The success of institutions is in providing good services to customers through making various and strategic decisions as quickly and accurately as possible. Expert systems are important in making strategic decisions by improving the quality of decision-making. An expert system is an information system that relies on systems based on knowledge bases. It may also contain a knowledge base in a particular field and advanced programming methods that make a computer capable of thinking, deducing, and providing advice and expertise.

This research aims to improve the period of time in decision making by using multiple experts systems and decision support system. The new system is implemented in MATLAB.

For analyzing the proposed system, the data is collected by the questionnaire method and distributing 70 questionnaires to managers, heads of departments, employees, and those responsible for making various decisions in the institution under study. The valid questionnaires were 63. A questionnaire and the data were analyzed using the statistical program (SPSS). Based on the obtained data, the linguistic variables were created for the time period of the data, and the skills of the decision-maker as inputs for the proposed expert system, and a stage was added to the stages of the proposed expert system to diagnose the problem and set the goal to obtain the correct strategic decision. To obtain this advantage, let's use expert systems compared to traditional methods of decision-making

Keywords: expert systems, decision-making systems, Quality of decision making, stability coefficient

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ANALYZING THE USE OF EXPERT SYSTEMS IN IMPROVING THE QUALITY OF DECISION-MAKING

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1. Introduction

The strategic decision is the essence of the administrative process in institutions and its primary means of achieving its objectives. The decision and its formulation have received attention and various studies in the field of enterprise business management because it mainly contributes to enabling the organization to continue its administrative activities efficiently and effectively, especially since the decision depends primarily on anticipating the future, as Strategic decisions are based on managers' future predictions, not just their current knowledge when making such decisions, and then focus on future scenarios that will enable the organization to choose the best strategic alternatives. The idea of expert systems is based on providing experts in a specific field with their knowledge of the computer. This knowledge is stored so that it can be referred to by (non-experienced) users of the system to obtain the advice they need in various fields of business and to support semi- and unstructured decisions and strategic decisions whose results affect the future of the enterprise [1].

2. Literature review and problem statement

The paper [2] looked into the significance of decision support systems and business intelligence, as well as the organizational elements that influence decision-making in a certain firm. The weakness of that was the data gathered from 20 articles. Could assist organizations provided appropriate decision support systems (DSS) by collecting accurate data through the use of BI and data mining. In [3] the "University Library" data was used to investigate and collect information regarding decision support systems and their applications in enterprises. purposed to analyze the reality of using expert systems in the Palestinian Ministry of Health and to determine the level of quality of decision-making for senior management in this ministry. The benefits of that work included the absence of statistically significant disparities between the average responses of the people who were interviewed. Inadequate understanding in current system management made the results appear hazy, but the dependability of modern systems in developing decision-making effectiveness had a direct and accurate impact on achieving the goals. The research [4] established a relationship between decision support systems and business intelligence, demonstrating that decision support and business intelligence systems are exceptionally efficient at Saudi Arabia's King Abdullah University Hospital. In the course of making a decision. Furthermore, a positive relationship between decision support systems and business intelligence was discovered. By investigating the relationship between information and knowledge, the study [5] tried to improve decision-making and tackle the problem of knowledge prediction. Following that, the most essential conclusions were presented: the significance of emphasizing the organic link between the changing information structure and the globalization process. The paper [6] proved that decision support systems contributed considerably to the resource planning process for data utilized by decision makers; nonetheless, human resources require effective tools to assist management in making choices with the essential knowledge. However, there are representation challenges (the symbol value can only be understood in the context of interpretation), representation uncertainty, and problems with restrictions and symbol interpretation in neural networks. The study [7] found that decision support systems are particularly effective in the decision-making process in businesses and focused on the management response on the DSS application's greater positive side. And intelligent strategies geared toward expertise orientation, and DSS application development is a problem-solving domain. The advantage of selecting the best technique to support each HR practice and the links between practices at each level of analysis is critical, and most resource elements have been improved by employing a decision support system. The purpose of the paper [8] was to shed light on the role of expert systems in influencing banking operations. The descriptive technique was employed in the study, using secondary data gathered from books, monographs, dissertations, and scientific conferences. They list the study's main disadvantages: The fact is that many administrative decisions are still made in the institutions under review using traditional and non-scientific methods such as estimation, self-assessment, and the personal decision maker's experience. These organizations also lack a defined decision-making process. The problem of making the right decision at the right time is an important issue in organizations.

