International Journal of Innovation Sciences and Research
Vol.7, No, 08, pp.1190-1194, August, 2018
Available online at *http://www.ijisr.com*

RESEARCH ARTICLE

A DEVELOPMENT OF HYBRID DECISION SUPPORT SYSTEM MODEL

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Accepted 28th July 2018; Published Online 30th August 2018

ABSTRACT

There are many type of model development for decision support system (DSS), but the uncertainty of their outcomes needs to be estimated when they are utilized for decision support. We review various methods that have been or could be applied to evaluate the uncertainty related to deterministic models outputs and proposed our new model which is a hybrid model in order to improve from two different model that proposed by previous researcher. The hybrid of knowledge based model and old customarily used model are coming with seven phases of analysis. The phases are problem identification, problem analysis and synthesis, available alternative generation and solver, model development, alternative analysis, choices and executions. Building a simple, easy-to-apply model but with a complete phases can help in explaining and describing the process of development for the decision support system. The hybrid knowledge-based decision support system architecture model to suite with the contemporary and future business management.

Key words: Decision Support System, Knowledge Based, Hybrid, Customarily Model, KB-DSS Model.

INTRODUCTION

Decision support system (DSS) is defined in many perspectives since more than thirty years ago. Itdepends on development and innovation of technology from one to another generation. The various definitions are very much related to the technology in that era. In the late 1970's, Keen and Scott Morton (Keen, 1978) defined DSS as the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. It is a computer-based support system for management decision makers who deal with semi-structured problems. Bidgoli (1989), who are coming after that, defined DSS as a computer-based information system consisting of hardware and software as well as the human element designed to assist any decision-maker at any level. However, the emphasis is on semi-structured and unstructured tasks. In the 1990's,Sauter (1997), then, coming with broader definition that DSS is a computer-based system that brings together information from a variety of sources, assist in the organization, analyzation of information and facilitate the evaluation of assumptions underlying the use of specific models. In the current era, Turban et.al (2005), broadly defined DSS as a computer-based information system that combines models and data in an attempt to solve semi-structured and some unstructured problems with extensive user involvement. All of the definitions stated are different when we compare to each other, but the important point that needs to be focus is

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DSS is a system that is being used to assist and facilitate the user in order to explore the technology. And it should be improved better time by time. The occurrence of DSS development has now become a trend as its purpose is to serve as an interactive computer-based system application, which consists of a group of homogeneous software applications and hardware that can inspect and analyze huge miscellaneous data collected from different types of measuring devices in various forms of formatting sources (Bâra, 2013; Valverde, 2011; Waghmode, 2014). The DSS can then present an output result that can help users and decision-makers to solve poorly structured, semi-structured or unstructured problem situations and by making more reliable, efficient and effective decisions out of the output results (Al-Gamdi, 2014; Alnajjar, 2012; Averweg, 2012; Nowduri, 2011 and Nowduri, 2011). DSS shapes the foundation of a decision making process of an organization (Waghmode, 2014). Al-Gamdiet. al. (2014) stated that DSS is deem as the "informational application" where data is systematically structured to perform regular and routine business operations. This is utterly the contrary of "operational application". On the other hand, Valverde (Valverde, 2011), considered that DSS should concentrate on strategic decisions, but agrees with Al-Gamdi et al (Al-Gamdi, 2014), regarding DSS on not focusing on operational ones. However, Nowduri (Nowduri, 2011), disagrees with Al-Gamdiet.al and Valverde by stating that all levels of people within a business organization uses DSS, whereby top management level uses DSS for strategic decisions, middle level for tactical decision while first line supervisors utilize it for day-to-day operational

