A Review On Expert Systems And Their Usage In Management

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ABSTRACT

So far, there's been many discussions concerning knowledge representation; but it hasn't been discussed enough on how we use it for solving real problems. So in this article, we will introduce expert systems and discuss usage and using of them. In recent years, organizations have evinced considerable interest in using Information Technology for competitive advantage. One of the areas where organizations are exploring the potential benefits of Information Technology is Expert Systems. Expert systems are programmed systems which their knowledge base is full of information that people use to make decision based on it, for a specific subject. In fact, expert systems are computer programs which simulate a specialist's thinking in a specific field. This study was un-systematic review study. The literature was searched on Expert Systems and their usage in management with the help of library, books, conference proceedings, data bank, and also searches engines available at Google, Google scholar. For our searches, we employed the following keywords and their combinations: Expert System, management, Artificial Intelligence, and information technology in the searching areas of title, keywords, abstract, and full text. Technical reports were excluded since we focus on research papers. In this study, more than 47 articles were collected and assessed 18 of them were selected based on their relevancy. These soft wares have logical pattern that a specialist makes decision based on them. Expert system is one of branches of artificial intelligence which tries to provide specialty services beside specialists, by collecting specialty knowledge and expert information in a specific field. In this article, we will introduce expert systems and discuss their usage, decreasing method and how to use them. The rapid development of Internet technology has changed the way that Expert Systems can be developed and distributed. The essence of an Expert System is to mimic expertise and distribute expert knowledge into non-experts’ hands. This can be enhanced significantly by using the Internet.

Key words: Expert System, Management, Knowledge Representation, Artificial Intelligence;

Introduction

In recent years, organizations have evinced considerable interest in using Information Technology for competitive advantage. One of the areas where organizations are exploring the potential benefits of Information Technology is Expert Systems (ES) [9]. Expert Systems (ES) emerged as a branch of Artificial Intelligence (AI), from the effort of AI researchers to develop computer programs that could reason as humans [5]. Many organizations have leveraged this technology to increase productivity and profits through better business decisions [4].

ES are one of most commercially successful branches of AI [13]. Although there have been reports of ES failures, surveys, show that many companies have remained enthusiastic proponents of the technology and continue to develop important and successful applications [6]. This paper presents a comprehensive review about the design procedure, advantages, drawbacks, and applications of the Expert Systems.

Materials and Methods

This study was un-systematic review study. The literature was searched on Expert Systems and their usage in management with the help of library, books, conference proceedings, data bank, and also searches engines available at Google, Google scholar. For our searches, we employed the following keywords and their combinations: Expert System, management, Artificial Intelligence, and information technology in the searching areas of title, keywords, abstract, and full text. Technical reports were excluded since we focus on research papers.

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In this study, more than 47 articles were collected and assessed 18 of them were selected based on their relevancy. By analysing our collected literature, we identified the main aspect of Expert Systems and their usage in management. These implications can be used to guide future research in this field.

Definitions of Expert Systems:

Definitions of Expert Systems vary. Some definitions are based on function. Some definitions are based on structure. Some definitions have both functional and structural components. Many early definitions assume rule-based reasoning. The following is a sample of some definitions.

1.1. An Expert System is software that uses a knowledge base of human expertise for problem solving, or clarify uncertainties where normally one or more human experts would need to be consulted. Expert Systems are most common in a specific problem domain, and are a traditional application and/or subfield of artificial intelligence (AI). Expert Systems may or may not have learning components [17].

1.2. Expert Systems are software programs, that store knowledge extracted from human experts. Expert Systems thus appear to mimic human experts in a specialize area. Early Expert Systems focused on expert emulation, attempting to replicate the behavior and decisions of human experts. In contrast to artificial intelligence, ES systems do not try to develop basic postulates and evolve these into intelligent behavior, but accept human knowledge / experience as its basics and attempt to formulate form of aggregate behavior. Most early Expert Systems captured knowledge in the form of rules and used algorithms to put these rules together into a set of decision systems. Most more recent systems are pragmatic in nature and combine rules from experts, to organized diffuse knowledge, and other form of knowledge representation [18].

1.3. Expert Systems (ESs) solve problems that are normally solved by human “experts”. An ES can also be defined as a computer program that exhibits, within a specific domain, a degree of expertise in problem solving that is comparable with that of a human expert. ESs need to exploit one or more reasoning mechanisms to apply their knowledge to the problems that are given. Then they need a mechanism for explaining what they have done to the users who rely on them [10].