All this allows to assert that it is expedient to conduct a study on design an expert system composed several expert systems to use all of the data in the form of linguistic variables that reflect the shifting time periods and the decision maker's skills.

3. The aim and objectives of the study

The aim of the study is to identify the extent of the interactive relationship and the power of mutual influence between the effective use of the mechanisms of expert systems and their impact on the quality of decisions taken, and to strengthen the current and future competitive position of the institution.

To achieve this aim, the following objectives are accomplished:

– to consider expert systems as one of the types of decision support systems in institutions;

– to show the importance of expert systems in making strategic decisions;

– to use of multiple expert systems for linguistic variables (time period) and (decision maker skills) to make decisions.

4. Materials and methods

4. 1. The object and hypothesis of the study

The object of the study is multiple expert systems and decision support systems to overcome the problem of traditional and non-scientific methods in these institutions under study.

The subject of the research is to establish the creation of multiple expert systems represented in a sub-expert system 1 (representing the time period) and a sub-expert system 2 (representing the skills of the decision maker) and using the outputs of this sub-system as inputs for the main expert system. Let's use the MATLAB programming language environment in the implementation and creation of these systems The multi expert. Statistical methods based on the statistical program (SPSS) were used to analyze the items of the questionnaire data and to show the extent of their impact when using expert systems in the decision-making process, especially the strategy.

From this standpoint, let's use multiple expert systems representing sub-expert system 1, language variables (time period), and sub-expert system 2 (decision-maker skills) to make decisions. Strategic decision making. To confirm the contribution of expert systems to increasing the efficiency and effectiveness of the strategic decision-making process by studying more alternatives with higher logic, in less time, objectively, and with a lower error rate.

Hence the importance of this research in showing the possibility of using expert systems in the decision-making process.

4. 2. Conceptual framework for the concept of expert systems

An expert system is simply a tool designed with a specific purpose and built to meet the needs and standards of applications in a given domain or expert-knowledge area. By offering an inference engine and a knowledge representation scheme, it can be characterized as a software package that makes it easier to create knowledge-based expert systems.

4. 2. 1. Theoretical concepts of expert systems

Expert systems belong to what is known as knowledge-based systems (KBIS), which represents a new addition to computer-based systems (CBIS), which represents one of the fields of computer science that studies the design and development of computer systems that simulate human intelligence, and that they are knowledge-based information systems that have been used in certain applied fields. And complex, so that it can be considered as an expert consultant for the end users of the system, that is, they are interactive systems based on computers designed to simulate the thinking of the human expert for the purpose of arriving at solutions to specific problems through deductive procedures and making recommendations to help in the decision-making process. An information system that solves problems, in particular, as it gives several solutions. Its goal is to determine the knowledge of a particular topic to reach a diagnosis, create a planning, translation, etc. and support the decision maker [9]. Expert systems have a number of characteristics, the most important of which are:

a) the ability to obtain and preserve rare human knowledge and experiences, and facilitate their use in a particular field;

b) providing solutions based on knowledge and experience to complex problems in record time with the ability to look at the problem from multiple angles;

c) achieving human participation in benefiting from rare human experiences by providing these experiences in more than one place at the same time;

d) the ability to explain the reasons for the proposed solutions to problems;

e) the possibility of working under uncertain information through the knowledge base.

The expert system is more flexible than the human expert in providing advice related to various administrative fields.

Expert systems were the first commercial systems to use a knowledge-based architecture. In general view, an expert system includes the following components: a knowledge base, an inference engine, an explanation facility, a knowledge acquisition facility, and a user interface. Fig. 1 shows the basic components of an expert system [10]:

1. User interface. With the help of a user interface, the expert system interacts with the user, takes queries as an input in a readable format, and passes it to the inference engine. After getting the response from the inference engine, it displays the output to the user. In other words, it is an interface that helps a non-expert user to communicate with the expert system to find a solution.

2. Inference engine (rules of engine). The inference engine is known as the brain of the expert system as it is the main processing unit of the system. It applies inference rules to the knowledge base to derive a conclusion or deduce new information. It helps in deriving an error-free solution of queries asked by the user.