decisions. The main purpose of developing various types of modern DSS is to help, support, improve and provide a wide range of capabilities in decision processes made by business managers (Liu, 2015). Information Technology (IT)-based technologies plays an important role in expending and establishing IT-based systems to assist decision processes through DSS (Felsberger, 2016) Alnajjar and Al-Zoubi (2012), suggested that DSS could assist human cognitive inadequacy by combining various sources of data information, providing intelligent access to relevant knowledge, and aiding the process of organizing decisions. DSS can also ratify option from among well-defined alternatives, and will adapt to any changes or demand made from the market due to any improvement in the world of IT and the advancing economy, to counter quickly and efficiently to decision makers and facilitate their decision process (Alnajjar, 2012). The potential of a person, group, or organization in making proper, reliable, efficient and effective decisions could intensify the organization's empowerment and survival among their competitors (Alnajjar, 2012 and Nowduri, 2011). The purpose of this paper is to study on the old customarily used model of a decision-making processwith the new Knowledge-Based Decision Support Systems (KB-DSS)[] in order to develop a newly DSS hybrid model that can be used by the organizations and personals to assist them in solving their problems by using DSS. From the developed DSS hybrid model, the potential of using it to manage problems situated to the organization or personals has yet been explored and deemed promising towards exploiting DSS and the knowledge-based systems.

DSS Concept Study

DSS was known proposed by Gorry and Scott Morton (Gorry, 1971), who inherit from integrated of Anthony's (Anthony, 1965), management activities regarding the strategic planning and Simon's [19] decision types. Simon describe the decision by dividing into solving the programmed and non-programmed problem. Gorry and Scott Morton (Gorry, 1971), used the terms structured, unstructured, and semi-structured, in their definition and plus with Intelligence, Design, and Choice description of the decision-making process as their improvement. DSS in the decades later evolved to include some innovation by adding some concepts, views and ideas as solutions and trends. Artificial intelligent and expert development started to involved in the DSS (Bonczek, 1981 and Courtney, 1993). But, it will not be the end of using DSS in our life. It will increase and improve from time to time as long as people still use the technology. Starting from the 21st century, the development of information technology takes place more quickly. Web and Internet technologies are widely used. Innovation in information technology is very fast and comprehensive. Communication technology is not only used by a certain parties, but various level of society and people. Even fact, the communication technology is part oflife. Even the organizations of political, social, corporate or culture are radically changing their thinking style and require more management skills and support. The evolution made by the information and communication technology will make people in-need of more computerize support. Mitroff and Linstone (Mitroff, 1998) suggests that DSS researchers have to work harder to propose with much more comprehensive view of organizational decision making and develop decision support systems capable of handling various technique, mathematical models and knowledge-based systems, which are being capable of handling all the possibilities.

Development of Hybrid DSS Model

The old customarily used model of a decision-making process, which is being displayed in Figure 1, illustrates on how does the model was been used in a DSS environment where the significance are model development and problem analysis. From the model, after a problem is being recognize, it will then be defined in terms that could assist in the creation of models. Different kinds of solutions will be created to form the development of models in order to analyze the various alternatives. Then, the choice will be made and implemented. The phases overlap and mix together with continual looping back to the early stage as more problems are being learned through fail solutions. This is model is uniformed with Simon's description (Simon, 1960).

