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EXSCD, AN EXPERT SYSTEM FOR CONSTRUCTION DISPUTES

نظام خبرة لتقليل المنازعات في مشروعات التشييد

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ملخص:

تعتبر المنازعات بين المالك والمقاول من أهم الاسباب التى تؤدى إلى زيادة فى التكلفة وزمن التنفيذ للعديد من مشروعات التشييد ويهدف هذا البحث إلى تطوير وإعداد نظام خبرة يمكن من خلاله التنبؤ بالأسباب المتوقعة لحدوث المنازعات فى أى من مشروعات التشييد وذلك بغرض اتخاذ الإجراءات التى تكفل التغلب على هذه الأسباب. ويعرض البحث المراحل المختلفة لإعداد النظام بالأضافة إلى إختبار مصداقية النظام المقترح على عدد من المشروعات.

ABSTRACT:

The objective of this research paper is to provide a prototype expert system that can materially help to reduce the likelihood of construction disputes. The inputs of this system include many relevant factors that can adequately describe the construction project environment. The outputs of the proposed expert system will be in the from of a complete tabulation for the expected causes of construction disputes for the construction project under discussion. The different phases of the system development will be deeply discussed. Some guide lines will be systematically provided to show how can the suggested expert system be operated. Finally, some selected case study applications will be provided to check the validity of the proposed system.

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1. INTRODUCTON

Construction disputes are one of the main factors that causes construction project to be finally completed out of the specified planned time or the expected budget ceiling. Construction disputes may frequently arise during the different phases of the construction project.

Construction disputes have many causes according to the point of view of each participants within any construction project. These causes may include delays, additional work, variation in contractual works, change in physical conditions, disasters and errors in contract clauses. Disputes between participants may consume long time from project period and add costs to the project. The negotiation process between the participates aims at additional time or money or both in order to compensate the injured party losses.

Some projects can be considered as dispute prone projects. This may be attributed to the project characteristics, project organizations or the contractual obligations. A strict effort must be expanded so that the potential causes of these disputes can by early identified. Consequently, suitable precautions can be taken at an appropriate point of time to avoid or reduce the likelihood of construction disputes.

It is expected that the Egyptian construction projects may have their special features in the area of construction disputes. These features may include the different types of disputes, the most frequent types, the different causes of these disputes, and finally the special characteristics that can be considered as indicators for the potential disputes.

The detailed identification of such features can materially help in providing the project team with knowledge that makes them able to avoid or reduce the likelihood of the expected disputes. It is felt that this can be effectively accomplished by the use of an expert system.

The objective of this research paper is the development of an expert system that can effectively help decision makers (Client and Consultants) in predicting the potential causes of construction disputes. So that, special precautions can be taken at a suitable time to avoid or reduce the likelihood of the expected disputes. The suggested expert system should compile current experience regarding the most frequent causes of construction disputes in the Egyptian construction environment. The main characteristics of projects and people that can be considered as good indictors for the main causes of construction disputes should be also considered.

The output of such expert system will be in the form of a prediction for the expected causes of construction disputes for the construction project under discussion so that some precautions can be taken to alleviate these causes. It has to be noted that the sources of experience investigated should cover the different types of the construction project in Egypt.

2. KNOWLEDGE ACQUISITION

2.1 Introduction

In consonance with the previously defined objectives, the process of knowledge acquisition was carried out through two stages. The first stage can be considered as a pilot study that aims at identifying the main causes of construction disputes. Based on the results of the first stage, the second stage tends to provide appropriate answers regarding the main characteristics that can represent a suitable land for growing construction disputes. Identifying this characteristics can materially help in

reducing construction disputes. To realize this objective the knowledge acquisition procedures include the following stages:

- Knowledge acquisition including defining sources and methods of collecting data.
- Design questionnaire to collect data concerning the main causes of construction disputes in the Egyptian construction projects.
- Analysis of collected data.
- Data acquisition regarding the question of when each of the previously defined causes of disputes is frequently arised.