With the help of an inference engine, the system extracts the knowledge from the knowledge base.

There are two types of inference engine:

– deterministic Inference engine: the conclusions drawn from this type of inference engine are assumed to be true. It is based on facts and rules;

– probabilistic Inference engine: this type of inference engine contains uncertainty in conclusions, and based on the probability.

Inference engine uses the below modes to derive the solutions:

– forward chaining: It starts from the known facts and rules, and applies the inference rules to add their conclusion to the known facts;

– backward chaining: It is a backward reasoning method that starts from the goal and works backward to prove the known facts.

3. Knowledge base. The knowledgebase is a type of storage that stores knowledge acquired from the different experts of the particular domain. It is considered as big storage of knowledge. The more the knowledge base, the more precise will be the Expert System. It is similar to a database that contains information and rules of a particular domain or subject.

One can also view the knowledge base as collections of objects and their attributes. Such as a Lion is an object and its attributes are it is a mammal, it is not a domestic animal, etc.

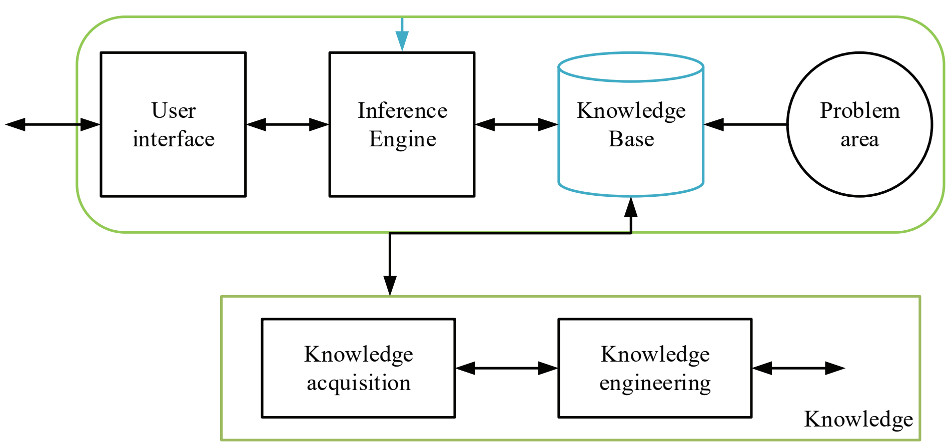

Fig. 1. Represents the architecture of expert systems

Components of Knowledge base:

– factual Knowledge: the knowledge which is based on facts and accepted by knowledge engineers comes under factual knowledge;

– heuristic Knowledge: this knowledge is based on practice, the ability to guess, evaluation, and experiences;

– knowledge Representation: it is used to formalize the knowledge stored in the knowledge base using the If-else rules;

– knowledge Acquisitions: it is the process of extracting, organizing, and structuring the domain knowledge, specifying the rules to acquire the knowledge from various experts, and store that knowledge into the knowledge base.

4. 2. 2. Expert System components

Fig. 2 shows how the expert system works [11]. It is possible to notice the following procedures which are essential components of the expert system:

– knowledge base: the knowledge base includes all of the facts that describe the problem area, as well as the methods of representing knowledge. Which explains linking the facts with each other in a logical way and this is related to the description of the problem area. This knowledge can be collected and derived from the expert as well as from the knowledge engineer who uses techniques, in order to assimilate the expert's knowledge, derive it from it, encode it in a program and store it in the knowledge base in the system;

– the inference machine: it represents the part of the expert system that interacts with the knowledge base where thinking is carried out by using the contents of the base and in a certain sequence, that is, the inference machine is a processor in the expert system where we derive or derive conclusions and solutions related to the problem in question, and that Through facts in working memory and specialized knowledge existing in the knowledge base and the derivation of new information;

– the beneficiary interface: the interaction between the expert system and the beneficiary takes place through a natural language that adopts a simplified dialogue method to reach the required solution to the problem in terms of the mechanism of conclusion, interpretation, clarification and the flexibility required to add new knowledge. Through this dialogue, the beneficiary can ask a series of questions in order to receive. The answers to the problem at hand, and in fact the design of environmental interfaces for expert systems based on meeting the needs of the end user.