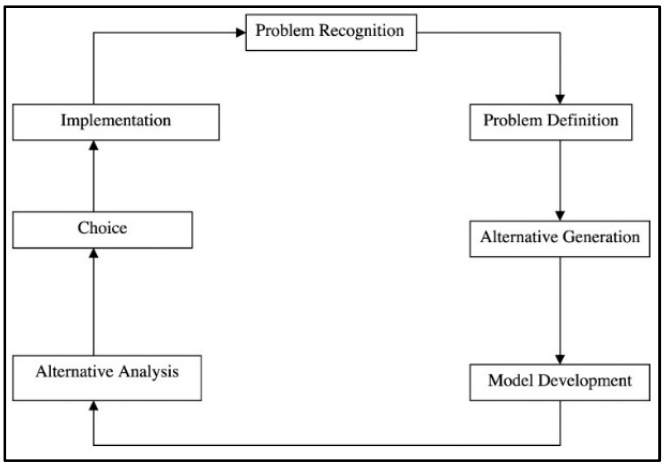

Figure 1. The old customarily used model of DSS

From the old customarily used model of a decision-making process (Simon, 1960), Liu et. al (Liu, 2015), proposed a new DSS model known as knowledge-based decision support system (KB-DSS). It have been investigated for nearly three decades and have supported real business management decisions in many industries. KB-DSS architecture model to suite with the current contemporary business management. The KB-DSS knowledge management sub-system has five new components in addition to the present inference engine and knowledge base, which includes with that reasoning mechanisms. Those five new components which have been implemented meta-knowledge, knowledge validation or evaluation, knowledge refinement, user profile knowledge, and knowledge traceability. The KB-DSS was been developed based on six findings that had made remarkable benefaction to the brand new knowledge in KB-DSS. Those six findings represents the knowledge support issue faced by DSS from different perspectives, which are knowledge acquisition or levels and structuring, knowledge reuse, knowledge mobilization, critical knowledge identification, knowledge chain management, and knowledge integration (Liu, 2015). The KB-DSS model is being illustrated in Figure 2. The comparison of the new KB-DSS model with the old customarily used model of the decision-making process in a DSS environment that is being shown in Figure 1 is that the old model highlights on model development and problem analysis. Where else the new KB-DSS model emphasizes on a wider range of components which covers the existing knowledge levels and structuring, knowledge reuse, knowledge mobilization, critical knowledge, knowledge chain management, and knowledge integration, as well as meta-

knowledge, knowledge validation or evaluation, knowledge refinement, user profile knowledge, and knowledge traceability.

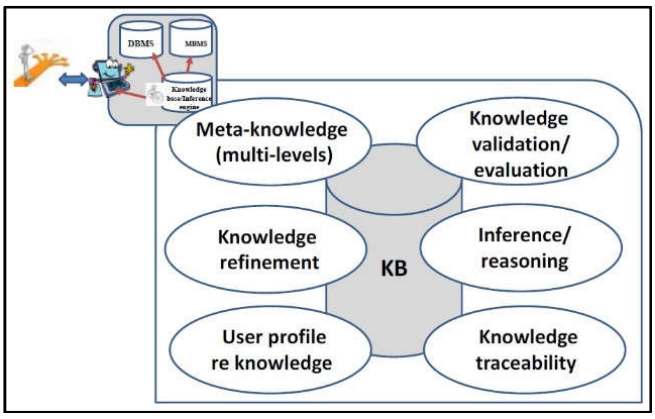

Figure 2. The KB-DSS model

Thus, from the given findings of the old customarily used model of the decision-making process in a DSS environment and the new KB-DSS model, an idea to bring both into one single model. We bring any suitable features from old customarily model and KB-DSS model and put together into one single model and named it as a DSS hybrid model. It has been developed as shown in Figure 3. From this model, after a problem is being identified, it will then be defined, analyze, and synthesize to come out identifying available alternative generation of model solver. The alternative generation of model solver will then help to form the development of models in order to make various alternative analysis.

Figure 3. A DSS hybrid model

These available alternative generation of model solver, model development, and alternative analysis stages are all being embedded in the three basic components of a classic DSS, which are database management system (DBMS), model base management sub-system (MBMS), and user interaction management sub-system which is often called a human-computer interface (HCI). This is because any changes in the DBMS, MBMS and HCI will effect these three stages. Then, a choice will be made. The chosen choice will be implemented and executed. The stages overlap and mix together with continual looping back to the beginning stage as more issues are being identified and learned through possible fail solutions.

The DSS hybrid model's phases: The concept of DSS hybrid model is carrying the establish phase from two different previous model into one single model by bringing only the suitable part from both into a new model. In order to get more understanding on the hybrid model, this chapter will extract the model in Figure 3 and describe the details for each phases in the model.

