Decision Support System: Towards Constructing a Secure Decisions Bank

Abdelrahman Osman Elfaki

University of Tabuk, Saudi Araba

Wahid A. Rajeh

University of Tabuk, Saudi Arabia

Summary
In business environment, the case could be highly uncertain, or ambiguity which makes decision making process is strenuous. Therefore, creating a Decision Support System (DSS) to deal with this complexity is significant. In this paper, a DSSs bank has been suggested, where a decision maker select a decision from group of suitable provided decisions. First Order Logic (FOL) has been used for modeling and validating the proposed bank. Four FOL rules have been presented and explained to validate this proposed decisions bank.
Keywords: *decision support systems, knowledge management, decision modeling.*

1. Introduction

The current era is the era of knowledge, where its sources and its ways of obtaining are varying. Decision support systems (DSS) are one of the pillars of the era of knowledge. It is scientifically and practically proven that choosing the right DSS is one of the foundations for the success of any organization. It refers to electronic machines used by businesses to make judgments. The management utilizes these gadgets to determine the right course of action. These systems can search and assess vast chunks of data, thus compiling it for effective problem-solving. With a DSS system, an organization can project the profits at the end of the financial year, estimated revenue, and stock process, among others. DSS comprised modest model-designed systems in the past, but they have evolved into intricate multi-function appliances. In the early 1960s, many DSS were founded on mainframe computers, which offered business people structured reports. However, in the 1970s, the MIS theory took over the business realm seeing the transformation of DSS into more precise electronic-based systems that aided promotion, production, marketing, and pricing of goods. These changes in DSS were more evident in the 80s as the incorporation of an advanced database was realized. The fast advancement in internet infrastructure that followed increased opportunities for DSS as versatile systems, such as OLAL, were designed and integrated. These advancements in DSS have been accompanied by security challenges associated with data integrity, such as the difficulty in quantifying all the gathered data. In that, the functionality of a DSS is dependent on quantifiable data. Thus, it is challenging for the system to assess indefinable or intangible data considering that other data aspects cannot be precise and defied by figures. It implies the end product of the collected and analyzed data may be unreliable for decision making and thus should be considered keenly by managers. Data integrity in DSS is also threatened by fraud, which may occur in many ways. Logic bombs are one of the ways through which data fraud can be orchestrated in DSS. It involves the introduction of unauthorized software into the mainframe. The introduced malware may pose a variety of threats to the stored data, such as modifying it or encrypting it. In case of a modified data, the intended users will end up accessing wrong data, thus making incorrect decisions. Moreover, such malware may encrypt data within the DSS with the threat that it can only be decrypted upon paying a ransom. Thus, businesses need to adopt best practices such as ensuring access right and privileges are observed to prevent these threats. Any system users downloading, altering, or removing access rights should be known through documentation. Thus, DSS are integral components within the business world, but they may also cause huge losses if the management does not observe data integrity.

2. Motivation

As decision support systems have become more sophisticated and mature over the years there are numerous efficacious DSSs that have been published in in research papers and technical reports [1].

In fact, the success of an organization depends on the correctness of the decisions that are made in it. Therefore, finding ways to ensure the correctness of decision-making has become requisite. Although in literature, theoretically and practically, there are abundant of DSS validation systems and tools still there is a necessity for tool that assist the decision maker in making a proper decision [2], [3]. This assistance to the decision maker can be in two ways: providing him with a set of decision options to choose the appropriate decision, and the other way is to verify that the choice that was made is the correct one. From the foregoing, we propose constructing a decision bank, where a decision maker may find group of decisions choices for any case, also the bank should include a mechanism for validating the

Manuscript received March 5, 2022
Manuscript revised March 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.3.77

selected decision and ensure that this is the appropriate decision. The establishment of a decision bank is a continuous cumulative process, as decisions are added to the bank whenever new decisions are found that do not exist in the bank and are commensurate with the nature of the institution's work.

Moreover, Decision Bank can act as a knowledge management platform where knowledge sharing and transfer could be performed through this bank. Where the knowledge and lessons learned from previous projects as well as from the evaluation of previous decisions are preserved as inherited knowledge in the form of decisions in the decision bank.

