Decision Support System Framework for Procurement Decisions in University of Babylon

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**Abstract** — The gap between social activities and technology is widening particularly with the advent of new and innovative methods of computing within a complex socio-technical divide. This gap has been partly attributed to the technical limitations arising from the complexity of the environment where these decision supports are needed. Procurement decisions are faced with several challenges such as selecting the right mix of product, price and method to procure it. However, how to marry this divide between decision support theory and the people this theory or technology actually support in practice has been the major challenge. In order to bridge this socio-technical divide, we have proposed the use of AHP technique to develop a framework for procurement decisions using University of Babylon, Iraq as a case study. The proposed decision support framework will attempt to address issued regarding information fusion by automatically integrating multiple information sources to enhance the decision making process through empirical and theoretical findings, the interdependencies that characterize the relationships between information fusion, and management decision making. A pre-implementation study was carried out in order to ascertain the usefulness of this framework in promoting user-centered decisions by explaining the various influences of different decision making on information systems and procurement processes in the University of Babylon, Iraq. The major contribution of this study would be to aid both practitioners and researchers in the decision making processes regarding procurement decisions such as Decision Support for Production Planning, Policy Making, ERP, Commerce and Business Intelligence and Data Warehousing systems.

**Keywords** – decision support systems; decision making; framework; procurement; information; university of Babylon

1. **INTRODUCTION**

The advent of distributed computing transformed the role which DSS plays in supporting decision makers of various positions and organization such as financial management, operations and strategic decision making [1]. These new roles was aimed at providing analytical ideas to decision makers in the context of a highly advanced and proliferating technological systems and the people who these technologies were meant to serve [2][12]. [3] defined procurement as a process of purchasing goods and services at the lowest price, best quantity and quality, and timely delivery while optimizing the order time so as to yield the best benefit in business process execution. This could be in the form of simple procurement procedures that include repeated purchases or complex procurement that can be achieved by finding the right partner and creation of contracts for the duration of the business endeavour itself [3]. [4] argued that procurement goals are influenced by internal and external forces. Thus, interactions between different elements, professionalism, budget resources, procurement organisational structure whether it is centralized or decentralized, rules and guidance, procurement regulations and internal control policies, all need to be addressed as they can affect the performance of the procurement function [5].

The University of Babylon, as an educational organization spends a large budget for its procurement needs. Procurement unit in financial department is responsible for the procurement process and decision. A typical procurement procedure starts from the procurement order to the final procurement decision by passing through many stages such as need analysis, specification requirements, market price analysis, and choice of vendor. This procedure usually takes a long time due to manual process and during this time, prices may change thereby requiring a repetition of the entire procurement decision making process, resulting to delays in procurement together with its associated problems and consequences. Decision support system (DSS) was applied to help managers to improve their analysis of semi-structured problems using data and models. The essential purpose of designing those systems is to support decision-makers, at any position in an organization [7]. In the context of DSS in procurement management, there are many sub-processes such as; defining and analysing the specifications of required goods, and vendor bids analysis. [1] suggested the need for the use of new techniques in addressing the problems associated with these sub-processes in a procurement system. This study has proposed the use of AHP technique to develop a DSS framework for the University of Babylon, Iraq. The proposed framework will not only aid decision makers in the procurement process, but will also help get rid of financial and administrative corruptions, reduce time, improve work efficiency, transparency in dealing, the possibility of making the right decisions in the government procurements, and helping
in drawing up strategic plans for the future in all government institutions. This framework is important, not only for the University of Babylon but also for other organisations where procurement decisions are required.

Thus, the paper has been divided into five sections. Section II looks at related works in this field, Section III explain the method used for this study, Section IV presents our proposed framework, and validates the framework based on our pre-implementation findings. Section V discusses the benefits of the proposed framework, the practical implications of the study and areas of further studies. Section VI concludes the study.