A brief History of Expert Systems:

Developments in ES have grown from research in Artificial Intelligence (AI) which provided insights into how to analyse problems and the subsequent development of general search strategies for problem solving. Research in AI may be classified into three broad categories:

• Natural Language Processing: Design and development of computer programmes that understand and respond in languages commonly used by human beings.
• Robotics: Development of visual and tactile programmes that will allow a robot to note changes in the environment and take appropriate action.
• Expert Systems: Design of computer systems that use symbolic knowledge to simulate behaviour of human experts.

Other areas which have led to advances in Expert System development include cognitive psychology, symbolic computing systems, and interactive programming.

One of the first large ES was MYCIN, developed at Stanford University in the mid 1970s. MYCIN provides consultative advice about bacterial infections in the blood and meningitis [9].

The Expert Systems are usually designed to have the following general characteristics:

– High performance. The system must be capable of responding at a level of competency equal to or better than that of an expert in the field.
– Adequate response time. The system must also perform in a reasonable amount of time, comparable to or better than the time required by an expert to reach a decision.
– Good reliability. The Expert System must be reliable and not prone to crashes or it will not be used.
– Understandable. The system should be able to explain the steps of its reasoning while executing so that it is understandable [16].

Expert System Component:

As Figure 1 shows, the typical Expert System consists of:

• knowledge base;
• inference engine;
• user interface and;
• explanation facilities (fact & experties) [3].

The knowledge base is the most important part of the Expert System, which implicates its total quality. This base contains the knowledge from which the inference engine draws conclusions. The expert knowledge will typically be in the form a set of IF-THEN rules [11].

A rule is composed of an if portion and a then portion. The if portion of a rule is a series of patterns which specify the facts which cause the rule to be applicable. The Expert System tool provides a mechanism, called the inference engine, which automatically matches facts with patterns and determines which rules are applicable. The then portion of a rule is the set of actions to be executed.
when the rule is applicable. The actions of applicable rules are executed when the inference engine is instructed to begin execution [1].

The function of the user interface is to present questions to the user and supply the user’s responses to the inference engine. The inference engine selects a rule from the knowledge base and then the actions of the selected rule are executed. The inference engine then selects another rule and executes its actions. This process continues until the final solution (required diagnosis) finding (Holsapple, Whinston, Benamati, & Kearns, 1996).

![Basic scheme of a typical Expert System](image)

**Fig. 1:** Basic scheme of a typical Expert System

**Typical Tasks for Expert Systems:**

There are no fundamental limits on what problem domains an Expert System can be built to deal with. Some typical existing Expert System tasks include:

- The interpretation of data such as sonar data or geophysical measurements;
- Diagnosis of malfunctions such as equipment faults or human diseases;
- Structural analysis or configuration of complex objects such as chemical compounds or computer systems;
- Planning sequences of actions such as might be performed by robots;
- Predicting the future such as weather, share prices, exchange rates;
- However, these days, "conventional" computer systems can also do some of these things [2].

**Characteristics of Expert Systems:**

Various definitions of Expert Systems have been offered by several authors. A general definition that is representative of the intended functions of an Expert System is:

An Expert System is an interactive computer-based decision tool that uses both facts and heuristics to solve difficult decision problems based on knowledge acquired from an expert. An Expert System may be viewed as a computer simulation of a human expert. Expert Systems are an emerging technology with many areas for potential applications. Past applications range from MYCIN, used in the medical field to diagnose infection blood disease, to XCON, used to configure computer systems. These Expert Systems have proven to be quite successful. Most applications of Expert Systems will fall into one of following categories:

- Interpreting and identifying;
- Predicting;
- Diagnosing;
- Designing;
- Planning;
- Monitoring;
- Debugging and testing;
- Instructing and training;
- Controlling.

Applications that are computational or deterministic in nature are not good candidates for Expert Systems. Traditional decision support systems such as spreadsheets are very mechanistic in the way they solve problems. They operate under mathematical and Boolean operators in their execution and arrive at one and one static solution for a given set of data.

Calculation intensive applications with very exacting requirements are better handled by traditional decision support tools or conventional programming. Conventional computer programs are based on factual knowledge, an indisputable strength of computers. Heuristic knowledge, composed of intuition, judgement, and logical inferences, is an indisputable strength of humans. Successful Expert Systems will be those that combine facts and heuristics and thus merge human knowledge with computer power in solving problems [12].

