteria [2]. SAW method requires the decision matrix normalization process (X) to a scale that can be comparing with all the existing alternative rating [1][3].

Knowing the SAW method two attributes the benefits criteria and cost criteria. The fundamental difference of these two criteria are in the selection criteria when making decisions. The completion step in using it is:

- Determine alternatives is A_i.
- Determine the criteria that will be used as a reference in decision-making is C_j.
- Provide compatibility rating value of each alternative on each criteria.
- Determine the level of importance or preference weights (W) each criteria.

$$W = [W_1 \quad W_2 \quad W_3 \quad \dots \quad W_j] \qquad (1)$$

- Create table rating the suitability of each alternative on each criteria.
- Making the decision matrix x is formed from the rating table matches of each alternative on each criteria. Value of each alternative x (A_i) on each criteria (C_j) are already determined, where, i = 1,2, ... m and j = 1,2, ... n.

$$\qquad (2)$$

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} \\ \vdots & & & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} \end{bmatrix}$$

- Normalized decision matrix X by calculating the value of the performance rating ternomalisasi (r_{ij}) of alternative A_i on criteria C_j.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{Max_i(x_{ij})} \\ \dfrac{Min_i(x_{ij})}{x_{ij}} \end{cases} \qquad (3)$$

- Results of normalized performance value rating (r_{ij}) matrix normalized form (R)

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ \vdots & & & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} \end{bmatrix} \qquad (4)$$

- The final result preference value (V_i) is obtained from the sum of the row elements of matrix multiplication normalized (R) with preference weights (W) corresponding element column matrix (W).

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \qquad (5)$$

V_i value calculation results indicate that the greater alternative is the best alternative Ai [2].

III. RESEARCH METHODOLOGY

A. Analysis of Issues

Problem analysis was performed to determine the issue at this stage of acquisitions made through the auction process. In determining the winner of the auction system and decision-making using criteria in accordance with the criteria set out in regulation procurement.

B. Requirement Identification

Identification of needs was conducted to determine used need for decision support systems to be built in the evaluation of new acquisitions winning elections precisely and objectively, in accordance with the regulations that apply to the procurement evaluation.

C. Design System

Decision support system evaluation acquisitions winner selection with simple additive weighting method start from the procurement process by utilizing SAW method to facilitate in decision make acquisitions conducted through the auction process.

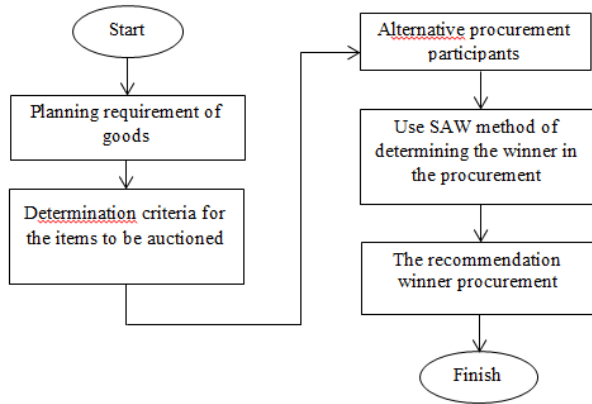Decision-making procedures in the use of the SAW method can be seen in the diagram in Figure 1.

$$\qquad (1)$$

Figure 1. Framework of a decision support system evaluation acquisitions winner selection with simple additive weighting method.

D. Implementation

In this stage of the system development process in order to perform according to the design that has been created to be used in accordance with user needs and present the necessary information.

IV. RESULTS AND DISCUSSION

Accordance with procurement regulations, to determine the winner in the procurement through tenders for 3 evaluation criteria: administrative, technical evaluation and cost evaluation [4].

A. Administrative evaluation.

Administrative evaluation given the maximum weight value 2, with the following provisions:

Nothing : 0
Not suitable : 1
Appropriate : 2
Description:

Nothing : Documents required are not included in the bidding documents.
Not Suitable : Documents required are not in accordance with the documents listed in the procurement.
Appropriate : in accordance with the required documents listed in the procurement documents.