2. RELATED WORKS

A. Developments in Decision Support Systems

The first use of decision support systems in organisations dates back to 1980 as a support to decision-makers at various levels of the organization [1]. Over the years, the deployment of DSS applications grew further into the domain of management application and initial business systems to support operations of decision making, strategic decision-making, and financial management [10][11][19]. Today, DSS are a set of information systems “IS” that supports decision making using any type of internal model [8]. [9] argued that it is important to deploy the decision support systems in any business organizations that need accurate summaries and aggregations, which are easy to use. Meanwhile, DSS have the advantage in posing various requirements on data-base technology, than the applications of traditional online transaction processing “OLTP” that need to be automated from day to day to clerical data processing tasks [10]. [1] identified three main characteristics common with all decision support systems. Many researchers like [7][19] suggested that the major applications for decision support systems emphasized on accessing and analysing large data bases, manipulating quantitative models, and supporting group decision making. According to [20], model-driven decision support systems are best suited for individual personnel, whereas data driven decision support systems were more appropriate for institutions and organizational use. [5] studied the factors that affect the structure of decision processes in DSS and proposed for the inclusion of executive information system as one of the applications of DSS applications. Today, decision support systems provide the right information in the right format to managers at the right time with factual cost [11]. They enable managers to accurately define and select the right criteria, formulate various attributes, objectives, or goals that can support the decision making process, and provide measures used to guide decision making to control relevant decisions in a given situation [8]. The Multiple Criteria Decision-making methods provide the mechanisms for utilizing and integrating the different criteria in order to make rational decisions [21].

B. Decision Support Systems Techniques

The analysis of decisions requirement for special cases of data is fundamental in DSS technique selection. The choice of model is most times guided by the size of data set and type of solution desired. [22] opines that intuition and judgment plays a very important role in choosing the appropriated technique for a particular research case. [23] studied several DSS techniques that related to procurement process and found that Linear Goal Programming (LGP), Multi-Attributes Utility Theory (MAUT), and Analytical Hierarchy Process (AHP) were the most commonly used techniques in DSS. [24] suggested that decision problems where the focus was on achieving several goals rather than on maximizing all objectives can be solved using LGP technique.

[25] highlighted the contributions and constraints of the LGP technique. MAUT technique aids a decision-maker simplify structure decision problem in a simple hierarchical form for easy evaluation of multiple qualitative and quantitative factors under risk and/or uncertainty [26]. The Analytical Hierarchy Process, as described by [27][28], is a methodology enabling decision-makers to right and effective decisions in complex problems by structuring the decision making process. AHP is a technique to collect information and judgements in selecting the preferred alternative. The feature that distinguishes AHP from other multiple criteria decision-making techniques is that it is not important to use an accurate numerical scale of ratio. Subjective judgements for which no scale of judgements exists can easily be accommodated. AHP has many advantages in a decision-making process [25]. [27] said it represents the natural direction of the human thinking to arrange system elements into multi levels and to combine the identical elements in each level. Because it is graphical, it is easily understood by all parties involved in the decision making process. AHP can force discipline in structuring the problem and provide a process that allows a complex decision to be broken into manageable parts [29]. It leads to a total estimation of the acceptability of each alternative and can deal with the interdependence of elements in a system [30]. It allows integration of various criteria such as; cost, technical performance and style in the decision process and helps identify the most important element of the decision. When the decision results are printed, there
is a record on how and why a decision is made [30]. [29] noted that AHP has been able to overcome the limitations of other multiple criteria decision-techniques.

C. Application of Decision Support Systems Techniques by Previous Studies

Electronic Decision Support System (e-DSS) framework is the most useful in procurement exercise which requires the determination of requirements and characteristics of the procurement process cycle [3][6]. Previous studies have used DSS techniques in several strategic decision-making including order analysis, procurement horizon restoration and computation of the sourcing strategy. Its first use for academic institutions was proposed by [13], and they advocated for a model-driven decision support system especially for institutions. [15] developed a goal-programming technique (GP) for organizing purchasing orders and supplement under the buying firm's quality, demand, time, and inventory regulations. Likewise, [16] developed a non-linear goal-programming technique for purchases plan in the general industrial sector. A multi-objective programming (MGP) model was used by [17] to compile accepted solutions for selecting the best supplier, and for allocating volume of purchases between suppliers.

