Development and Implementation of Clincal Decision Support System: Success and Risk Factors

Kholood M. Al Motairi[1], Tahani F. Al shareef [1]

[1]*Information System Department, Faculty of Computiong and Information Technology, King Abudlaziz Universtiy, Jeddah, Saudi Arabia*

Abstract - *Decision support systems (DSSs) are used to assist in the design making process and sometimes replace the decision-maker role. DSSs are implemented in different fields, and one of them is the healthcare field. The clinical decision support system (CDSS) is one of the implementations of DSS in the field of healthcare. In this paper, we will investigate the success and the risk factors that come from adopting CDSS. Thus, studies in the performance measurement of implementing CDSS either in real-life case study or in experimental ways will be presented to show the positive impact resulting from adopting such a system.*

Keywords - *Clinical Decision Support System, Healthcare, Decision Support System, CDSS Development.*

I. INTRODUCTION

Decision support systems (DSSs) are defined as computer-based knowledge solutions that are utilised to assist the managerial staff in their decision-making process and problem solving [1]. The concept was early defined by Morton and Gorry. They combined the decision type descriptions by Simon with the management activity categories of Anthony, using the concepts of unstructured, structured, and semi-structured instead of programmed and non-programmed [1]. DSS technology enables efficient integration with the managerial decision-making process, which leads the organisation to gain a competitive advantage in business. In addition, it enables the organisation to discover a new opportunity in business or improve their business process. This technology has theability to analyse data in an efficient and effective way to discover a new pattern or knowledge, as well as saving time through reducing the decision-making cycle time. DSSs have been used in different fields, such as industry, economics, and healthcare.

Decision-making requires several steps. These steps are shown in Figure 1 below.The figure clearlyshows that the decision process first recognises the problem, followed by a clear understanding of the problem, which then will lead to the definition of all the perspectives related to the problem. Then, a decision must be considered with different alternative solutions, followed by building the model and analysis of these alternatives. The choice will then be chosen and implemented. Figure 1 illustrates the arrangement of these steps.

The process of decision-making is crucial in many firms because decision-makers are willing to provide firms with a solution to complex situations by collecting complex information. For that, using DSS in the healthcare environment will become like a professional advisor taking into consideration all the data collected from patients' histories along with the knowledge extracted and the rules engine. The common types of DSS used by clinicians in the healthcare area to assist their decision-making are the clinical decision support system (CDSS) and expert system (ES), which can make an early diagnosis and analyse the determined diagnosis to enhance the output and determine the treatment. [2].

Our focus in this paper is to investigate potential success and risk factors of adopting DSS in the field of healthcare. Thus, deep description of studies conducted to observe the implications of CDSS in assessing healthcare services. The flow of the paper will be as follows: Section II will introduce CDSS with definitions, components, and types. Section III will present the impact of CDSS in the field. Section IV will present CDSS implementation along with success and risk factors. Then, Section V will present the common trends in CDSS; Section VI will present the implementation of CDSS in real situations. Finally, Section VII concludes the paper.

II. CLINICAL DECISION SUPPORT SYSTEMS CDSS

DSSs in the healthcare field that assist the decision-making of clinicians are known as clinical decision support systems (CDSSs). It was first presented thirty years ago. The purpose of this system is to assist clinicians in their decision-making process by using a computer-based information system [3]. Thus, it improved and enhanced healthcare quality based on actions and decisions made during patient care [3,4].

