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Research Article

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A Rule-Based Expert System for Simulation of Litigation Outcome Disputes Arising from the Withdrawal of Work from the Contractor

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Abstract In Egyptian administrative construction contracts, the employer has the authority to impose penalties (including withdrawal of work) on the contractor by its own decision, and any disputes arising from the contractor's appeal of its penalty decisions can only be resolved through litigation. Therefore, the need arises to develop this integrated legal and engineering expertise into an expert system that can be used in a preliminary prediction to simulate the outcomes of litigation to determine the advisability of recourse to the judiciary. The goal of this research is to identify the factors influencing the outcomes of litigation. A case study is presented to demonstrate the capabilities of the proposed rule-based expert system.

Keywords Administrative Construction Contracts, withdrawal of work from contractor, Rule-Based Expert System, Litigation, Egyptian Public Tender Laws

1. Introduction

The nature of construction contracting contracts that are subject to the administrative laws and judicial oversight of the Egyptian State Council determines the disputes that arise from the imposing of penalties decisions by the Administrative authorities "employer" against the contractors as a result of the performance breaches of those contracts and displays the litigation proceedings in formal and substantive terms in the administrative judiciary courts.

The paper scope was limited to disputes arising from imposing the employer on the contractor withdrawal of work penalty. Throughout this paper, other limitations also stood. These limitations follow disputes arising from financial compensation because of floatation, inflation, and financial rebalancing of the Contract, changing contract quantities by more than 25%, and methods of calculating the newly.

Forward chaining inference techniques are used because the data and facts required for carrying out the research process have been obtained, and the data and facts can be combined to form a system that will provide a conclusion or solution based on a set of data and facts. Using inference techniques allows you to reach a more specific conclusion than is otherwise possible [1]. You're also an expert in performance and can solve the problem sequentially if you use the rule-based approach that has an if-then pattern on the basis of knowledge in diagnosing in this expert system application. Using the same approach, the generated rules can be reviewed by experts for repair or modification in order to achieve better results.

As a result, litigation is more expensive and has negative long-term consequences. This burden motivates construction litigation specialists and professionals to develop methods for predicting the outcome of construction litigation before it begins. Researchers investigated multiple techniques for predicting litigation outcomes by developing a specific learning algorithm and feeding it with training cases through its input cells, a perceptron, including Arditi and Pulket [2] and [3], and Chau [4], [5], and [10]), and Arditi et al. [4]. The first

step in predicting the outcome of a construction lawsuit is to compare the current case to a previous case with similar characteristics. The researcher would look for a case with similar characteristics and proceedings held under a similar statute in a similar jurisdiction. A construction project is, by definition, a one-of-a-kind endeavor; therefore, identifying historical parallels to predict a specific current case is nearly impossible. Advances in artificial inelegance, on the other hand, have enabled programmers to train on specific patterns, determine the relationship between input and output sets, and forecast new systems based on data from previous systems.

2. Experience-Based Theories

Expert Systems

Here are some definitions of expert systems:

- A computer program that simulates an expert's problem-solving abilities, according to Durkin [6].
- According to Ignizio [7], a model and procedures relating to a specific domain where the level of expertise can be compared to that of a specialist.
- According to Giarratano [8] and Riley, a computer system can match or mimic the abilities of a human expert.
- According to Turban [9], decision-making or problem-solving software package can achieve performance levels comparable to or even better than a human expert in some specialized fields and typically narrow problem areas

Turban (2001) [10] categorizes expert systems into two categories: development and consulting. Non-expert users use consultancy to obtain expert knowledge, whereas expert system development is used to incorporate expert knowledge. The following components comprise the expert system:

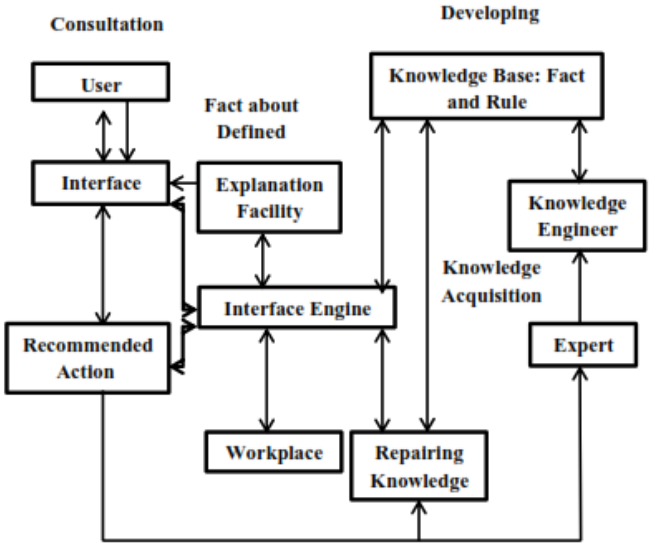

Figure 1: The Expert System's Components

A. The Expert System's Components

User Interface

A user interface is a form of communication used by experienced system users. This section of the dialogue, according to McLeod (1995) [11], occurs between the program and an expert system that allows users to receive instructions and information from the user as well as provide information to the user.