2. Decision Bank

The proposal of this paper has been presented and discussed in Fig 1 which shows framework the proposed decision bank. The first step is a decision acquisition where the decisions are collected and found. The decisions could be collected from different sites, such as: reports of previous projects where the lessons learned has been highlighted, reports from domain experts, or suitable ideas from white and research papers. The second step in proposed decision bank framework is decision abstraction where the decision is abstracted to reach the general meaning. This step is similar to stemming step in natural language processing. For instance, the decision of promotion to executive manager could be abstracted to promotion. The third step in proposed decision bank framework is decision leveling. The decision level should commensurate with the management level of decision maker. For instance, the first decision level will only be for the first management level, i.e., CEO.

The fourth step is direct step, where the prepared decision will be inserted in the decision bank. The fifth step is the most important step as it reflects the importance of the proposed decision bank. In this step, the decision maker chooses the appropriate decision from a set of options provided by the decision bank. The decision maker should select the appropriate decision to deal with a case at hand. The last step is decision evaluation, where decisions made before are evaluated. According to decision evaluation result, the level of this decision will be updated.

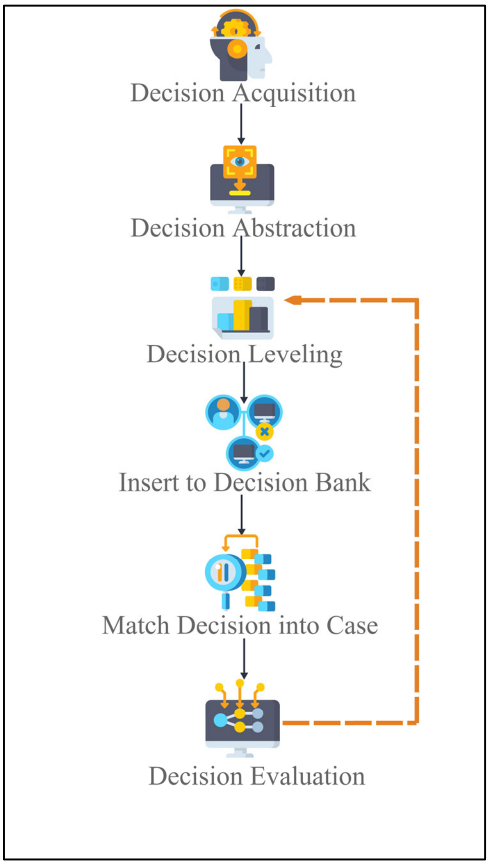

Fig. 1 Framework of the proposed decision bank.

The use-case of the proposed decision bank include two actors: knowledge engineer, and manager. The knowledge engineer is responsible for decision acquisition, and decision abstraction. On the other hand, in Fig 2, the manager is responsible for decision leveling, insert acquired decision in decision bank, decision evaluation, and match decision to a case. The use-case in Fig 2 prove that the proposed decision bank is interact externally with two entities each one is responsible for some operations. The first entity which is denoted by knowledge engineer is responsible for the establishment stage. The second entity is responsible for the transaction operations. In real implementation, the responsibilities of these two entities could be divided to many people.

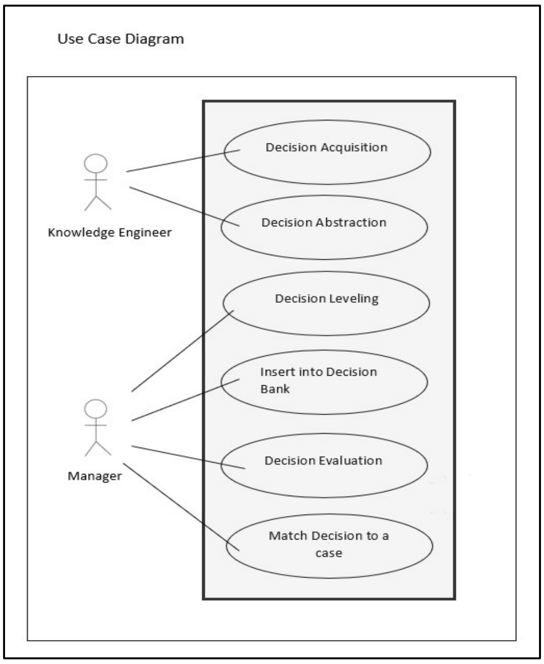

Fig. 2 Use case diagram for the proposed decision bank.