Problem Identification: Er (1988) stated that in general, there are three types of problem classes, which are structured, semi-structured, and unstructured. These types of problems are usually being solved by the management. The classification various according to the available solving methods that exist for handling and solving the problems. For an example, before the emergence of linear programming, profit maximization or cost minimization was being viewed as a semi-structured problem. However, with the existence of simplex method, the problem is being viewed as a structured problem (Er, 1988). Er, (1988) described that the classification of management activities are being categorized as operational control, management control, and strategic planning, which are being executed by supervisory, middle, and top management respectively. Usually, supervisory management deals more with structured problems affected by internal factors, top management with unstructured problems affected by external factors, and middle management sitting in the middle of all (Er, 1988). Currently, Averweg (Averweg, 2012), added the need of technologies to help in identifying the type of problem classes and to support the various decisions that are being made by the management team through the management activities categorization. Thus, in the future, with the help of vast amount of technologies that are assumed to be far more advance in the future, it is expected that identifying problems would be far less tedious than they are right now even though now it is much simpler than before.

Problem Definition or Analysis or Synthesis

Once a problem had been identified, defining or analyzing or synthesizing the problem would be an important stage towards solving the problem. A problem without a definition could have the tendency of expending and changing its direction while greeting more problems that could accumulate towards a danger situation which could fall apart. According to Shim et. al (2002) the organization and personals should analyze and synthesis the problem with the effected stakeholders through discussions as to come-out with perspectives that will be taken into consideration during the creation of the DSS model in order to solve the situated problem. All relevant variables should be ensured to be included in the DSS model or at least to be taken into consideration during the analysis if they cannot be quantified (Shim, 2002).

In the past, problem definition or analyzing or synthesizing would be much tedious, whereas now with the help of Information and Communication Technologies (ICT), it is much easier and the future is presume to be a lot more easier whereby the computers may probably would be able to do the problem definition or analyzing or synthesizing.

Available Alternative Generation of Model Solver: Before constructing the appropriate DSS model to solve the situated problem, a study or research on previous models that had been able to help in solving similar problems should be explored. Although according to Shim et. al (2005), on Gorry and Scott Morton (Bâra, 2013), arguments regarding the development of DSS could be differed by the characteristics of both information needs and models, it would be wise to take into consideration as well on previous developed model solvers as to their achievement level of solving a situated problem. Through this, appropriate adjustments or developments could be implemented onto the new model. Ever since UNESCO in the year of 2002, had stated ICT as the range of technologies that caters the process of collecting, editing, storing, retrieving and transfer of information in various kinds of forms (Etudor-Eyo, 2010), and the use of the Internet, retrieving available alternative generation of model solvers is easy and fast. It is hope that in the future, many more supporting models would be available for others to make use or innovate them.

Model Development: The technical aspect has influence DSS problem formulation in the past, and now it involves the development of databases and models (Shim, 2002). The use of models is needed to simplify and represent the reality in an easy manner in order to clarify understanding between the relationships of the phases' factors. It would also be easy to predict or forecast the outcome from a given solution. Thus, with the available alternative generation of model solvers and the advancement of technology, a suitable, efficient and effective DSS solving model could be created. A model development is required to determine the best possible solution and provide a positive feedback from solving the situated problem. In future, with progressive amount of technology tools will ease and fasten the model development method.

Alternative Analysis: After developing the suitable model, analyzation on various alternatives should be conducted as through time and data changes could affect the solution of the problem. These available alternative generation of model solver, model development, and alternative analysis stages are all being embedded in the three basic components of a classic DSS, which are DBMS, MBMS, and HCI. As for any changes through time and data will have an effect on the problem solution. Thus, alternative analysis should be identified in order to choose the best possible solution towards the situated problem. In the future, broader forms of analysis are needed as they may become more appropriate in the future, such as group sessions (Shim, 2002).

Choice: After identifying all alternatives of solutions, it is time to make the best possible choice to solve the situated problem. Normally, discussions among the organization, personals and stakeholders is important in this stage as for the wrong chosen solution will give an unwanted impact towards No doubt that different individuals with different decision styles will prefer different kinds of solution or decision support Er[9]. For example, DSSs that can support cost-benefit analyses of hard data are been preferred by systematic decision makers, whereas DSSs that can provide 'what-if' analyses are been preferred by speculative decision makers (Er, 1988). In the end, a choice must be made and a solution must be carried-out to solve the situated problem. The choice made must be the best choice out of all with a given strong reason and a well forecasted output of what every party wants. Nevertheless, for the future, from time to time through advance technologies, more research efforts should be conducted at matching DSSs with individuals' decision styles (Er, 1988).