Administrative evaluation criteria listed in the benefit for more complete administrative requirements, the higher the benefits which the administrative requirements can be using as indicators of the existence of procurement participants.

B. Technical evaluation.

Technical evaluation given the maximum weight value 2, with the following provisions:

Nothing : 0
Not suitable : 1
Appropriate : 2
Description:

Nothing : Item is not including in the bidding documents.
Not suitable : Specifications of goods are not in accordance with the documents listed in the procurement.
Appropriate : the goods in accordance with the specifications listed in the procurement documents.

Each criterion in the technical evaluation will be assigned weights according to the value of the real condition of the technical documents submitted by the bidders as compared to the technical specifications of the items to be auctioned. All weights will be totaled as a weight on the technical evaluation criteria.

Technical evaluation criteria listed in the benefits due to the higher weight to each criterion then shows that the quality of the goods to be received, the better and the lower the score the quality of the goods to be received progressively less.

C. Price evaluation.

Price evaluation formula is used:
Offers the estimated cost (HPS) = Value offers / HPS.
Price evaluation criteria listed in the cost due to the lower weight to each criteria, the costs associated with the lower.

Of the subsequent evaluation of the above will be put into a matrix for calculation of the Simple Additive Weighting Method (SAW), with the following example:

A. In this research, alternative bidders characterized by A_1 to A_4, with the breakdown is:
A_1 = procurement participant 1
A_2 = procurement participant 2
A_3 = procurement participant 3
A_4 = procurement participant 4

B. The criteria given by C_1 to C_3 used as a reference in decision maked is:
C_1 = Administrative evaluation
C_2 = Technical evaluation
C_3 = Cost evaluation

C. Providing compatibility rating value of each alternative on each criteria procurement participant. For administrative evaluation criteria and technical evaluation by providing and sum scores of each of the criteria assessed with 0 to 2 is:
0 = Nothing
1 = Not suitable
2 = Appropriate
As for the price evaluation criteria of each alternative is given value by:
Offers the estimated price (HPS) = Value offers / HPS.

D. Determine the weight of preference or level of importance of each criteria, with a value of:
1 = Very low
2 = Low
3 = medium
4 = High
5 = Very High
Preference or importance weights in this calculation are given a minimum value on each criteria (1, 1, 1), where the weight of preference or importance levels was taked from the results of the assessment committing officer on the implementation of the procurement. For example, in a procurement auction

Educational Tool after was weighted scores obtained in table I below:

Table I	Weighting score		
Participant	Administrative evaluation	Technical evaluation	Cost evaluation
participant 1	24	15	0,9853
participant 2	24	16	0,9668
participant 3	24	14	0,9226
participant 4	24	16	0,9221

E. Table II below shows the suitability rating of each alternative on each criteria:

Table II	Rating the suitability of each alternative on each criteria.		
alternative	C_1	C_2	C_3
A_1	24	15	0,9853
A_2	24	16	0,9668
A_3	24	14	0,9226
A_4	24	16	0,9221

F. Make a decision matrix rating the suitability of the table of each alternative on each criteria.

$$X = \begin{bmatrix} 24 & 15 & 0.9853 \\ 24 & 16 & 0.9668 \\ 24 & 14 & 0.9226 \\ 24 & 16 & 0.9221 \end{bmatrix}$$

G. The decision matrix normalization process by calculating the value of normalized performance rating (r_{ij}) based on equations that was adapted to the type of criteria. For administrative evaluation criteria and technical evaluations use the criteria of the benefits while for the cost criteria use the criteria of cost.