3.1 Decision Modeling

Modelling of the decision bank has been introduced, presented, and discussed. First Order Logic (FOL) has been used for modeling the proposed system. FOL has been proved as a successful tool for problem modelling [4-5]. There are four predicates have been used for modelling the decision bank, which are "type", "level", "match", and "evaluate". In the following, the Syntaxes and semantics of each predicate have been highlighted.

Syntax: type (C, case).

Semantic: identify the type, "C" defines the name of a case, e.g., type (applying for promotion, case).

Syntax: type (D, decision).

Semantic: identify the type, "D" defines the name of a decision, e.g., type (promotion, decision).

Syntax: Level (D, L).

Semantic: identify the level of a decision, e.g., level(promotion,1). This example shows that the level of "promotion" decision is 1 which means only managers with this level can deal with this decision.

Syntax: Level (C, L).

Semantic: identify the level of a case, e.g., level (*apply for promotion*,1). This example shows that the level of "*apply for promotion*" case is 1 which means only managers with this level can deal with this case.

Syntax: Match (D, C).

Semantic: identify that the decision "D" has been chosen for case "C".

Syntax: Evaluate (D, C).

Semantic: The predicate evaluates (D, C) is Boolean predicate which means is return only "true" or false". For instance, evaluate (immediate promotion, Jon apply for promotion) = false, means evaluate of a decision "immediate promotion" that had been taken for case "*Jon apply for promotion*" is false.

3.2 Decision Validation

Rules that should been considered for validating a proposed decision bank have been presented. Table 1 shows rules for validating the proposed decision bank. In the following each rule in Table 1 has been explained.

Table 1: Validation Results

Rule	***Result***
1	$\forall$ d, c: type(d, decision) $\wedge$ type(c,case) $\Longrightarrow$ match(d,c)
2	$\forall$ d,c, lc, ld: d, c: type(d, decision) $\wedge$ type(c,case) $\wedge$level(d, ld) $\wedge$ level(c,cl) $\wedge$ ld ==lc $\Longrightarrow$ match(d,c)
3	$\forall$ d, c: match(d,c) $\Longrightarrow$ *evaluate(d,c)*
4	*evaluate(d,c)=false* $\wedge$ level(d, ld) $\Longrightarrow$ level(d, ld-1)
5	$\forall$ d,D:contain(D,d)) $\wedge$ type(D, decision) $\Longrightarrow$ $d \in D$
6	$\forall$ d,D: contain(D,d) $\wedge$ type(D, decision) $\wedge$ level(D, ld) $\wedge$ $\Longrightarrow$ level(d,ld).

Rule 1: The case cannot be matched with a decision unless the decision is defined in the decision bank and the case itself is defined as a case in a decision bank.

Rule 2: The decision and the case should be in the same level to be match together. In other words, if the decision and the case in different levels and the decision cannot match this case.

Rule 3: Any selected decision for matching specific case must be evaluated. In other words, any taken decision will be evaluated.

Rule 4: If a taken decision for specific case is evaluated as false decision, then decision level will be decreased one level. Here, the reduction of decision level will allow more studies and discussion for this decision.

Rule 5: If a decision “d” is a sub decision from decision “D”, the type of “D” is decision then this means “d” is belonging to “D”.

Rule 6: If a decision “d” is belonging to a decision “D” and the decision “D” has the level “ld” then the sub decision “d” will take the same level as its master decision “d”.

4. Related Works

We have investigated the research works that dealing with the general modeling of a DSS considering time period for last five years. [6] proposed design principles to validate DSS in creating business models. However, the processes of creating these design principles are not tested and validated. The work in [7] proposed an intelligent DSS system that using support vector machine to learn from different datasets. The work in [8] proposed a benchmark to compare two intelligent methods that are used in developing DSS which are fuzzy logic with Artificial Neural Network. The results of benchmark proved that fuzzy logic is more accurate for modelling the uncertainty in DSS. The work in [9] proposed a DSS based on fuzzy logic as assistance for aircraft pilots. The work in [10] proposed a using genetic algorithm fuzzy logic for nurse scheduling problem. It is clear from previous research that the use of logic has a good reputation in developing DSS [11]. [12] developed decision support system for measuring learning outcomes by using fuzzy logic. The results proved the importance of lecturer role in learning outcomes achieving.