The beneficiary receives information from the interface of the expert system in the workplace in the form of queries and facts or summaries and conclusions, in addition to the fact that the beneficiary is able to use other elements when interacting with the interface such as lists, images, shapes, sounds and various expression patterns. The nature of the expert system is mainly represented in the repetitive interactive processes between the user of the system and the computer, and the nature of the work of this expert system is governed by a mechanism that includes a number of successive steps as shown in Fig. 2.

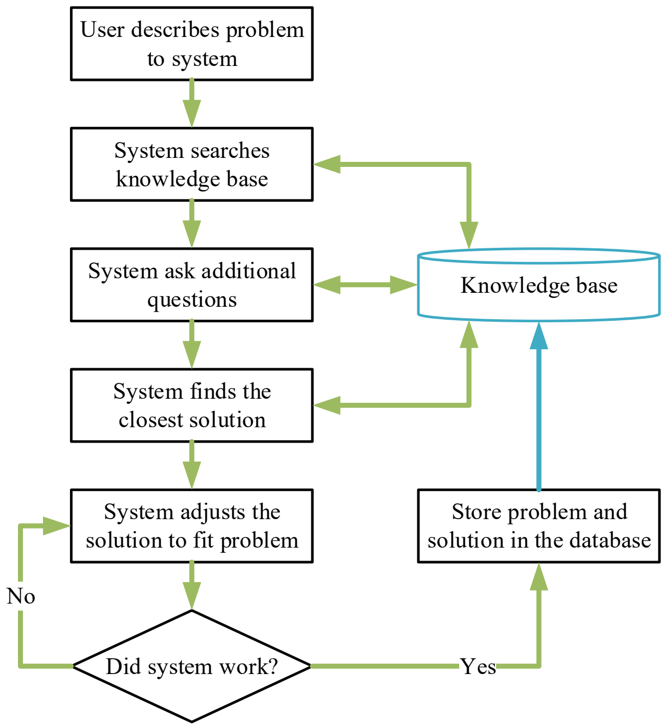

Fig. 2. Working mechanism of expert system

4. 2. 3. How expert systems work

The different stages are represented in the moment:

– the user of the system describes the problem of the expert system by entering it to the computer screen;

– the system searches in its knowledge base for problems or situations similar to the given problems of interest;

– the expert system used asks other additional examples to narrow the scope of the search within the knowledge base;

– the expert system finds the closest suitable alternatives to solve the problem.

– the system adjusts the solution to fit more with the problem;

– the system stores the problem and its valid solution in the database;

– the system provides expert advice to the user related to the solutions that have been reached, knowing that the expert advice is the solution reached by the system and presented to the user.

4. 3. Decision-making systems in the institution

At the beginning of the seventies, decision support systems were designed on the basis of individual decision support. The concept of decision support systems expanded at the end of the eighties and it became clear that most decisions are taken collectively, not individually. Expert systems were developed and became called collective decision systems; the definition of decision support systems is that it is a computer system that provides a mutual interaction in an easy way for information and decision-making for managers for a programmed and non-programmed decision-making process [12]. Group decision support systems are made by a group of decision makers who work as one team as an interactive computer system in solving non-programmed problems [13].

Let's note from the two definitions that the two systems are based on computer systems that support the decision-making process. This process is done after providing these systems with data that suits the needs of decision makers. There are a number of limitations specific to this process and the most important capabilities offered by these systems [14].

4. 3. 1. The use of models, graphics and maps in the process of in-depth data analysis

By applying the structure of this study, indicate that to obtain the following below:

1. In the system's database there is both descriptive and quantitative data that is directly accessed.

2. The decision taken is commensurate with its circumstances and the data used.

3. The data is displayed in a way that is misleading to the user.

4. Individual answers are instant.

5. The problem-solving process is based on emphasizing the comparison of relationships and trends.

6. The use of command language that helps the ability to interact with all elements of the system and to access the system and put it directly.

4. 3. 2. Goals and capabilities of decision support systems

The goals and capabilities of decision support systems and their representation are shown in [15]:

a) in semi-structured or unstructured activities it assists managers in their own decision-making processes;

b) data collection and complex analytical models aid in the process of improving decision-making;

c) administrative support by finding available alternatives and choosing the best ones;

d) adaptation to the changes that occur in the economic environment.