Knowledge Base

A knowledge base is a database that contains facts, ideas, theories, procedures, and their relationships, as well as information that has been organized and analyzed (knowledge from an expert's education or experience) and entered into a computer. There are two widely used approaches to knowledge bases.

a. Rule Base: Facts and rules are used to present knowledge. This illustration is divided into two parts: a premise and a conclusion. This form is used because it contains expert knowledge on a specific issue, and experts are capable of solving these issues logically and sequentially. Rule-based representations with a pattern that if the condition/premise is met, then action/conclusion is given to a table of experts will benefit in a variety of ways, including the ease of modifying both data changes, data addition, and data deletion. It can be represented as a dispute in this case and then used to determine the outcome of a legal proceeding. When an explanation of the steps required to achieve a solution is required, this form is also used. If the premises, conclusion, and premises are all present, they can be linked to the operator and/or the premises to some extent. Finally, there may be a single sentence or several sentences that are linked, and it is simple to create.

b. Case Base: Before narrowing down a solution to the current situation in a case-based approach, the knowledge base will include previous solutions (facts).

Knowledge Acquisition

The accumulation, transfer, and transformation of expertise in the resolution of problems arising from knowledge sources into a computer program are referred to as knowledge acquisition. Because human knowledge can be unstructured and difficult to express clearly, expert knowledge acquisition activities typically necessitate the use of an expert computer system, who is a specialist in the field of expert systems [12].

Inference Engine

An inference engine is a computer program that provides a method for reasoning about information in the knowledge base and in the workspace in order to reach conclusions. Throughout the process, the inference engine employs reasoning and control strategies. The strategy is made up of both sure and uncertain strategies. If all of the data needed to draw a conclusion had been available, the strategy would have been used, whereas the uncertain reasoning strategies were used in the opposite situation. Controlling the direction also serves as a guide in carrying out the reasoning process.

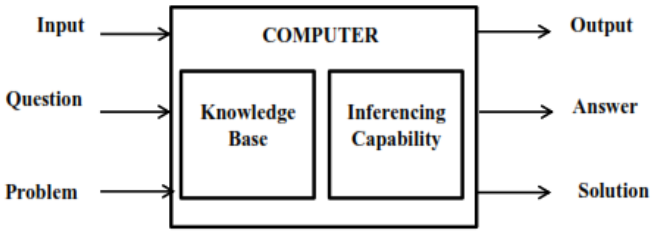

Figure 2: Inference Engine

In the inference engine, there are two tracking techniques: tracking forward and trace-driven approaches developed on the data. This method begins with tracking the input data that further describes a conclusion and tracking backwards or forwards alphabetically with a goal-driven approach. In this approach, tracking begins with the next goal sought, a rule with the goal of reaching a conclusion.

Workplace

Working memory is used to keep track of the user's current situation, circumstances, hypotheses, and decisions.

Explaining Facility

Users can learn about the process that led to a decision by reading facility explanations.

Knowledge Maintenance

Experts can analyze their performance and improve it while also learning from it.

B. Forward Chinning

Forward chaining is a method of reasoning that begins with facts and progresses to a conclusion based on those facts [8]. Forward chaining inference is a strategy based on a known set of facts. The search is carried out by applying rules whose premise matches the known facts in order to obtain new facts, and the process is repeated until the goal is reached or the premise is no longer compatible with the known facts and the obtained facts. Tracking techniques can be used on a variety of systems, including:

a. One or more conditions are presented to the system.
b. For each condition, the system searches the knowledge base for rules that correspond to the conditions in the if- statement.
c. At the end of the first section, each rule can generate new conditions. These new conditions can be combined with existing ones.
d. Any new condition that is introduced into the system will be addressed. If a condition is encountered, the system will return to step 2 and look for rules in the knowledge base. If no new conclusions are reached, the session is adjourned [13].