The works in [13, 14] demonstrates the significance of the changes, enhancements, and improvements that could be established by inserting Artificial Intelligence techniques and strategies within DSS. In [13], the work stresses using technology to address environmental challenges such as poor quality. According to the authors, DSS is an integral artificial intelligence tool that stakeholders can use to formulate effective policies that will enhance the quality of surface water in rivers. The idea that DSS can be essential in the agricultural sector is shared by Zong [14], who believe that the system is helpful in all industries. Today, there is a need to increase freshwater availability for the ever-rising population. Only 0.5% of freshwater is available for use, which is not enough for the human population. Thus, to enhance water quality management, DSS should be used. Water quality management implies enacting water quality enhancement measures ranging from collection to storage, among others. It begins with determining the water quality status after which protection measures are implemented. The process involves collecting on-site data and comparing it with the required standards, a procedure that takes time. Thus, for efficiency, a DSS should be employed as it will support the enactment of a solution, especially in relation to such a non-structured issue. With a DSS, stakeholders can assess the potential scenarios prior to making determinations, which will affect people’s lives.

With artificial intelligence, DSSs have become more effective as problems can be identified and solutions created through technology. AI-linked DDSs are revolutionizing the environmental sector through the proposal of effective solutions. The author suggests that expert systems have since been utilized in addressing industrial wastes recovery and climate change simulation, among others. One of the major areas is the planning aspect, which forms a vital element of environmental conservation. Policy analysis is a critical step in the planning process as it employs scientific knowledge and skills to elaborate the impact of various solutions and scenarios on certain indicators. The authors agree that DSS framework is critical in river basin modeling where stakeholders look for answers regarding water quality. First, data measurement and collection can be successful by employing DSS. Data processing is also supported by DSS, considering that a relational database is utilized to store assessed data. Decision-making and selection is the next activity where the stored results are retrieved to formulate policies. In the end, decision support systems facilitate the implementation of solutions through the dissemination of decisions concerning the usage of water in varying environments.

The works in [15, 16] illustrated by real cases and examples how using Intelligent logic in DSS will reflect in successful of its results. The logic is used in modelling and evaluating DSSs. Modelling DSS using logic is first step and corner step in automated the DSS.

5. Conclusion and Future Work

Designing an intelligent decision support system that assists the decision maker is a legitimate goal for researchers and academics. In this paper, a smart model of a decision support system is proposed that relies on providing a set of appropriate decisions for the decision maker to choose from. The intelligence in this system is to help the decision maker by providing choices, which makes it easier for him. The system is flexible as the taken decision will be evaluated and accordingly the decision level will be updated. As future work, a complete case study will be developed to evaluate the applicability and correctness of our proposed system.

References

[1] Taber, Peter, Christina Radloff, Guilherme Del Fiol, Catherine Staes, and Kensaku Kawamoto. "New Standards for Clinical Decision Support: A Survey of The State of Implementation." Yearbook of medical informatics 30, no. 01 (2021): 159-171.

[2] Schemmer, Max, Niklas Kühl, and Gerhard Satzger. "Intelligent Decision Assistance Versus Automated Decision-Making: Enhancing Knowledge Work Through Explainable Artificial Intelligence." arXiv preprint arXiv:2109.13827 (2021).

[3] Kumar, Rahul, and Rahul Thakurta. "Exfoliating decision support system: a synthesis of themes using text mining." Information Systems and e-Business Management 19, no. 1 (2021): 247-279

[4] Elfaki, Abdelrahman Osman, Khaled M. Alhawiti, Yahya M. AlMurtadha, Osman Ahmed Abdalla, and Asim Abdallah Elshiekh. "Rule-based recommendation for supporting student learning-pathway selection." Recent advances in electrical engineering and educational technologies (2014): 155-160.