The decision support process includes four main dimensions, as each of these dimensions represent an added value to the total value or return behind the policies, programs or procedures in question, as these dimensions represent touch points that must be passed to reach optimal decisions.

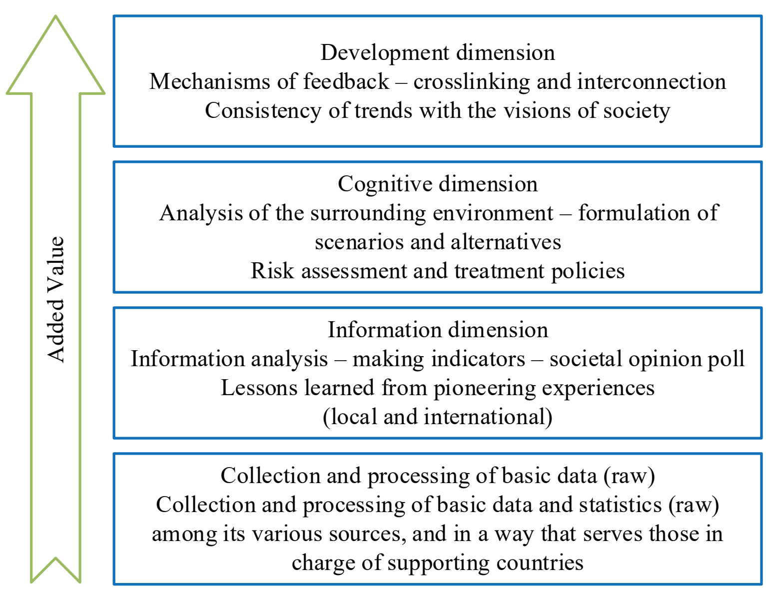

Fig. 3. Dimensions of the decision support process

By identifying the four main dimensions the decision support process, it is easily possible to identify the stages of decision support, as defining these stages is subject to the idea of employing and serving the different dimensions of decision support in a way that achieves the maximum possible benefit and maximizes the returns of development policies, and these dimensions are represented in Fig. 3 dimensions of the decision support process [16–19].

4. 4. Application part

The proposed expert system architecture includes a user interface, an inference engine, and a knowledge base. A questionnaire was added to it to collect data about the institution to be entered in the data bank. And the addition of the diagnosis stage, which is considered a stage for diagnosing the problem and setting the goal, and this stage is important in the strategic decision-making process. The proposed expert system is shown in Fig. 4.

The proposed system includes a number of steps to accomplish the decision-making process:

– step 1. Data collection: The data used in this work was collected through the use of a questionnaire method;

– step 2. The data was distributed in the proposed system so that the linguistic variables were distributed to sub-groups and each group explains the nature of these variables.

The first group: represents a sub-expert system 1 where the linguistic variables (time period) are shown for decision-making, where guiding rules are created for these variables in order to reach the outputs of being (very new, new, medium, old).

The second group: represents a sub-expert system 2 where the linguistic variables (decision maker skills) are explained for decision-making, where guiding rules are created for these variables in order to reach the outputs of being (excellent, very good, good, bad).

The third group: The results of the outputs of the sub-expert system 1 and 2 are used as inputs to the main proposed expert system and the establishment of guiding rules in order to reach the strategic decision-making process for the outputs of being (very acceptable, acceptable, relatively acceptable, unacceptable).

