Devising Decision Support System for the Selection of Medical Equipment Delivery Service

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Abstract—Decision support system is computer-based systems that assist business and organizational in complex decision-making environment. In this study, a Decision support system application program was devised based on the Analytic Hierarchy Process (AHP) method, which consists of three parts, namely (i) decision making model, (ii) calculating model, and (iii) inputting model. The results showed that the application program was able to provide output about the selected bidder on a spesific project instantly. That is, the program was able to complete the task in mjuch less time compared to the current system of decision making which consumes too much times. (i.e., the decision makers has to meet with each participants intensively at least 3 times). Based on the outputs provided by the application program, it is conlude that the Decision support system developed in the present research is effective and successfully answers the existing problems.

Index Terms—decision support sytem, Analytic Hierarchy Process (AHP), tender project, medical equipment delivery service

I. INTRODUCTION

Decision Support System (DSS) has generated considerable recent research. DSS [1]-[3] can be defined as a computer-based systems that assist business and organizational in complex decision-making environment. According to Daihani [1], DSS run and process input of unstructured or semi-structured problems in order to support rather than replace decision-making process. The ultimate selection in decision-making is under human authority.

There is a considerable of literature on DSS that help to make a decision in every field. Consider, for example, studies conducted by Hutahaean [4], [5], Eniyati [6] and Kumar [7]. Hutahaean [4], [5] has designed a DSS for strategic planning that meet the capacity needs of heavy equipment. Eniyati' study [6] designed a DSS to assess the performance of lecturers using AHP method. Kumar [7] research implement AHP method for vendor selection decisions of power transmission industry. Kumar develop a rule based model, to evaluate the performance of vendors using AHP Model, but they aren't design decision-making program to implement the model. Previous work has only focused on design a DSS for structured data analysis. Traditional DSS lack of

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capability to tackle with dynamics and ill-defined data. Few researchers have addressed the issue of decisionmaking for large volumes of both structured and unstructured data. Mohemad' research [8] give a review on current practices of DSS technology in construction tendering processes. Tendering processes in construction industry, as in other industry or other projects, are often very complex and uncertain, involving coordination of many tasks and individuals [8], [9].

PT X is a distributor company based on medical equipment project activities that commonly used in hospitals. The equipments consist of CT Scan, X - Ray, Magnetic Resonance Imaging (MRI), etc.

As a distributor, the company plays an important role in distributing the medical equipments from the factory to the consumers. This process is divided into two stages: *delivery factory phase*, where this stage begin from factory to airport or port, which spread in Indonesia, and *delivery consumer phase*, where this stage begin from airport or the port into the consumers. Generally, the *delivery factory phase* using global contract, where the company has done a contract deal with a long-term period, while the *delivery consumer phase* using the tender system. Distribution process using tender system has some characteristics that are more complex. For example, the delivery process have a difference location for each consumer who spread across Indonesia, and many else.

PT X has some alternative of tender service providers for up to 3 (three) companies. The selection for each companies are adapted on the characteristics of the project by using comparison method. The main factor concern on safety, where this factor describes the level of safety along delivery process to the destination. By prioritizing the safety factor, the other factors such as the price is not the most important thing, but the offering price should be reasonable.

Based on that goal, deciding the selected bidder is a crusial part, because making a mistake decision will impact the bad result to the survival of the company. The decision that has been takes must be supported not only by objective reason but also prosper in achieving some value without ignoring to give the reasonable remuneration / wages for the selected bidder.

This situation has led an idea to design a Decision Support System. As the name implies, this system is used as a "second opinion" or "information source" that can be used as a consideration before deciding the policy that will be taken. In Fig. 1, the selected bidder is determined by Decision Support System (DSS), where the system is expected to provide output that combines between intuition and past experience in order to be considered for decision makers.



Figure 1. Formulation of problem

Therefore, the objectives of this research were to devised DSS application program in the selection of medical equipment delivery service by using the Analytic Hierarchy Process (AHP) method, and to made a comparative analysis between the current system and the proposed system. Technical analysis in this research focuses on the decision-making criteria of expertise and working methods, where cost and safety factor are included in two criterias. This application program allows users to overcome the problem when deciding the selected bidder, where users could enter the data and information relating to the company and fill the level of importance on each criterion, sub-criterion and sub-subcriterion.