2.2 Domain of experts

Interviews have been successfully implemented with 49 experts with different scope of experience in the Egyptian construction industry and different years of field experience for each construction category. The selected sample has different field of experience to actually typify the different construction projects. They also selected with suitable period of experience so that their answers can represent valuable information. The analysis of data shows some interesting findings regarding the selected experts.

A careful investigation to the collected data clearly shows that the majority of experts have their scope of experience in the area of building projects, about 75 % , experts that are specialized in the area of industrial and heavy construction projects represents 15 % and 10 % respectively. This may be attributed to the fact that building projects represent the major portion of the total construction projects in Egypt.

The selected experts were also classified according to their years of experience. The results of such classification clearly show that 75 % of the selected experts have a period of experience ranged from 10-30 years. In addition a small portion of experts about 9% have an experience period of more than 30 years. The last portion of experts about 16% have a period experience of less than 10 years.

Moreover, the study encompasses information from 16 substantially completed construction projects. The selected projects can be classified as:-

1- Nine projects from Arab Contractors (Osman Ahmed Osman) Company, covering many different projects types.

2- Four projects from private contractor SIAC Company.

3- Three projects from other different companies.

The size of the selected projects varied greatly from a minimum value of 150,000 L.E to a maximum value of 22,500,000 L.E. The collected data cover a wide variety of items that may help in identifying the suitable environment for growing construction disputes. Among these items are project type, owner, contractor, contract, project delivery system and the consultant system. The different causes of disputes with their relative frequency were also collected. The study also investigates construction claims since they represent a major source for disputes.

A deep investigation clearly shows that about 34 causes were identified for construction disputes. These causes may greatly vary to cover a wide variety of areas. Among these areas are owner responsibility, contract problems, scheduling problems, site problems, and financial problems. Such causes represent the backbone of the proposed expert system. The user of this system can have a complete tabulation for these causes .

2.3 Claims as A Source for Disputes

This section lends a great emphasis to claims since they represent a major source for disputes. So, the collected claims data were organized to show some useful relations that can be considered as a useful step in reducing

construction disputes. The results of such organization are show in Figure (1) to Figure (6). Such figures relates the occurrence of construction claims to owner type, project type, contract type, and PDS. The percentage of disputable claims were also identified. A careful review to these figures clearly show some interesting findings:

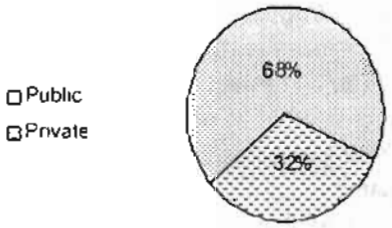

Fig .(1) Owner Type versus Claims Value.

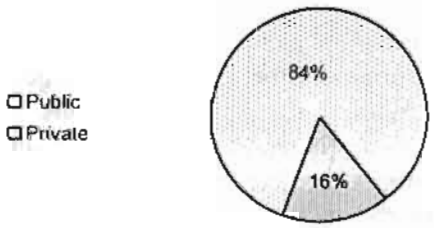

Fig .(2) Contractor Type versus Claims Value.

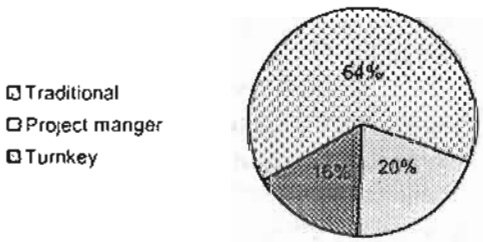

Fig (3) PDS Versus Claims Value.

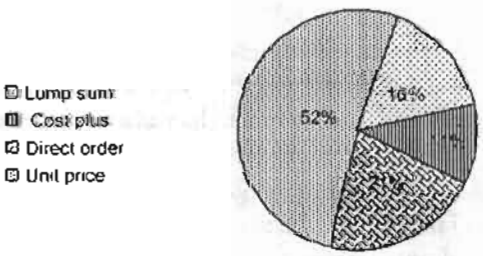

Fig. (4) Contract Types versus Claims Value.