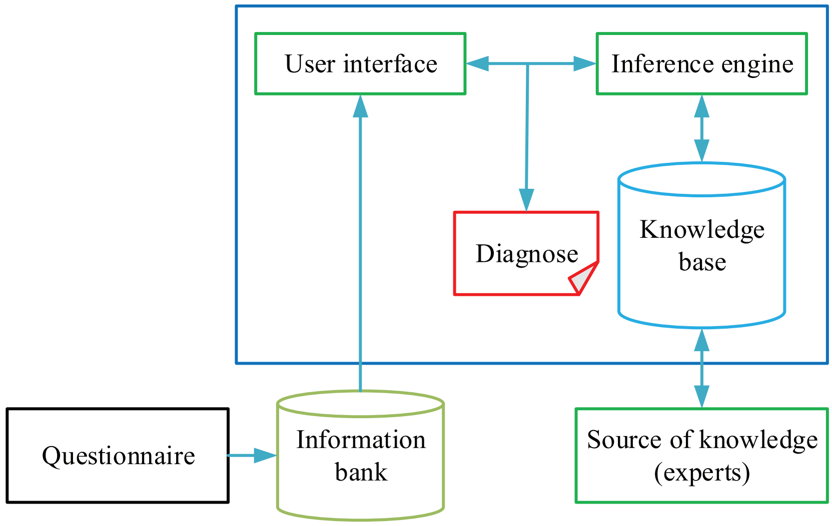

Fig. 4. Proposed expert system

5. Results of research of using expert systems

5. 1. Building the model for expert system

This section displays the results associated with sub-expert systems by indicating the number of guidelines formulated for the construction of the proposed system, based on the presentation of all sub-modules of the proposed expert system. The results are shown for each sub-module by indicating the number of indicative rules. And the graph for each unit as output, according to what is known as (Membership Function).

The results display related to the experimental subsystems through the number of rules that were created to build the model and to present all sub-systems of the main expert system.

From Fig. 5, 6, let's note the development of guidelines for the outputs of language variables for sub-expert systems 1 and 2. They represent (data period) and (decision maker skills).

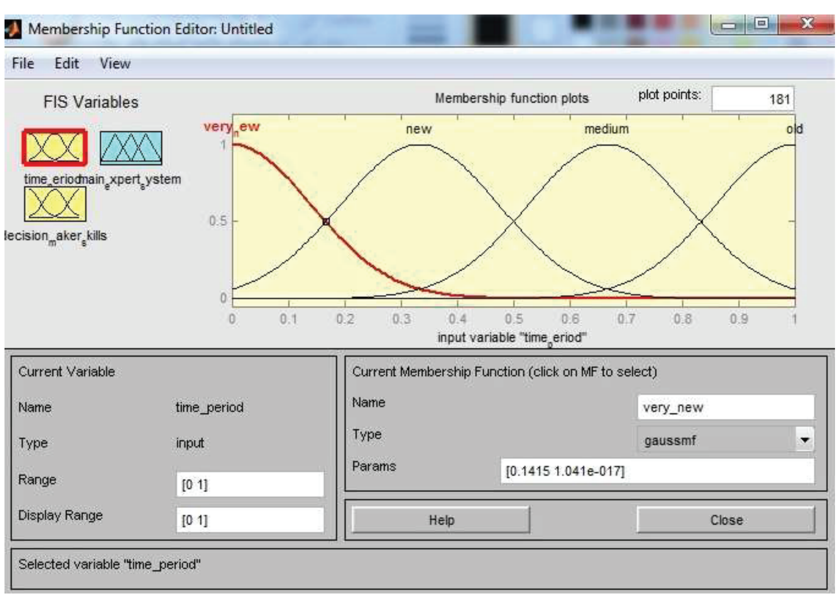

Fig. 5. Represents time period

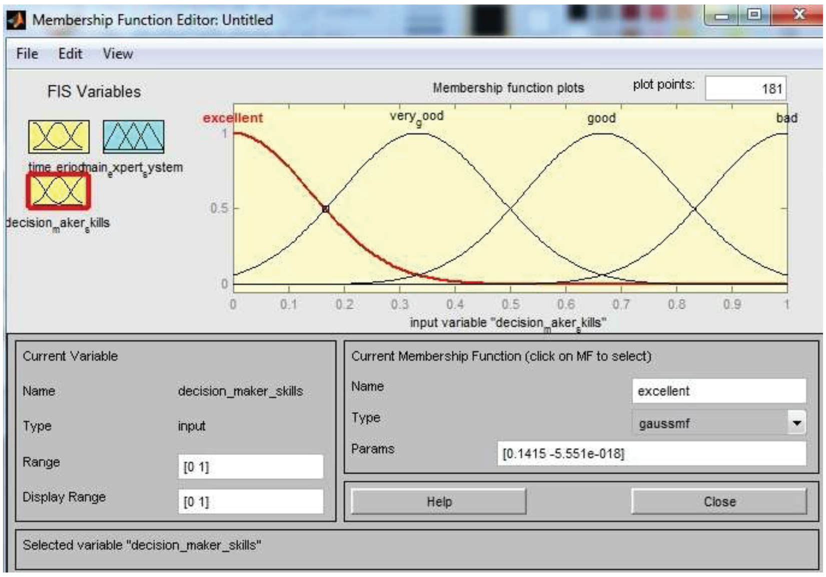

Fig. 6. Decision maker skills

Accordingly, Fig. 5, 6 show the partial results associated with the sub-expert systems and the main expert system. The number of rules for creating the model was formulated based on the presentation of all sub-units of the main expert system.