3. Mental Framework

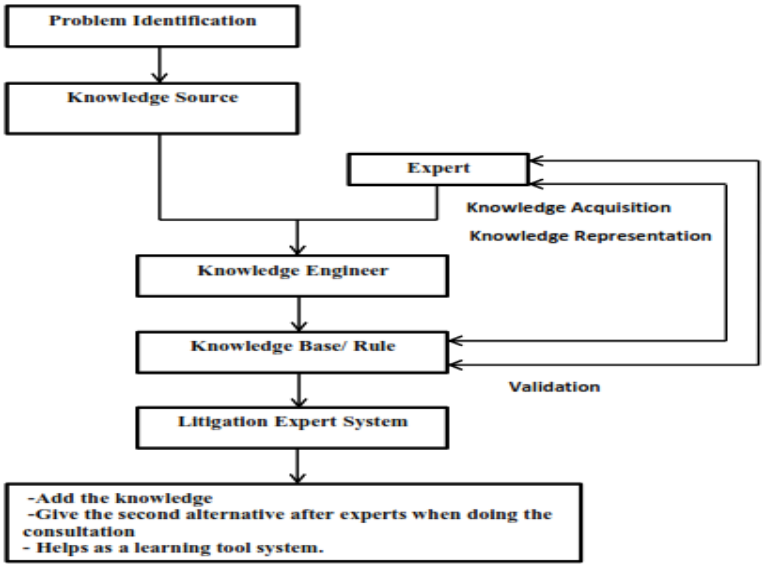

Figure 3: Mental Framework

4. Method of Research

Based on the principles of the Expert System Development Cycle, expert system application research methods were developed to simulate the outcome of induction litigation (SDLC). SDLC consists of four steps: planning, knowledge acquisition, coding, and evaluation [10].

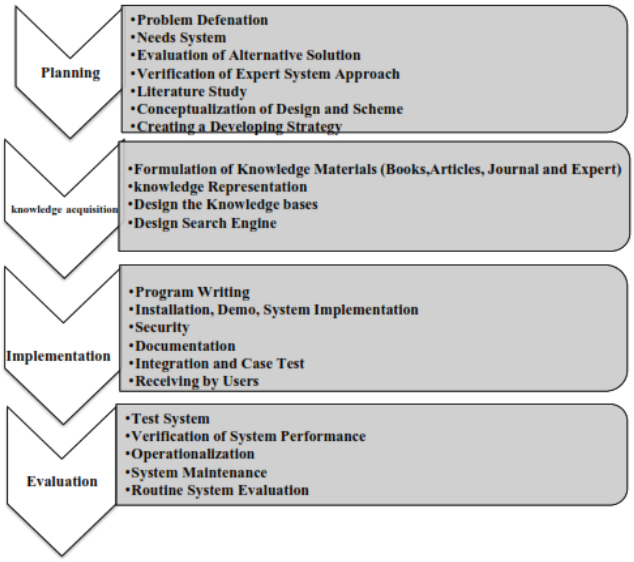

Figure 4: Method of Research

5. Process of Research

The following is the procedure for applying an expert system to simulate the induction of the litigation outcome process using forward chaining and a rule-based approach:

a) Determine the object of research to be applied in an expert system, namely that the administrative authority "employer" imposes a penalty (withdrawal of work) against the contractor.
b) Collecting and identifying data about the laws and regulations that govern the contractual relationship in administrative construction contracts.
c) Investigation: analyzing the existing litigation lawsuits in the Supreme Administrative Court that were caused by contractor claims to annul the penalty (withdrawal of work) decision.
d) Selection of expert knowledge (articles stipulated in the Egyptian Public Tender Laws (Law No. 89 of 1998 and Law No. 182 of 2018) as well as their Executive Regulations; 2) the legal principles approved by the Egyptian Council of State's Technical Office of Fatwa and Legislation Department; and 3) previous lawsuits stored in the Supreme Administrative Court's archive) to be acquired to be interviewed by the Judge in the Supreme Administrative Court and engineering experts at the Egyptian Ministry of Justice.
e) Creating the design inputs and outputs. Enter the expert system in the form of answering the questions. The output is a report containing expected outcomes in the event of resorting to litigation, as well as the best strategy that the claimant party must employ in order to obtain satisfactory results for its claims.
f) Expert system architecture ,Technically, the architectural design simulates the induction litigation outcome and is divided into 3 sections as follows:

1. Interfaces

In expert system applications, this interface can be used to interact with users. The object is used to gain access to the necessary information.

2. Parts of the application

Expert system applications include knowledge and inference engines. The inference engine enters the wheel to connect the interface and the knowledge base.

3. Exodus

This expert system produced Exodus.

g) User interface requirements

The user interface acts as a bridge or communication medium between the user and the computer. In this case, the application of an expert system designed as a user interface to provide facilities containing knowledge and expertise can be enhanced. The software makes use of a visual display. The sub-menus and sub-menus are user-friendly so that they can provide consultation and charging base facilities as well as their knowledge of the rules.