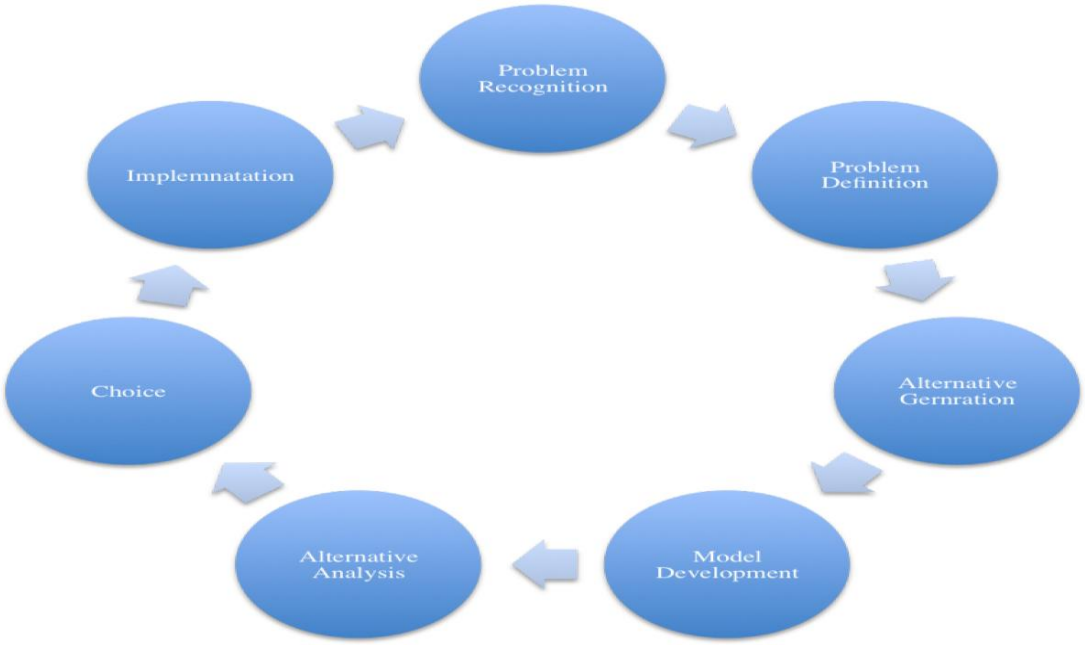

Figure 1: Decision-making process of DSS [1]

Clinicians' ability and their knowledge of particular issues affect the decision-making process. The main aim of the CDSS is to enhance decision-making through enhancing optimal problem solving and the actions of the decision-makers. It is also used to simplify the everyday process of patient care such as facilitating access to patient data that need assessing or dealing with [3,4].

CDSSs were integrated expert-based along with knowledge-based to assist clinicians to determine the proper medication of patients, where the characteristics of patients are organised in a computer knowledge base that creates suggestions using a software algorithm [3].

CDSS is known as a system that provides information that can enhance healthcare. There are different definitions of CDSS from different perspectives based on institutes, professionals, and non-profit organisations. On one hand, CDSS can be known as a supporting tool for improving the efficiency of healthcare decision-making, which can help hospital staff to provide precise and better patient care [5].

Moreover, CDSS is considered an important tool to provide hospital staff with well-filtered information that can be used as knowledge to enhance the quality of healthcare service provided [5].

On the other hand, [6] refers to the definition of CDSS from a writer who defines it as a connection between the knowledge in medical records and health control in a way that leads to the improvement of healthcare services.

Upon all these definitions and more, CDSS is a computer-based system that is programmed to assess the medical practitioners' decisions while treating patients. In fact, it can act as an intelligent medical practitioner that makes decisions based on a series of factors in the patient file and the symptoms given as well. The decision can be in the form of suggested medicine, a precaution to take, recommendations based on clinician consideration, or a warning to clinicians of potential problems. These decisions would help in reducing human errors and medical faults that can be derived from incorrect diagnoses [7].

This section reviews the components and types of CDSS. In addition, it provides guidelines for selecting CDSS.

A. CDSS Components and Development

According to [8], to classify the CDSS as a successful decision support mechanism, its content needs to be very rich with knowledge, evidence, and references. Also,it must be more intelligent and powerful to process the large amount of data as well as quick in terms of response time. In addition, the CDSS must be very advanced with the cognitive ability to gain users' attention without disturbing their work. From the definitions of CDSS, there are three main components of a typical CDSS: knowledge, intelligent filters, and presentation. Table 1 shows the different components and the definition of each along with the structure of these components. Each of them must define in well-structured to guarantee the response time and the ability to process a large amount of data [5].