[18] discussed on six common traditional supplier selection decision making techniques. Many studies such as [7][19][20][7] looked at the major applications of decision support systems and emphasized that they were appropriate for accessing and analysing large databases, manipulating quantitative models, and supporting group decision making. Other applications of DSS techniques include: used as management model, [31], applied it for facility location selection, and [14], applied it in production planning. [19] mentioned that the important characteristic of MAUT is its capability of dealing with both stochastic and deterministic decision environments. According to [24], the main disadvantage of MAUT is its unfriendliness, i.e. difficult to apply. It is a high level approach and needs long time, high cost, and is depressing to implement. Today, AHP is being used in more than 200 known applications in academic, corporate planning, industry, military, marketing, finance, medicine, government administration and sports in many countries worldwide [6]. The increasing popularity of its use is testimony of its academic and industrial value to support management and other decision makers in making quality decisions.

3. METHOD

This study adopted a qualitative research design using interview method of data collection. A total of eight participants consisting of one procurement manager, one financial manager, three procurement employees and three ICT employees were interviewed through face-to-face meeting and online media. An open-ended question type was used for the study because of the need to understand everything related to UOB procurement decisions. AHP multi criteria decision-making technique was used due to its applicability to the decision making process given our context (See Table 1). C# programming language was used to design the prototype and inputs via questionnaire from our case study (UOB) were used to evaluate the pre-implementation phase of the prototype system design so as to validate our proposed framework. The methodology flowchart is presented in Figure 1.

<table>
<thead>
<tr>
<th>Procurement characteristic</th>
<th>AHP matching capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large number of criteria and alternatives</td>
<td>Able to handle with large numbers.</td>
</tr>
<tr>
<td>Multi criteria decision making environment</td>
<td>Able to handle multi criteria</td>
</tr>
<tr>
<td>Quantitative and qualitative criteria</td>
<td>Able to handle quantitative and qualitative criteria</td>
</tr>
<tr>
<td>Re-buy and one time buy</td>
<td>Flexible</td>
</tr>
<tr>
<td>High accountability to stakeholders</td>
<td>Able to provide audit trails clearly</td>
</tr>
<tr>
<td>Quick and simple evaluation process</td>
<td>Quick and simple</td>
</tr>
<tr>
<td>High degree of transparency</td>
<td>Process centric and group consensus on all decisions</td>
</tr>
</tbody>
</table>
4. THE PROPOSED DSS FRAMEWORK

Designing UOB DSS framework is based on the data collection from the interview and its analysis, and the study of literature review. The proposed design, as shown in Figure 2, can be used to process simple and complex decision probabilities and provide accurate results of each criterion and sub criteria. The framework consists of five constructs each of which passes through five distinct stages in simulating the UOB procurement requirements using AHP technique. A detailed explanation of each of these constructs and stages is provided in the subsequent sub sections.

FIGURE 1: Methodology Flowchart

FIGURE 2: The proposed UOB DSS Procurement Framework
A. Stage One: Initial Goods Evaluation

This stage is concerned with the identification and categorization of the criteria to be used and the procedure to be adopted (simple or complex decisions), as well as the logical processes which include: identifying the type of goods to be purchased, price expectation, source of manufacture, criteria to be used for choosing the best goals, sub criteria for each criterion, and the storage of information in the database. Figure 3 shows the logic process in this stage.

![Initial Goods Evaluation Process](image)

**FIGURE 3: Initial Goods Evaluation Process**

B. Stage Two: Development of Goods Evaluation

This stage employs the use of complex decision processes for goods evaluation based on AHP technique to rank the criteria and sub criteria based on their performance; make comparisons between each criteria and sub criteria according to Saaty’s table; construct a matrix between these criteria and sub criteria; find the RVV/Eigen vectors for each criteria as well their consistency ratio; and store the information in the database. This process is illustrated in Figure 4 below.