**Need of Expert System:**

Expert Systems are necessitated by the limitations associated with conventional human decision-making processes, including:

- Human expertise is very scarce;
- Humans get tired from physical or mental workload;
- Humans are inconsistent in their day-to-day decisions;
- Humans have limited working memory;
- Humans are unable to comprehend large amounts of data quickly;
- Humans are unable to retain large amounts of data in memory;
- Humans are slow in recalling information stored in memory;
• Humans are subject to deliberate or inadvertent bias in their actions;
• Humans can deliberately avoid decision responsibilities;
• Humans lie, hide, and die [15].

Benefits of Expert System:

There are several benefits of Expert Systems:
• Increase the probability, frequency, consistency of making good decisions;
• Help distribute human expertise;
• Facilitate real time, low cost expert level decisions by the non-expert;
• Enhance the utilization of most of the available data;
• Permit objectivity by weighing evidence without bias and without regard for the user’s personal and emotional reactions;
• Permit dynamism through modularity of structure;
• Free up the mind and the time of the human expert to enable him or her concentrate on more creative activities;
• Encourage investigations into the subtle areas of a problem [15].

Key Steps in Designing ES:

Implementation of ES in an organization is a complex task and for better monitoring and evaluation, it may be viewed as a sequential, iterative process of which the key steps are:

10.1. Definition of Scope:

Step 1: Involves arriving at the definition of the problem to be implemented, identifying beneficiaries, and estimating time and cost given the limitations on (a) the complexity that may be handled by the existing hardware/software (b) availability of human expert for the period it takes to implement the ES, and (c) availability of funds and time stipulated for completion of the project.

10.2. Development or Prototype and Construction of ES:

Step 2: Requires implementation of prototype in the first phase. This would help in identifying both problem areas as well as the potential for a full-fledged system.

10.3. Validation and Evaluation of ES:

Step 3: Requires validation by knowledge engineers for correctness of data and reasoning strategies and by experts, for correctness of the outcome. Subsequent modifications need to be incorporated into the ES.

10.4. Integration and Implementation of ES:

Step 4: Involves providing training, support, and documentation to the user. This may also be the most time-consuming aspect since the ES may require the existing procedures to change or there may be reluctance on the part of users to use the ES.

10.5. Maintenance of ES:

Step 5: Involves updating, refining, and changing the ES to keep it current [9].

Languages and Tools:

Expert Systems have two integral components: a knowledge base and a mechanism for drawing inferences. Both need to be represented within the computer.

ES have usually been designed using programming languages like LISP (List Processing), a language specifically designed for symbolic and list manipulation, or PROLOG (Programming in Logic), a language which facilitates specification of facts and inferences that may be drawn from it. LISP and PROLOG are referred to as AI languages. These naturally lend themselves to design of knowledge systems. Often designers of knowledge systems may also want access to a prepackaged code that facilitates the programming task. Packages which allow access to such a code are called programming environments. INTERLISP, a version of LISP which contains a large number of prepackaged routines is an example of programming environment. A number of ES (e.g. DRILL ADVISOR) [8] have been implemented using INTERLISP.

However, if rapid development of ES is to take place, the designer must have access to what are known as Knowledge Engineering Tools or Shells. Shells are packages that contain elementary constructs for modeling and specific strategies for representing knowledge, inference, and control. The extent to which a shell facilitates development of a knowledge system will depend on how closely and accurately the problem domain can be modeled by the constructs available in the shell.

Steps for developing an Expert System:

There are several steps in developing an Expert System.
• Step1. Background;
• Step2. Concepts;
• Step3. Problem selection;
Expert System structure:

In order for the computer to be able retrieve and effectively use heuristic knowledge, the knowledge must be organized in an easily accessible format that distinguishes among data, knowledge, and control structures. For this reason, Expert Systems are organized in three distinct levels:

Level 1. Knowledge base consists of problem solving rules procedures, and intrinsic data relevant to the problem domain.

Level 2. Working memory refers to task-specific data for the problem under consideration.

Level 3. Inference engine is a generic control mechanism that applies the axiomatic knowledge in the knowledge base to the task specific data to arrive at some solution or conclusion.

The inference engine, such as VP-Expert, may come from a commercial vendor. The knowledge base may be a specific diagnostic knowledge base compiled by a knowledge base is the nucleus of the Expert System structure.