5. 2. Evaluation performance of the proposed expert system

After reviewing a group of studies and research that dealt with the reality of using expert systems in the decision-making process, and based on the results of the survey visit to the institutions under study, a questionnaire was designed that included a set of questions related to the research topic. The researcher distributed 70 parentheses questionnaires to managers, heads of departments, observers, and members of the administrative staff responsible for making different types of decisions in the institutions under study. 63 questionnaires were retrieved, and 7 questionnaires were excluded from them for not completing their data. Which 63 questionnaires were completed. The researcher downloaded the data using the statistical download program (SPSS).

Step 1. Test questionnaire and its validity.

The stability of the questionnaire has been confirmed, as the stability coefficient is calculated by the (SPSS) program, and its value is usually acceptable if it exceeds 0.60, as the value of this coefficient increases as the questionnaires increase, which indicates that the questionnaire includes all the details of the research, and it also increases the value of this coefficient is also the same whenever the responses of the respondents are heterogeneous. To ensure the stability of the questionnaire, the researcher calculated the stability coefficient for each axis of the questionnaire on the one hand, and for all paragraphs of the questionnaire on the other hand. The results were as shown in the following Table 1.

Table 1 shows that the value of the stability coefficient is high for each item of the resolution, as it ranges between (0.884) and (0.976). The same applies to the value of stability, as it ranged between (0.881) and (0.971). It is of validity and reliability, which means that it is distributable to the sample and valid to obtain the required data.

Step 2. Search items test.

To test the research item, the data was entered into the computer in preparation for processing it using the statistical program (SPSS), where the researcher's confidence probability (*P*) was compared with the level of significance (α=0.05), and the result was reported as follows: The item hypothesis is accepted if the probability value is (*P*) is greater than the significance level (α=0.05), while the item is rejected if the probability value (*P*) is equal to or less than the significance level (α=0.05).

Table 1

Items the questionnaire

No.	Questionnaire items	Stability coefficient	Constancy
1	Physical requirements available for expert systems	0.941	0.968
2	Software requirements available for expert systems	0.935	0.965
3	Senior management's interest in expert systems	0.884	0.881
4	Human requirements available to expert systems	0.976	0.971
5	The quality of decisions in the institutions under study	0.915	0.912
6	All items together	0.938	0.967

5. 3. Impact of implementing tasks through using multiple expert systems

Step 1. Item Impact Test Material Requirements.

To test the impact of the material requirements available for expert systems on the quality of decisions in the institutions under study, the average of the sample's responses to the statements related to the axis of material requirements available for expert systems was calculated, and then tested for the existence of a significant difference between the calculated mean and the mean of neutrality 3.

Table 2 shows the average responses of the respondents to the statements and test results related to the axis of material requirements available to the expert organizer and their impact on improving the quality of decisions.

Table 2 shows that the average was 4.41. Its value and the value of mean neutrality 3. Let's note that there is a significant positive difference from the mean of neutrality by 1.06, and that the probability value (*P*=0.000) is smaller than the level of significance (α=0.05). The quality of decisions in the institutions under study.

Step 2. Testing impact of the focus of attention of senior management.

To test the impact of senior management's concern for expert systems on the quality of decisions in the institutions under study, the average of the sample's responses to the phrases related to the item of concern for expert systems by senior management was calculated, and then tested for the existence of a significant difference between the calculated mean and the mean of neutrality 3.

Table 3 shows average responses of the respondents to the statements and test results related to the focus of senior management's concern for expert systems and their impact on the quality of decisions.

Table 3 shows that the average was 4.54. Its value and the value of the average neutrality 3. Let's note that there is a significant positive difference from the average neutrality by (1.09) and that the probability value (P=0.000) is smaller than the level of significance (α=0.05). Senior management of expert systems has a very significant impact on improving the quality of decisions in the institutions under study.

Step 3. Testing impact of the human requirements axis.