![Development of Goods Evaluation Process](image)

**FIGURE 4: Development of Goods Evaluation Process**

C. Stage Three: Vendor Bids Evaluation

In this stage, comparison is made between vendors’ bids and goods evaluations for each criterion (as discussed in the two previous subsections) in order to identify the best bid with respect to each criterion. The processes include the analysis of the type of goods and evaluation of the vendor specifications for each sub criteria; ranking the bids of vendors to their respective sub criteria based on evaluations; comparisons between each vendor’s bids and other bids based on Saaty table; construction
of matrix between for each vendor’s bid; and finding the Eigen vectors for each criteria and their respective consistency ratios. Figure 5 presents the processes in this stage.

**D. Stage Four: Vendor Selection**

Here, we select the best vendor’s bid using AHP technique to compute and compare the results of goods evaluations and vendors’ evaluations with respect to each criterion based on the output of the three previous stages mentioned above. Figure 6 shows the processes in this stage.

**E. Stage Five: Supplements**

This is the final stage of the DSS framework. In this stage, the framework maps the best vendor bid with the best supplier criteria with some decision variables such as which vendor to choose, for what type of good, and for what purchasing volume, and then proffers the supplement process to be carried out (either with the government or the private sector’s supplier), as shown in Figure 7 below.
F. Framework Validations

Based on the findings of our survey, most of the questions (see Table 2 below) focused on the DSS output quality to sample the respondents’ opinions about the quality of this DSS framework. The findings reveal that almost all the respondents agree or strongly agree that the framework rules captured the UOB procurement regulations, the stages are logically structured, agreeable, sequenced, helpful, and presented in the way that can identify and evaluate the goods specifications and vendors’ bids. The findings further show that the framework is consistent, not complex, not difficult to use and that the properties of DSS framework is sufficient and not excessive.

TABLE 1: DSS Output Quality Results

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>DSS Output Quality Perspectives</th>
<th>Scale</th>
<th>Strongly Disagree 1</th>
<th>Disagree 2</th>
<th>Uncertain 3</th>
<th>Agree 4</th>
<th>Strongly Agree 5</th>
<th>Mean</th>
<th>Median</th>
<th>Final Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5</td>
<td>I find this decision support system framework is flexible to apply.</td>
<td>Frequency</td>
<td>0 0 1 15 19</td>
<td>percentage</td>
<td>0 0 2.9 42.9 54.3</td>
<td></td>
<td></td>
<td></td>
<td>4.51</td>
<td>5</td>
</tr>
<tr>
<td>Q11</td>
<td>The decision support system framework is helpful.</td>
<td>Frequency</td>
<td>0 0 0 19 16</td>
<td>percentage</td>
<td>0 0 0 54.3 46.7</td>
<td></td>
<td></td>
<td></td>
<td>4.46</td>
<td>4</td>
</tr>
<tr>
<td>Q12</td>
<td>The stages sequences in decision support system framework are able to capture UOB procurement regulations.</td>
<td>Frequency</td>
<td>0 0 0 21 14</td>
<td>percentage</td>
<td>0 0 0 60.0 40.0</td>
<td></td>
<td></td>
<td></td>
<td>4.40</td>
<td>4</td>
</tr>
<tr>
<td>Q13</td>
<td>The decision support system framework is difficult to use.</td>
<td>Frequency</td>
<td>42.9 48.6 2.9 2.9 2.9</td>
<td>percentage</td>
<td>57 54.3 40</td>
<td></td>
<td></td>
<td></td>
<td>1.74</td>
<td>2</td>
</tr>
<tr>
<td>Q14</td>
<td>The presentation of decision support system framework is consistent.</td>
<td>Frequency</td>
<td>0 0 1 12 22</td>
<td>percentage</td>
<td>0 0 2.9 34.3 62.9</td>
<td></td>
<td></td>
<td></td>
<td>4.00</td>
<td>5</td>
</tr>
<tr>
<td>Q15</td>
<td>The decision support system framework is unnecessarily complex.</td>
<td>Frequency</td>
<td>0 0 0 2.9 45.7 51.4</td>
<td>percentage</td>
<td>0 0 0 17.1 34.3</td>
<td></td>
<td></td>
<td></td>
<td>4.17</td>
<td>4</td>
</tr>
<tr>
<td>Q21</td>
<td>The number of properties presented in this decision support system framework is excessive.</td>
<td>Frequency</td>
<td>8 22 5 0 0</td>
<td>percentage</td>
<td>22.9 62.0 14.3 0 0</td>
<td></td>
<td></td>
<td></td>
<td>1.91</td>
<td>2</td>
</tr>
<tr>
<td>Q22</td>
<td>The number of properties presented in this decision support system framework is insufficient.</td>
<td>Frequency</td>
<td>1 0 1 8 25</td>
<td>percentage</td>
<td>2.9 0 2.9 22.9 71.4</td>
<td></td>
<td></td>
<td></td>
<td>4.62</td>
<td>5</td>
</tr>
<tr>
<td>Q24</td>
<td>The decision support system framework faithfully reflects reality.</td>
<td>Frequency</td>
<td>0 0 0 13 22</td>
<td>percentage</td>
<td>0 0 0 37.1 62.9</td>
<td></td>
<td></td>
<td></td>
<td>4.62</td>
<td>5</td>
</tr>
<tr>
<td>Q25</td>
<td>The relationships between the stages in the decision support system framework are acceptable.</td>
<td>Frequency</td>
<td>0 0 0 20 10</td>
<td>percentage</td>
<td>0 0 0 28.6 71.4</td>
<td></td>
<td></td>
<td></td>
<td>4.71</td>
<td>5</td>
</tr>
</tbody>
</table>
5. DISCUSSIONS