TABLE I: THE DIFFERENCES OF CDSS COMPONENTS [5]

	CDSS Component		
	Knowledge	**Intelligent**	**Presentation**
Definition	The knowledge in CDSS comes from	It is the part where it responsibl	It is an important part to connect the

	its data repository. The repository in CDSS is huge and contain enormous amount of data derived from patients history along with saved disease information .	e for translate-ng and analysi-ng the knowle-dge in reposito-ry.	information system of hospital and the CDSS. It's considered the user interface of CDSS
Structure	The structure of a repository should be derived from known medical repositories like FDBE (drug data) or BMJ (an information institute) or it can be derive from ERP application	The rule and regulations in the intelligent component should be "clever" to understand the context of data in repository. It should be designed to give a solution and suggestion as well	It is important when designing a presentation component to cosider a screen to a knowledge that shows the clinicians the data they asked for.

From the above view, the CDSS contains three components: a data repository, rules engine, and interface. Figure 2 illustrates the CDSS components. The knowledge is represented in a data repository form, while the intelligence is represented in knowledge form, and finally, the presentation is drawn as a user interface. The figure shows how these components interact and process the information extracted from the repository through the rules engine to produce support for the decision-making process.

The data repository contains all CDSS content. This content could be either taken from a known data repository that saves knowledge in a structured form such as FDBE where they say data about drugs, or structured data taken from ERP applications. In addition, it could be unstructured text documents taken from institutes of medical information. The rules engine is considered the core component in the CDSS, which has the ability to analyse and interrupt the knowledge data. The interface is the urbane part in any system. In CDSS, the interface has a different role; it communicates the CDSS with the ERP application in server-based or UI-based [5].

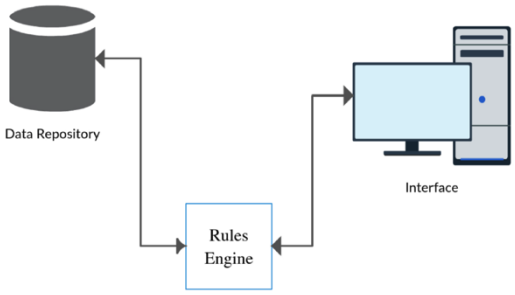

Figure 2: The Components of CDSS [5].

B. Types Of CDSS

CDSS can be categorised in many different perspectives. One perspective is the existence of an ERP application in the healthcare institution itself. In fact, the stored information in the institution database can be considered an assistance tool for helping in the decision-making process; thus, it can be applied in different ways. In contrast, CDSS can be used in healthcare institutions without the existence of an ERP, which will be considered an independent decision support tool [5].

Another perspective to categorise CDSS is the type of function it produces. Table 2 shows different types of CDSS based on the provided functionality and descriptions [5].

TABLE II: TYPES OF CDSS BASED ON PROVIDED FUNCTIONS [5]

CDSS Type	Description
Alert and Reminder	This type has capability to alert the clinician when information is received or recorded for patient. The form of alert could be of the following: • Simple pop-up message. • SMS. • A detailed message with guidelines and any entry into a task list. • E-mail or Paging.
Document Templates	This type has the capability to produce templates document / note based on patient situation.
Patient data report / Dashboard	This type has the capability to provide information dashboards based on group of patients who has compatible information with rules.
Order Sets	This type has the capability to suggest order set based on patient condition.
Clinical Guidelines	Tis type has the capability to make care path based on potential patient situation. The path contains reference link or guidelines to possible clinical diagnosis when recording information, recommendation of investigation, and recommendation plan treatment. It also has the capability to provide the alerts of screening based on patient condition.

C. Guidelines for Selecting CDSS

There are some issues and factors that need to be considered and guidelines to follow when selecting appropriate CDSS. Some of these include the type of existing CDSS, its workflow, security, and vendor offerings [7]. The author in [8] addresses some of these based on interactions with vendors to meet the user expectations for CDSS. The following list specifies some of these guidelines:

- Ensuring the recognition of all barriers and limitations.
- Ensuring the good reputation of the knowledge source.
- Ensuring the system is suitable for the institution.
- Ensuring the provision of a well-trained staff for the system.
- Ensuring the adequate employment of CDSS [8].