II. LITERATURE REVIEW

Decision making involves three (3) phases that are interconnected with each other:

A. Intelligence

This stage consist of tracing, detectioning, and recognizing process on the scope of the problems. Input data is obtained, processed, and tested in order to identify the problem.

B. Design

This stage consists of discovering, developing, and analyzing possible alternatives process in order to understand the problem, give the best solution, and verify how much feasibile the solution.

C. Choice

At this stage, there is a selecting process among a variety of alternative with a purpose to know which one may be implemented. Then, the results are implemented in the decision making process, so the implementation stage include in the third stage, although there are some argue that this stage should be seen as a separate section, in order to describe the relationship between the phase of a more comprehensive.

According to Turban [2], there are three (3) types of decision, namely:

- 1) Structured decision, has characterized by:
- Repeated, routine, and easy to understand
- It has a standard solution based on quantitative analysis

- Created by customs, rules, and procedures (written or not), also often automated
- 2) Semi-structured decision, has characterized by:
- Incomplete regulation
- It has two features, namely partly structured and partly unstructured (most decisions can be handled by the computer and the rest remains to be done by the decision maker).
- 3) Unstructured decision, has characterized by:
- No repetitive nor routine
- There is no model to solve this problem

DSS [1]-[3] is defined as an interactive system, which helps decision maker through using data and decision models which based on computer, to solve the types of semi-structured and unstructured decision.

Some of the characteristics that distinguishes it from other information systems are:

- DSS is designed to help decision makers in solving problems that are semi-structured or unstructured.
- DSS is designed to emphasize the aspects of flexibility and high adaptability, so it may be easily adapted to a variety of environmental changes that are occurred based on user needs.

III. RESEARCH METHODOLOGY

The methodology that is used in this research consist of the preparation phase to the conclusion one. In data processing phase, data that has been collected were processed according a predetermined method to form a system design [10]-[12]. The establishment-design of this system consists of two stages: Analytic Hierarchy Process (AHP) model building and database design on DSS.

Generally, the calculation of the AHP method using pairwise matrices which are used as an input to calculate the eigen-values and eigen-vector for each critera [7], [10]-[12]. However, in this research, the pairwise matrices, eigen-values and eigen-vectors are not used. In exchange, at the proposed system, user may fill their own level of importance in the providing fields. Then, the level of importances are multiplied by the count of each sub-sub-criteria in order to produce temporary result on each sub-criteria [12]-[14].

DSS design using the latest version of Visual Basic namely "vb.net". Processing of data collection will be used as an input in the program by using the MySQL database system.

IV. COLLECTING AND PROCESSING DATA

Data which are collected in the form of:

- Product description, consisting of MRI, CT Scan, dan Cathlab
- Material handling description, consisting of *forklift, mobile crane, lift, and handpallet*
- Tender documents

The tender document containing a proposal and quotation workplan for each bidder.

A. Analytic Hierarchy Process (AHP) Model Building

AHP model building consists of three parts [6], [10], [15]: decision making models, calculating model, and inputting model. The picture of decision making model can be seen in Fig. 2, while the inputting model can be seen in Fig. 3 – Fig. 7 below.





Figure 3. Input model (1)



Figure 4. Input model (2)



Figure 5. Input model (3)

	Expertise		*	Work M	lethod	Ð	Sign Out	
Project andardization	Company Performance	Financial Policy	Alternative A	ccess Road	Use of Material Handling			
						Signific	ant Level	
Vend	or Panel	Assesment Form of PT A						
PT A	•	Scal	e Score	Information				
PT B		1	0.2	0.2 Each bidder only provide one option				
PT C		Each bidder provides two options ; there is an option to which 2 0.4 passes through the ER or do break- wall at the emergency root			to which access ency room			
Add vendor		3	0.6	Each bidder provides > 2 option ; there is an option to which access passes through the ER or do break- wall at the emergency room			which access ency room	
		4	0.8	Each bidder provides two options; Overall option assessed feasible (allowed by local stakeholders and at minimal disrupt service functions Hospital)			essed feasible service	
		5	1	Each bidder provides> 2 option; Overall option assessed feasible (allowed by local stakeholders and at minimal disrupt service functions Hospital)			sed feasible service	
		Result PT A PT B PT C						
Figure 6. Input model (4)								
	Expertis	se	*	Work N	lethod	÷ si	gn Out	
Project	Company				Use of Material			



Figure 7. Input Model (5)

B. Database Design on Decision Support Systems (DSS)

The initial step in the development of Decision Support Systems (DSS) is develop the existing information systems, where it commonly uses FAST (Framework for the Application of Systems Thinking).