A. Benefits of the Proposed DSS Framework

The benefits of the proposed DSS framework are as listed below:

- This DSS framework based on UOB procurement regulations and can give simple and complex decisions, and the type of decision can be known from the first stage after inputting the order information.
- This DSS framework can provide decisions based on the inputs of simple specifications (only main specifications). It can also provide decisions based on the inputs of complex specifications (main and sub specifications).
- The DSS framework can distinguish between each criteria/sub criteria according to its input degree of importance relative to other criteria/sub criteria.
- The DSS categorises the vendor bids evaluation of each vendor with respect to each criterion /sub criterion so as to ensure a more accurate decision making process.
- The transition after each evaluation input stage is not possible if there is any mistake in evaluation or comparison.
- The final decision report can include many details that validate the accuracy of the decision.

B. Practical Implications of the Study

The practical implications of this study include:

- This study is the first of its kind in Iraq being the first DSS framework in University of Babylon (UOB).
- Given that all Iraqi educational institutions are subject to the same government procurement regulations, this outcome of this research (and the framework in particular) can be used for their procurement decisions.
- The adoption of this proposed DSS framework in Iraqi institutions can solve a large part of the problems caused by financial and administrative corruption.

C. Areas of Future Studies

This study recommends for the following areas to be considered as areas of further studies:

- The improvement of the current prototype to cover all the procurement units that require procurement decision to be made.
- The development of an artificial intelligence technique to add with the current AHP technique so as to be able to predict the criteria/sub criteria for any order of goods and be able to specify the suitable vendors based on the history of previous orders information.
- Link the system with other related financial systems.

6. CONCLUSION

This paper has proposed a new framework by using AHP to develop a decision support system framework for procurement decision in the University of Babylon, Iraq. It has addressed several issues related to delays previously experienced in the old manual procurement system used by UOB. It also addressed the need for information fusion necessary to bridge the socio-technical gap currently existing between theory and practice by automatically integrating multiple information sources to enhance the decision making process through empirical and theoretical findings, the interdependencies that characterize the relationships between information fusion, and management decision making. The outcome of this study can be applied across all systems engaged in decision making processes regarding procurement decisions in any decision support systems. The limitation of this study, however, is that it is a standalone system and thus requires further studies in this direction. The major contribution of this study is that this DSS framework can proffer simple and complex decisions to support procurement managers or officers in the University of Babylon, Iraq in their routine procurement activities.

REFERENCES