$$r_{11}= \frac{X_{11}}{Max_i(X_{11,}X_{21,}X_{31,}X_{41})} = \frac{24}{24} = 1.0000$$

$$r_{21}= \frac{X_{21}}{Max_i(X_{11,}X_{21,}X_{31,}X_{41})} = \frac{24}{24} = 1.0000$$

$$r_{31}= \frac{X_{31}}{Max_i(X_{11,}X_{21,}X_{31,}X_{41})} = \frac{24}{24} = 1.0000$$

$$r_{41}= \frac{X_{41}}{Max_i(X_{11,}X_{21,}X_{31,}X_{41})} = \frac{24}{24} = 1.0000$$

$$r_{12}= \frac{X_{12}}{Max_i(X_{12,}X_{22,}X_{32,}X_{42})} = \frac{15}{16} = 0.9375$$

$$r_{22}= \frac{X_{22}}{Max_i(X_{12,}X_{22,}X_{32,}X_{42})} = \frac{16}{16} = 1.0000$$

$$r_{32}= \frac{X_{32}}{Max_i(X_{12,}X_{22,}X_{32,}X_{42})} = \frac{14}{16} = 0.8750$$

$$r_{42}= \frac{X_{42}}{Max_i(X_{12,}X_{22,}X_{32,}X_{42})} = \frac{16}{16} = 1.0000$$

$$r_{13}= \frac{Min_i(X_{13,}X_{23,}X_{33,}X_{43})}{X_{13}} = \frac{0.9221}{0.9853} = 0.9359$$

$$r_{23}= \frac{Min_i(X_{13,}X_{23,}X_{33,}X_{43})}{X_{23}} = \frac{0.9221}{0.9668} = 0.9539$$

$$r_{33}= \frac{Min_i(X_{13,}X_{23,}X_{33,}X_{43})}{X_{33}} = \frac{0.9221}{0.9226} = 0.9995$$

$$r_{43}= \frac{Min_i(X_{13,}X_{23,}X_{33,}X_{43})}{X_{43}} = \frac{0.9221}{0.9221} = 1.0000$$

H. The results of normalized performance value rating would be a normalized matrix:

$$R = \begin{bmatrix} 1.0000 & 0.9375 & 0.9359 \\ 1.0000 & 1.0000 & 0.9539 \\ 1.0000 & 0.8750 & 0.9995 \\ 1.0000 & 1.0000 & 1.0000 \end{bmatrix}$$

I. Preference value to each alternative participant is:

$$V_1= \{(1.0000)(1) +(0.9375)(1)+(0.9359)(1)\} = 2.8734$$

$$V_2= \{(1.0000)(1) +(1.0000)(1)+(0.9539)(1)\} = 2.9539$$

$$V_3= \{(1.0000)(1) +(0.8750)(1)+(0.9995)(1)\} = 2.8754$$

$$V_4= \{(1.0000)(1) +(1.0000)(1)+(1.0000)(1)\} = 3.0000$$

The greatest value is in V_1 the alternative A_1 is selected alternative recommendation as the best alternative (winner procurement recommendations).

V. THE DESIGN OF PROTOTYPE

In the main view of decision support systems procurement evaluation winner selection with Simple Additive Weighting Method (SAW) the user will be input the category or type of items to be auction, the criteria items to be auction, the weight of criteria and participants will be follow the auction. The input will be processed by the system using SAW method for calculation.

Figure 2. Input in decision support systems procurement evaluation winner selection with Simple Additive Weighting Method,

On the application of decision support system evaluation winner selection procurement of goods with Simple Additive Weighting Method (SAW) will be display information about procurement participants with scores from each criterion. Preverensi greatest value is an alternative recommendation chosen as the best alternative (winner procurement).

Figure 3. Display the results of the participant evaluations of procurement.

VI. Conclusion

Simple Additive Weighting Method (SAW) used to support decision making in the process of evaluating alternative procurement of goods selection winner, especially, in the process of ranking based on predetermined criteria in order to provide recommendations election winner acquisitions evaluation more objective as it can be weight against criteria determined.

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