FAST method consists of eight phases: scope definition, problem analysis, requirements analysis, logical design, decision analysis, physical design, construction, and installation. Scope definition to the requirement analysis phase is a symptom of the problem identification, setting a goal of system improvement, which will further identified what should be provided by the system.

Logical design phase aims to translate business requirements into system modeling with an overview of:

- Logical data models that describe the data and information requirements, example: DFD
- Logical process model that describes business process requirements, example: ERD
- Logical interface models that describe business requirements and system interfaces







Figure 9. DFD level 0







Figure 11. DFD level 2





V. RESULT ANALYSIS

The proposed system is based on the existing problems in the current system has a different procedure information systems with the current system. This distinction refers to the standardization that is adapted to the desires of the user. Therefore, a comparison needs to be made between these two systems (the current system and the proposed system), which is contained in Table I, to determine the extent of the proposed system is effective and successfully answer the problems that are exist.

 TABLE I.
 COMPARISON OF CURRENT SYSTEM AND PROPOSED

 SYSTEM

Comparative criteria	Curret System	Proposed System	
System	Manual system that conduct meetings with the bidders one by one	Quantitative assessment conducted for each criterion with AHP method using computer assistance	
Software	Decision-making process does not use a computer system (only by intuition snd prediction)	More computerized decision- making process with the help of the program Visual Basic → vb.net Database → MySQL	
Time to Decide Winner	Long enough (meeting conducted at least 3x)	More Faster	
Security	-	Implementing security system in the form of a username and password	

The same case with the current system, the proposed system was not completely perfect, so there are some deficiencies or weaknesses. However, while ignoring the existing weakness, the application of the proposed system is urgently necessary.

- a. Through the testing phase, the proposed system is considered that its design by conceptually and physically are verified and valid.
- b. It is said to be verified because it has been able to produce a report according to the required needs and unspecified by the user.
- c. It is said to be valid measured by looking at the similarity between the real system data with the data generated by the model, where is it appropriate process modeling and data modeling with application program tables. The proposed system is designed to fullfil the effective information when making a decision to select the bidder on tender project that is organized by PT X.
- d. With the proposed system, the determination of the selected bidder is constructed using the AHP method with the characteristics of the criteria, sub-criteria, and sub-sub-criteria. Each sub-criteria has a quantitative scale that aims to minimize the subjectively assessment.
- e. The proposed system has more computerized system both in accessing information, input data, and data processing, so user can easily and quickly conducte the process on the system.

The existence of a database system is also balanced with the implementation of security such as username and password. It makes the data privacy to be controlled so everyone can't get into the system to increase or decrease the data that should not be altered.

A. Implementation of Proposed System

The proposed system is designed and produced only as a draft proposal or a tool that aims to improve the current system which was considered not optimal. Certainty, the company needs to analyze the system or even might do some changes when it will be applied.

Here is a procedure that needs to be considered if the company will implement this system:

- The proposed system is run by entering the username and password that have been registered previously.
- Rate the level of importance rate on each sub-subcriteria filled by the user so it may changes according to the current conditions at the PT X.

VI. CONCLUSIONS

The conclusions of this research are:

1. This study develop a model as a tool to determine the selected bidder of the tender project by using the Analytic Hierarchy Process (AHP) method.

2. A model based on AHP method consists of there parts: decision making model, calculating model, and inputting model. Each stages are interconnected with each other to become the input for the decision-making process of data processing using Visual Basic programming language with MySQL as the database.

3. At the proposed system, the resulting output is the selected bidder on a spesific project in a short time. Using

not too much time is considered to be very effective, because the current system of decision-making consumes much time (meeting with each participants needs to be done with a minimum of 3 times intensively).

Several suggestions related with this study are:

- With the implementation of the new system, a system builder must provide some new educational system.
- Considering of the growing number and scope of projects, which are organized by PT X, it is necessary add and develop other tools to complete the system needs.
- This system can be used as an illustration when deciding the selected bidder using web-based AHP method (computerized) to be used widely by all agencies who condute tender project.

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DSS work as supporting tools in assisting users by giving suggestions especially when involving fragmented information and complex problems.

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