The knowledge base constitutes the problem solving rules, facts, or intuition that a human expert might use in solving problems in a given problem domain [15].

Examples of applications of Expert Systems:

Expert Systems are designed to facilitate tasks in the fields of accounting, the law, medicine, process control, financial service, production, human resources, among others. Typically, the problem area is complex enough that a more simple traditional algorithm cannot provide a proper solution. The foundation of a successful Expert System depends on a series of technical procedures and development that may be designed by technicians and related experts. As such, Expert Systems do not typically provide a definitive answer, but provide probabilistic recommendations.

An example of the application of Expert Systems in the financial field is Expert Systems for mortgages. Loan departments are interested in Expert Systems for mortgages because of the growing cost of labour, which makes the handling and acceptance of relatively small loans less profitable. They also see a possibility for standardized, efficient handling of mortgage loan by applying Expert Systems, appreciating that for the acceptance of mortgages there are hard and fast rules which do not always exist with other types of loans.

Another common application in the financial area for Expert Systems are in trading recommendations in various marketplaces. These markets involve numerous variables and human emotions which may be impossible to deterministically characterize, thus Expert Systems based on the rules of thumb from experts and simulation data are used. Expert System of this type can range from ones providing regional retail recommendations, like Wishabi, to ones used to assist monetary decisions by financial institutions and governments.

Another 1970s and 1980s application of Expert Systems, which we today would simply call AI, was in computer games. For example, the computer baseball games Earl Weaver Baseball and Tony La Russa Baseball each had highly detailed simulations of the game strategies of those two baseball managers. When a human played the game against the computer, the computer queried the Earl Weaver or Tony La Russa Expert System for a decision on what strategy to follow. Even those choices where some randomness was part of the natural system (such as when to throw a surprise pitch-out to try to trick a runner trying to steal a base) were decided based on probabilities supplied by Weaver or La Russa. Today we would simply say that "the game's AI provided the opposing manager's strategy".

A new application for Expert Systems is automated computer program generation. Funded by a US Air Force grant, an Expert System-based application (hprcARCHITECT) that generates computer programs for mixed processor technology (FPGA/GPU/Multicore) systems without a need for technical specialists has recently been commercially introduced.

There is also a large body of contemporary research and development directed toward using Expert Systems for human behavior modeling and decision support systems. The former is especially important in the area of intercultural relations and the latter in improving management operations in small businesses.

In health and medicine, simple (non-complex) Expert Systems exist in both large and small health environments (Hospitals and general practitioners [GPs]). For example at a GPs desk, during a patient's visit, the GP could prescribe medication to the patient using his integrated patient manager system (like Zedmed Clinical). The system will check the medication prescribed to the patient and any other data on the patient and use these as inputs, the inputs are processed through the system's knowledge base and it'll processes the result.

If the medication prescribed has any adverse effects on the patient it'll be flagged and the clinician will be alerted to this. The system could also supply a list of any alternative medication available for the patient to assist the clinician in creating a decision on...
a possible effective treatment plan if possible [17].

**Role of Management in ES Development:**

To be able to fully exploit this technology for organizational benefit, it is necessary to understand the technical, organizational, and social implications of integrating ES in organizations. Management has a crucial role to play if ES technology is to be exploited to organizational advantage. Organizations where ES have been implemented successfully have reported large savings. However, since ES development is costly both in terms of physical resources and time, the management must examine the following issues before initiating ES development:

- If non-AI or non-Expert System solutions exist for the given problem, then those alternatives need to be examined first.
- If human expertise in the area is not available, then development of ES may become a difficult task.
- If the area of Expert System involves a lot of natural language processing or incorporation of human in tention or processing of complex geometrical or spatial data then development of ES in such areas should not be taken up especially in view of the current status of computing technology.
- Availability of knowledge engineers or people who have the necessary expertise to elicit knowledge from an expert and encode it for representation in the computer may be limited.
- ES are expensive to build and involvement of experts is required over a long time for its successful implementation [14].

**Conclusion:**

The rapid development of Internet technology has changed the way that Expert Systems can be developed and distributed. The essence of an Expert System is to mimic expertise and distribute expert knowledge into non-experts’ hands. This can be enhanced significantly by using the Internet. In this paper we have studied various researches done in the field of Expert System, and the fundamentals of the system.

**References**