Examine effect of the human requirements of expert systems on the quality of decisions in the institutions under study. To test this item, the average responses of the sample were calculated on the statements related to the axis of human requirements for expert systems, and then tested for the existence of a significant difference between the calculated mean and the mean of neutrality 3.

Table 4 shows average responses of the respondents to the statements and test results related to the item of human requirements for expert systems and their impact on the quality of decisions.

Table 4 shows that the average was 4.48, but since calculating the arithmetic mean and knowing its value and its tendency towards approval or not is a necessary but not sufficient condition, the researcher tested the existence of a fundamental difference between its value (and) the value of the average neutrality 3. Let's note from the table that there is a significant positive difference from the average neutrality by 1.06 and that the probability value (P=0.000) is smaller than the level of significance (α=0.05). This confirms that the answers of the sample tend towards the strong agreement that human requirements of expert systems greatly affect the improvement of the quality of decisions in the institutions under study.

It is clear from Table 2 (step 1), Table 3 (step 2), Table 4 (step 3) in section 5. 3 that the values of the correlation coefficient are (0.868, 0.857, 0.855) respectively, which means that the relationships are positive and strong between the material requirements, interest of the senior management, human requirements and the improvement of the quality of decisions in the institutions under study.

The values of the determination coefficient were (0.756, 0.804, 0.756), which means that the material requirements, interest of the senior management, human requirements affect approximately (76 %, 80 %, 76 %) respectably on improving the quality of decisions in the institutions under study.

The results also shows that the values of the coefficient of variation were (48.379, 52.102, 50.471) at the probability value (0.000), which are smaller than the level of significance (α=0.05), which means that there are effects of the material requirements available to expert systems, senior management's interest, the human requirements of expert systems on improving the quality of decisions in the institutions under study.

Table 2

The average responses of the respondents to the statements and test results

N	Mean	Test Value=3		Correlation coefficient	Coefficient of determination	Contrast coefficient
		P	Mean Difference			
63	4.41	0.000	1.0621	0.868	0.756	48.379

Table 3

Testing impact of the focus of attention of senior management

N	Mean	Test Value=3		Correlation coefficient	Coefficient of determination	Contrast coefficient
		P	Mean Difference			
63	4.54	0.000	1.09152	0.857	0.804	52.102

Table 4

Testing impact of the human requirements axis

N	Mean	Test Value=3		Correlation coefficient	Coefficient of determination	Contrast coefficient
		P	Mean Difference			
63	4.48	0.000	1.06324	0.855	0.756	50.471

6. Discussion

The suggested system is an Expert System designed to help in strategic decision-making. Where the language factors for the time period in which the information was accessible, as well as the decision-skills, maker's which leads to assessing the quality of the choice chosen, were described (Tables 2–4). It may be capable of solving a variety of decision-making difficulties, such as lack of time, lack of reliable data, and lack of resources, and it may be a superior option to traditional approaches for reducing time and effort in the decision-making process. This method is intended to make recommendations for the process being worked on, as well as to defend the decision taken. It can assist both human specialists and users in explaining why a given decision was reached.

The research improves the performance of expert systems in decision making. However, managers still need to learn how to overcome obstacles to successful implementation. Therefore, it seems that there is much to be learned about the potential use of ESs in the realm of public sectors. This study has productive implications for both theory and practice; first, it expands on the existing knowledge by formulating a conceptual framework that identifies the desired role of ESs in improving managerial decision-making, specifically in institutions, and second, the research provides a practical directory to executives and decision-makers to help them enhance their choices using modern technology, aside from providing an educational material to support the application of the expert systems.

The disadvantages of this method include its dependency on a limited number of questionnaires and results analysis in order to achieve high accuracy in decision-making, and therefore it necessitates the growth of data by depending on a greater number.

7. Conclusions

1. The result of the decision determines its value: From a scientific point of view, this approach is clearer and more ac-

ceptable; the time period must be taken into account during the evaluation of the decision because there are some decisions that are undesirable for long periods of time.

2. Decision-making is determined in the light of the circumstances when it is taken: the skills of the decision-maker, the information, and available resources must be taken into account.

3. The variation according to the level of variation of the material requirements by applying ES amount of (0.76), but the interest of senior management in expert systems shows an amount of (0.80) moreover, expert systems show an amount of (0.76) for the human requirements in this study.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

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