III. CDSS Impact and Effectiveness

The impact of CDSS can be noticed in the performance of the health institution and both the services provided for patient care and their cost. In fact, a few institutions have implemented this system, such as Vanderbilt University, which uses CDSS in their medical centre, an LDS hospital, and Registries Medical Center, where they have proven that using the system brought favourable outcomes. One researcher has stated that, to understand the impact of CDSS, the quality must be assessed in terms of three important factors: efficiency, cost, and structure [9,10]. The impact of CDSS will be measured in these areas:

- Impact on efficiency and outcomes of patient care.
- Impact on cost.
- Impact on health institution structure.

A. Impact on Efficiency and Outcomes of Patient Care

Clinicians use the system to get a precaution or warning when an incorrect diagnosis is given to a patient. The system has the ability to send a notification to warn the practitioner if an inappropriate prescription is released. These warning messages can certainly reduce and in some cases prevent a risk from happening. Moreover, the system may provide the ability to warn a practitioner if there is a risk from prescribing two medicines together, which may lead to dangerous effects. In addition, these warnings can be used to give clinicians deep insight into whether a drug may cause addiction by studying and analysing a patient's history [5,9,10]. The impact and capabilities of CDSS can benefit from smart hometechnology, which will help dementia patients who experience memory loss to complete their daily activities without the existing of human care through the nearest hospital implemented CDSS [11]. In fact, a study of the impact of CDSS on efficiency was conducted at an institution with a complex implementation of the system in which staff members use the system in their daily operations and activities. The idea of conducting the study in these situations and circumstances was to measure the effect in a complex, structured healthcare environment [9].

Although studies that show the positive impact of CDSS are more numerous than those that show the converse side, some studies show that the impact of implementing CDSS was not noticed or never existed. According to [9], a KLAS survey shows that there are some reasons for failure in taking advantage of CDSS. One is the insufficient use of the alerts provided by the system. The survey shows that some institutions did not use more than 10 warnings, and some did not use the warnings at all [9]. Thus, some observations indicate that the insufficient use of CDSS can include ignoring it. A practitioner could use the CDSS and get a result and warning but act upon his point of view and ignore the suggestions given to him. Therefore, the decision to implement such systems needs some guidelines as mentioned in previous section and success factors as will be mention in next section of this paper.

B. Impact on Cost

The impact of CDSS can be noticed in increased income by decreasing the cost of the services provided to patients. In fact, the cost of the negative effects of prescribing the wrong medicine (ADEs) is high. Thus, side effects results in more attention paid to patients. Such attention would include keeping the patient under supervision for days, which increases the cost of staying in the hospital. Also, problems occur when necessary patient preparation for surgery is forgotten or incorrectly implemented (checking blood pressure or giving an antibiotic), which can lead to infection in patients. All these problems can be diapered if CDSS is implemented and used as mentioned previously with warning messages and alerts [5].

The studies implemented to measure the impact of CDSS on increasing cost were done by modelling or studying and analysing performance before using CDSS and after. These studies were implemented in institutions that use CDSS with full capabilities and support, which enables the use of the system to achieve the maximum benefits (academic institutions). Therefore, it is not quite accurate to apply the same results to non-academic institutions [5,10]. Because of that, the author in [5] pointed to one study done in this area where the cost measurement was narrow, including only the service of prescribing medicine and the total cost of implementing the system. It was found that nearly half the cost was spent on clinician reviews of the system, which lead them to say that implementing the system reduced the cost of services [5].

C. Impact on Health Institution Structure

The impact of CDSS on the structure of the healthcare institution can be seen after adopting the system. The impact on the structure includes changing and increasing the institution staff to fit the system needs. Thus, implementing the system will cause the managers to change the workflow and sometimes the planning in the CDSS. The important fact to consider when adopting such a system is to make sure that the implementation will not waste the clinicians' time. The more training the clinicians have and the more the design of the system meets their expectations the more advantages will be brought out by the system [5].

All these studies show that CDSS has a major positive impact on several factors, including the performance of the services provided by the healthcare institution to the patient, the cost of these services with increase the outcome and the structure of healthcare staff and managerial activities. Thus, studies have shown that the impact of CDSS was better than hiring a professional practitioner [5,9,10].