[5] Elfaki, Abdelrahman, Amer Aljaedi, and Yucong Duan. "Mapping ERD to knowledge graph." In 2019 IEEE World Congress on Services (SERVICES), vol. 2642, pp. 110-114. IEEE, 2019

[6] Dellermann, Dominik, Nikolaus Lipusch, Philipp Ebel, and Jan Marco Leimeister. "Design principles for a hybrid intelligence decision support system for business model validation." Electronic markets 29, no. 3 (2019): 423-441.

[7] Ambika, M., G. Raghuraman, and L. SaiRamesh. "Enhanced decision support system to predict and prevent hypertension using computational intelligence techniques." Soft Computing (2020): 1-12.

[8] Teles, Gernmanno, Joel JPC Rodrigues, Kashif Saleem, Sergei Kozlov, and Ricardo AL Rabêlo. "Machine learning and decision support system on credit scoring." Neural Computing and Applications 32, no. 14 (2020): 9809-9826

[9] Seitbattalov, Zhexen Y., Sabyrzhan K. Atanov, and Zhanar S. Moldabayeva. "An Intelligent Decision Support System for Aircraft Landing Based on the Runway Surface." In 2021 IEEE International Conference on Smart Information Systems and Technologies (SIST), pp. 1-5. IEEE, 2021

[10] Odumosu, Oluwakemi Omolara, John B. Oladosu, Odugbemi Olawale Odumosu, and Kehinde Isaac Ojuope. "A Hybrid Genetic Algorithm Fuzzy Logic Based Decision Support System for Nurse Scheduling Problem."

[11] Elfaki, Abdelrahman Osman, Saravanan Muthaiyah, Chin Kuan Ho, and Somnuk Phon-Amnuaisuk. "Knowledge representation and validation in a Decision Support System: Introducing a variability modelling technique." CS Jao (ed.), Efficient decision support systems: practice and challenges from current to future (2011): 29-48

[12] Anifah, L., Sulistiyo, E., Zuhrie, M. S., Achmad, F., Nugroho, Y. S., & Schulte, S. (2021, October). Decision Support System of Student Learning Outcomes Assessment on Digital Electronic Subject using Fuzzy Logic. In 2021 Fourth International Conference on Vocational Education and Electrical Engineering (ICVEE) (pp. 1-6). IEEE.

[13] Sulistyaningsih, T., & Oktaviari, V. (2021, March). Artificial Intelligence and Decision Support System to Determine Policies for Controlling River Pollution from Industrial Sectors. In IOP Conference Series: Earth and Environmental Science (Vol. 717, No. 1, p. 012026). IOP Publishing.

[14] Zong, K., Yuan, Y., Montenegro-Marin, C. E., & Kadry, S. N. (2021). Or-based intelligent decision support system for e-commerce. Journal of Theoretical and Applied Electronic Commerce Research, 16(4), 1150-1164.

[15] Gupta, S., Modgil, S., Bhattacharyya, S., & Bose, I. (2021). Artificial intelligence for decision support systems in the field of operations research: review and future scope of research. Annals of Operations Research, 1-60.

[16] Yahya, A., & Abdalla, A. G. E. (2021, May). A Fuzzy Logic-based Decision Support System for Minimizing Delay of VoIP in MANET. In 2021 IEEE 1st International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering MI-STA (pp. 858-863). IEEE.

Abdelrahman Osman Elfaki is currently an associate professor at University of Tabuk, before he was a senior lecturer at Management and Science University in Malaysia. He is involved in many projects and research related to software engineering in different countries, which refined his software engineering experience in both practical and academic fields. His current interests are automated software engineering, and knowledge management. He has published many papers related to his current interest.

Wahid Rajeh received the B.S. in Computer Science in 2007 from Taiba University, Medina, and M.S. degrees in Information Technology in 2010 form Queensland University of Technology Brisbane. He received the PhD degree in Computer Applied Technology in 2018. He is now an assistant professor since at College of computer and Information Technology at University of Tabuk. His research interest includes Cloud Computing – Big Data – Security Analysis – Grid Computing – Risk Assessment.