6. Results and Discussion

By using SQL Server Management Studio (SSMS), the litigation expert system that uses forward chaining inference techniques and a rules-based approach has been successfully created and runs on the Microsoft Windows platform.

Figure 5: Basic Menu

Figure 6: Main Menu

Figure 7: Output Menu

The research objectives are to develop application litigation expert system simulations of litigation outcomes in construction disputes and then determine the necessary stages in system implementation and evaluation using the method used in the ESDLC study (Expert System Development Life Cycle). These stages can also be used to assess the research's success.

A. System Implementation

A.1. Programming Development

The program made it simple to encode knowledge contained in the knowledge base by employing rule-based reasoning and forward chaining as inference techniques, allowing the program to be carried out in accordance with the designs and designs that had previously been created.

A.2. Installation, System Setup, and Training

Installation, system setup, and training Installing the program necessitates practice/training as well as a demonstration in front of two experts with acquired knowledge..

A.3. Computer Security

A security computer system must meet several aspects of the data to be protected from unauthorized use, namely, preventing data insertion and deletion (data manipulation from outside the right's knowledge), which include [14]:

1. Confidentiality: take all reasonable precautions to keep sensitive information out of the hands of those who are not authorized to see it.
2. Privacy of personal data: refers to the nature of personal data.
3. Integrity: the information must not be changed without the permission of the owner.
4. Authentication: The method or method of declaring that the information is truly original and that no one has the right to change it.
5. Availability refers to the availability of data and information when needed.
6. Access control refers to how to configure information access. The security expert system applications generated in this study met some of these requirements because they were equipped with a charging user id and password (which was registered by the Administrator) prior to use. If the user id and password are entered incorrectly three times, the application will halt the charging process.

A.4. Documentation

Documentation is used to store data on the application so that it can be accessed if the data is corrupted but the system backup file is still available. According to the system documentation, the original file system (if not already installed) should be kept on another drive disc.

A.5. Integration

Testing Integration testing is a technique for building the structure of a program by running tests to detect errors when combining modules. The program's structure is built from the ground up. Modules are integrated by working their way down the control module hierarchy, starting with the main menu, then sub-programing to the main menu, and incorporating into the structure depth-first.

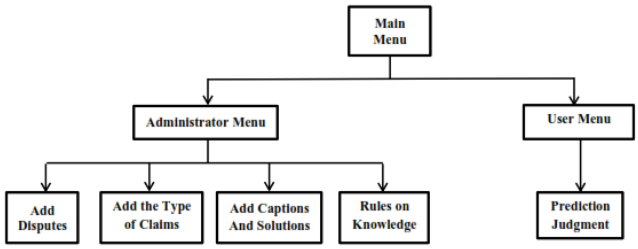

Figure 8: System integration testing

A.6. Case Evaluation

When the application of litigation run is used, the display log in appears first. The Administrator and Level User Level can log in using their User Name and Password. The test case includes three tests: one for each menu in the application, one for the questioning process, and one for knowledge base modifications.

B. Evaluation

B.1. Test System

Because it represents the fundamental study of specification, design, and coding, system testing is an important part of software quality assurance. In this study, the test system was performed by testing a black box for all functions within the application.

B.2. System Mechanism Verification

System performance verification is a component of expert system validation that specifies how well expert systems can solve problems. The performance of the system was validated by comparing its output to the judgments issued in five lawsuits stored in the Supreme Administrative Court's archive.

B.3. System Evaluation

The purpose of the evaluation system is to determine the extent of the epidermis and the useful application of expert systems in order to ensure that the new system can deliver expected results. A questionnaire was distributed to ten respondents for that test, which included two engineering experts, six Supreme Administrative Judges, and two lawyers..

7. Conclusions

The litigation expert system is a useful tool for improving the following:

- Assisting the claimant party (whether the administrative authority or the contractor) with how to prepare its claims vis-à-vis the other party.
- Clarifying the influence of experts, judges, and other parties involved in litigation on the formation of the beliefs of the litigating parties, thus demonstrating how to deal with them.
- Providing solutions for the parties to future disputes by presenting the final judgments of previous disputes with claims similar to those of future disputes, thus reducing the number of future disputes before the courts.
- Identification of the legal basis, along with their technical and engineering counterparts, that the claimant party must use to sway the convictions of the parties involved in litigation.
- Determining the best course of action for the parties to the dispute upon the emergence of the claim.
- Examining the expected outcomes in the event of litigation to determine whether or not to accept settlement and mediation offers to resolve disputes.
- Boosting the decision-making process for resorting to litigation by utilizing the best strategy that the claimant party must employ in order to obtain satisfactory results for its claims.

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