IV. CDSS IMPLEMENTATION

Developing any system requires several steps that each company and organisation needs to follow. First, they should identify their needs and functional requirements. In addition, they need to decide whether they will build their own system or use a commercial one. Moreover, they should configure the system with the local environment. Finally, the system must be evaluated to see how it addressed the identified needs. Any system faces issues in both the design and implementation phases. According to[7], the issues of design and implementation in CDSS are related.

This section reviews the success and risk factors of CDSS, in addition to the challenges and barriers that affect the implementation of CDSS.

A. Success Factors

Recently, the performance and productivity of CDSS have been improved, which increased healthcare service quality and reduced errors. According to [4], one of the significant success factors that affects CDSS is clinicians' acceptance of the system. In addition, the author in [4] identifies three other factors that can be considered success factors: the input data and decision algorithm; CDSS output; and human-computer interaction.

1) ***Input Data and Decision Algorithm:*** The input data of CDSS require a minimum amount of information. This will reduce the time spent on data entry, improve healthcare services, and satisfy the clinical staff. Implementing CDSS will limit user intervention in data. The decision algorithm is another success factor in a new CDSS that can be automatically and periodically updated and maintained based on changes in patient management. In the past, some CDSSs faced difficulties updating the systems since they were created based on soft funding [4].

2) ***CDSS Output:***The format and types of system output should be based on the clinicians' expectations from the system. Since clinicians differ in the way of performing their work, the expectations and outcomes from the system will be different for each function. Thus, the development of a successful CDSS will be very complex since the information should be provided in a simple and efficient manner. A CDSS must be able to provide valuable information to its users and be suitable for clinicians' workflow [4].

A CDSS has characteristics that are considered success factors such as smart alerts and information. The number of alerts must be balanced, if the system gives too many alerts, it will cause inconvenience to clinicians, especially with false alerts. It is very important in designing and developing the system to work along with users [4].

3) ***Human-Computer Interaction:*** Human-computer interaction is a significant factors that has an impact on the success of a CDSS. One of its essential features is the user interface, which must be user-friendly. It also should provide easy and secure access to the system's information. The CDSS also should be designed to provide quick clinician login and quick display of requested information. The system should support cross-platform access for mobile and other devices [4].

B. Risk Factors

There are some crucial factors that can be considered risk factors in a CDSS that lead to unreliable or failure the decision. The authors in [4] list four of these critical factors: full dependence on the knowledge base; knowledge management; clinical workflow complexity; and ineffective clinical data analysis.

1) ***Full Dependence on knowledge Base:*** CDSS decisions are entirely dependent on the knowledge base, which can be classified as a critical factor in any DSS. Thus, if clinical dataset sources are inaccurate, it will lead to incorrect diagnosis, which is not accepted in a CDSS. In addition, CDSS algorithms such as ant colony algorithms and genetic algorithms require a highly qualified and accurate data source to retrieve knowledge to support the decision-making process [4].

2) ***Knowledge Management \ Knowledge Maintenance:*** Knowledge management and maintenance arerisk factors that affect a CDSS. Knowledge management is the process that interrupts, retrieves, captures, and analyses information to create the best use of knowledge. Knowledge management in the healthcare field is significant and can enable clinicians to avoid new diseases and symptoms. Therefore, the dataset

dealing with knowledge management must be accurate and precise [4].
Knowledge maintenance has two risk factors that should be taken into account. According to [7],the first one is accurate maintenance of patient records. The author researched the most of high rates alert overrides studies show that most medical records were not regularly updated, which led to inaccurate alerts. Based on this, the clinicians will ignore all decision advice from the CDSS. Therefore, it is very important to take into account the monitoring accuracy of patient records and deal with the problem. The second factor in knowledge maintenance is based on the knowledge that is embedded in the CDSS. New diagnoses and drugs are frequently discovered, which rapidly expands clinical knowledge. In addition, the collection of new evidence resulting in changes to evidence-based guidelines. To deal with this issue, organisations need either to use a commercial knowledge base system, which provide updates information, or to develop an in-house system to reduce the risk [7].