Implementation or Execution: Finally yet importantly, implementation or execution of the chosen DSS solution must be conducted to solve the situated problem. The implementation should give the forecasted results that are being expected. The DSS hybrid model is a looping model due to problems always arise from time to time. Thus, after implementing or executing the chosen DSS solution, the next following phase will be the earlier phase, which is the problem identification phase as for more issues are being identified and learned through possible fail solutions. As always, more research should be carried out from time to time on different usage of technologies. Data, information, findings and results should be always documented for future references.

Related Studies

There are various classifications system that implement knowledge-based DSS. Some of the hottest issue covers including: Decision Support for Convergence; Knowledge-based Applications and Management; Knowledge Acquisition and Representation; Knowledge Bases; Knowledge based Recommendation Systems; Data Modelling; Database Management Systems; Data Mining; Management Systems; Intelligent Healthcare Systems and Management; Decision Support Systems and Management; Machine Learning; Systems Analysis; and Design and Development (Chung, 2016). Liu et. al. (Liu, 2002), proposed a knowledge-based DSS specifically for contemporary business management. The objective of this study is to support business manager to improve their decision making on speed, accuracy and consistency. They show some of the current research project that focus and related to the management function of the knowledge-based DSS. The output is a new architecture of knowledge-based DSS proposed as a future work. Another knowledge-based DSS is proposed by El-Sappagh and El-Masri (El-Sappagh, 2013). This open and distributed clinical architecture used as a clinical support system to take advantage on electronic health record.

They come out with a new model named as Clinical Decision Support System (CDSS) to assist physicians and other health professionals' by connecting data mining engines to each local knowledge base. Rinaldi and He (Rinaldi, 2014), working on DSS to manage irrigation in agriculture since it is very important to control the water supply in agriculture technology. The knowledge-based model was applied together with remote sensing technology. It is attempts to present the technique, principles, design, and application of DSS in agriculture, particularly irrigation practices. Naseemet. Al (Naseem, 2017), proposes a new approach and presents a combination of decision-support and threat perception systems, with simultaneous evaluation, neutralization, weapons supply, inventory and assignments. They were reviewed the evolution in the development of a threatened or developed threats system.

They provides an overview of existing methods, highlighting the features of the approach used in the development of decision support systems. Then, they suggest a new approach for threat evaluation and weapon assignment (TEWA). The proposed approach explains the importance of the new parameter entry identified in the literature review. The proposed TEWA-DSS important features are: (1) GIS mappings of assets / exposed currencies (VA / VP), (2) Weapon Placement (WD) based on VA / VP critical and using prediction techniques, Threat Perception (TP) and assessment, (4) operational tactics, (5) Selection of Weapons (WS) based on supply chain and its inventory management using predictive methods and (6) Optimal and cost-effective Weapons Solution. They compare the proposed model with Simon and Turban simulation process.

Conclusion and Future Work

The Internet, web, and telecommunications technology in the 21st century can be assumed to be implemented in most organizational environments that will increasingly evolve to a more worldwide, complex, and connected conditions (Shim, 2002). DSS can now be executed in geographically distributed companies and to geographically distributed stakeholders including suppliers and customers at a reasonably low cost due to the vast usage of the Internet infrastructure. For example, a web browser user interface allows the implementation of DSS technology with very little user training (Shim, 2002), and little amount of training would cost little amount of money only. Changes from time to time will occur in technologies and in the implementation environment whereby users become more knowledgeable, sophisticated and demanding, organizations become more complicated yet more agile and flexible, and global regulatory and competitive factors rapidly alter giving effects to the design and use of these tools (Shim, 2002). The future is yet to offer surprises but certain trends must be observed as changes occurs from time to time. The vast advance of ICT will shape the future of DSS to be a better, fast, effective, efficient and relevant one with flexibilities that can suit all management level in helping them to make and choose the best possible decision making in solving their concurrent problems.

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