3) ***Clinical Workflow Complexity:*** The clinical workflow is very complicated and does not consider any routine work that can be easily managed. Thus, in this field, there is a chance at any time to have unexpected incident that needs quick and correct action. The unpredictable workflow is considered one of the major risk factors that lead to incorrect diagnoses. The system designer and implementation specialist of a CDSS must take into account this issue of the workflow, which contains processes, work system features, and a structured system that supports healthcare. Based on the workflow, the CDSS needs to optimise care either in the first stage of adopting the CDSS or in the adaptation of the CDSS [4,7].

4) ***Ineffective Clinical Data Analyse:***Ineffective clinical data analysis is a significant factor that leads to an inaccurate CDSS. The clinical repository contains huge and complex data, requiring either a new technique or specialist who has the ability to extract and analyse the data to make decisions [4].

C. Barriers and Challenges

Health organisations around the world are under pressure to implement a successful CDSS to improve care quality and patient satisfaction, follow regulatory agreements (i.e., JCAHO, ACO, etc.), reduce cost, and attract clinicians [5].
Previous research classified challenges as implementation barriers, technical and clinical challenges, evaluation issues, and high levels of maintenance [5]. In addition, the author of [8] considered data entry issues as a challenge; some systems require manual patient data entry, which might cause double data entry. Thus, it will disrupt clinicians and their process and consumes time. The integration of CDSS with the hospital information system caneliminate disruption and reduce time consumption. The integrations shouldhave atechnical standard and ensure that data are entered once into the system.

Another challenge is system complexity, which requires the extraction of a huge amount of knowledge to provide suitable decisions. Additional issues are poor system usability that requires much training; a user interface that is not friendly; and decisions provided with low accuracy that does not match the clinicians' diagnostic performance. Furthermore, lacking clinical evidence and explanations of suggested decisions and unstructured patient data are the other issues faced in the clinical field, along with an algorithm known as NLP (natural language processing) that mostly handles the analysis process for data of this type, but this algorithm does not work very well with clinical systems [4].

In addition to all these challenges, there are some barriers that face implementation processes. According to [4], the main barrier is the resistance of healthcare providers; some clinicians believe that the adoption of CDSS will decrease their work involvement, which will affect financial resources. The high cost of implementation is considered a barrier of concern. This cost can be categorised according to [4] as design and analysis cost; system customisation cost; cost of both deployment and testing, and training and maintenance cost. Overloaded information is another barrier that will face the adoption of CDSS.

V. Clinical Decision Support Systems Trends

Trends in CDSS show how much development and improvements have appeared in this field. The rapid change of DSS has concurrently improved along with the improvement of IT. These changes have a major influence on how patients' diagnoses can be taken and how the work will be done in healthcare institutions. This section will feature some of the major trends in the field and how much these trends will affect the performance of a CDSS. The trends to be discussed are as follows:

- Big Data.
- Personalised systems
- Standards and privacy issues

A. Big Data

The huge amount of data stored in a typical information system creates a challenge for the institution to handle it from the searching to the processing. Consider the complexity and diversity of clinical data; processing this stored information and the knowledge extracted is a challenge by itself. The use of technology to handle these data is compulsory. The big data concept offers arrangement and indexing of the data, which make it useful to extract

valuable knowledge, and improved one from them by creating relations between and connecting instances and variables. Furthermore, the analytics of data through the semantic web is an advantage of the big data concept in the healthcare field that can offer customised treatment and services based on the patients' needs [12]. In addition, the UI plays a significant role in the process of applying big data practices on the clinical dataset from analysis to interpretation through the integration [4,12]. The diversity of the data stored in different medical sections causes insufficient use of these data if there is no proper linkage between them. For example, the data stored in a dental clinic are different from the data stored by other medical clinics. The connectivity provided by big data practices will create better use of these data, which can prevent errors or at least avoid human errors in diagnosis or treatment [12]. As an example of the benefits from this linkage, the connectivity between medical and dental clinics will help the dentist avoid giving his patient a medicine that he is allergic to by knowing his medical past and records [12].

B. Personalized Systems

Genetic differences are differences between people in their genome. The need for a specific medicine or treatment may depend upon one's genetic profile. A cost reduction is one of the valuable outcomes from applying personalised systems in a clinical DSS. Thus, the researcher focused on personalised systems in this field using genetic information along with patient files to produce "personalised medicine", which will be a revolution in CDSSs [12].

C. Standards and Privacy Issues

The aim of a CDSS is to give doctors and researchers the ability to share knowledge to improve the medical field. Such joint work needs to have a unified language among those researchers. The differences in location and the format of the data entered in different clinical systems will make it harder to accomplish this aim. Standardising the approach to knowledge sharing between repositories is one solution to such differences is to reprocess data. The standardisation is a challenge itself to the CDSS designers because of its complexity [12]. Solving this issue will cause another issue to appear, which is privacy. Revealing sensitive information about a patient to a researcher or a developer must be done with the approval of the patient himself. According to [12], regulations and privacy must be provided and assured for both clinicians and patients to sustain the "trust" relation in the field of healthcare.

VI. Related Work

In this section, we will discuss different adoptions and implementations of CDSSs in different areas in the field of healthcare. The CDSS is suggested to be used in different areas.

One researcher defined a model to implement a DSS in the field of healthcare as a case study to measure the effect of designing the DSS based on the involvement of the user (in this case, the clinician is the potential user). The involvement of the user was to implement the concept of HCI (human computer interaction) by using one of its model designs, the U model, along with software engineering methods. The purpose of this study was to implement the system in one unit of a hospital located in Tunisia, the ICU, to help the clinicians avoid one major type of infection and then measure whether the system helped avoid this infection or not [13]. What is clearly shown is that, KDD, knowledge discovery from databases, along with user involvement, is beneficial in the development process because sometimes the developer has less knowledge about the field adopting the system, and this cooperation will definitely result in a more powerful implementation [13].

Another implementation of a CDSS in the field of healthcare was conducted in a dental clinic. The study was conducted to determine whether a DSS can be implemented in a dental clinic and have a positive impact. The problem is the whitening degree that a patient can ask for because the whitening of teeth can differ after days of implementation. The proposed DSS was used to predict the maximum degree of whitening a patient could reach considering all the factors that would affect the degree after days of implementation. The study compared the degree of whitening predicted by the DSS and the degree applied to the patient. The results were relatively close, and the DSS proved helpful in this situation [14].

A recent study of the implementation of a DSS in the healthcare field was conducted in a form of a system that used a machine learning approach (fuzzy logic) to make a relation between a patient dataset and physicians' problems [2,15]. The system proposed grouping physicians' common problems and then forming a relation using the patient data to predict these problem occurrences. Thus, the system used clustering along with empirical analysis in the case of missing data, which is very common in the healthcare field. The system was tested using a dataset from a sample of patients used as an input to the system. It was proven that the system had the ability to match the probabilities of the occurrence of physician problems along with the history of a patient [2].

All the above studies of CDSSs are in the field of assisting clinicians in their prescribing of medicines or predicting future side effects or problems. In contrast, this study presented a system that will help the hospital management staff to arrange a surgical team based on the case they are treating. The proposed system in [9] is called DisTeam, which

uses DSS techniques to help hospital management staff to schedule their operations and choose the team for surgeries based on the patients' condition, evaluating the team chosen to reach the best results. Thus, the system proposed has the ability to store the evaluation and the performance of the teams chosen for the patients they treat. The system was tested using a sample dataset from a specified healthcare institution, and the results showed that the system was very helpful in the manner of scheduling surgeries but it definitely cannot be replaced by the usual scheduling technique [9].

VII. CONCLUSION

The paper aimed to investigate the CDSS with respect to its success and risk factors. This investigation has shown that the adoption of such a system is crucial because it is implemented in a crucial field that relates to human lives. CDSSs are defined from many perspectives according to different authors. A CDSS has several components that form the decision-making process. Thus, categorising of a CDSS depends upon different perspectives, from the services it provides to the existence of an ERP as an extension. The decision to adopt such a system must be based on several factors. There are several challenges in the implementation of a CDSS that must be considered when adopting the system. There are numerous trends in DSSs in the field of healthcare, and we listed the most common ones. Studies have shown that CDSS implementation has a major positive impact on the performance of predicting future side effects, minimising human errors in prescribing drugs, and managing surgical team members.

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