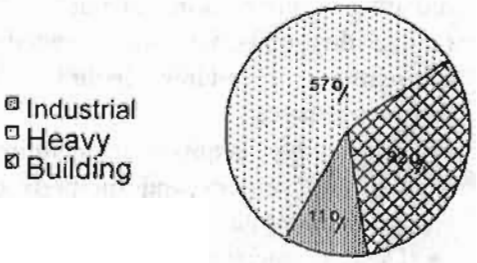

Fig. (5) Project Types versus Claims Value.

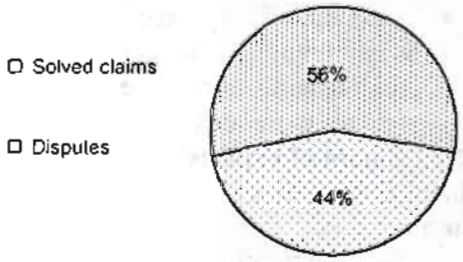

Fig. (6) Disputes Versus Claims Value.

- There is a consistent relationship between the size of claim settlements and contract size. Claims on small projects averaged less than claims on large projects.
- Public owner sector is more claims than private sector.
- Public contractors are heavy claims than private.
- Traditional system as a project delivery system is more claims than other types.
- Unit price contract is more claims than other types.
- Heavy construction can be more claims compared with other types of projects.
- Construction claims can be reached as a disputes in 56% of all cases.
- Disputes act as 3.5% averaged from contract sizes.

2.4 Disputes Indicators

The last section of this stage was devoted to shed a great deal of

light on the main parameters that can represent a suitable environment for growing construction disputes. The relationship of these parameters with the previously defined causes of disputes will materially help to provide red flags regarding the potential causes of construction disputes. Such relation can be considered as a suitable tool to identify those projects that can be classified as a dispute prone projects. A primary list of these parameters are prepared based on Diekmann work (4).

(Diekmann,95) classify these parameters into three main categories: people factors, project factors and process factors. People factors generally include capability of management,organization's experience, individual motivation, owner type, contractor type and project delivery system, while the main parameters of project factors include environmental issues, site limitations, design complexity, construction complexity and contract type. Finally, process factors covers certain items such as financial planning, scope definition, risk identification, and adequacy of technical plans.

Having identified the main causes of construction disputes and the main parameters that can lead to stimulate the occurrence of these causes, a final questionnaire was formulate to collect data that can help to derive the relationship between the causes of disputes and the stimulated parameters.

3. SYSTEM DEVELOPMENT

3.1 Introduction

In this section, phases of the development of the knowledge based system for representing construction disputes will be illustrated (the current version of the system will be referred as "Expert System for Construction Disputes [EXSCD]"). The overall architecture of EXSCD will be presented. The detailed structure of each construction disputes phase will be briefed including: people factors, project factors, and process factors. Samples of classes and rules will be briefed. On the other hand, the procedures of evaluation and the results of the validation process of the proposed EXSCD system will be discussed.

EXSCD is developed for all types of construction projects in Egypt (building, engineering, and industrial) but more emphasize is exerted to building construction projects. This is mainly attributed to their predominate nature in the Egyptian construction industry. In addition to their repetitive nature that makes programming their concepts and procedures into computerized system an easier task.

System can predict the expected causes of construction disputes for the user's project depending on user's project information. It can describe every item for every question that asked to the user. The user of the system has the ability to show all items that affect every construction dispute. Also, the system can save user's project information, user inputs (user's answers), and systems output (construction disputes). Then, the user can retrieve the saved data and he can update the data and rerun the system to show the new construction disputes.

3.2Architecture of the Expert System

As the problem of defining the construction disputes is well defined, and the knowledge is available in the form of recommendations, the rule-based knowledge representation technique (Visual Rule Studio's production Rule System) was selected to implement the proposed prototype expert system. The Architecture of Visual Rule Studio's production rule system is comprised of five primary components:

1. Data: The facts and values of the knowledge problem.
2. Rules: The IF Condition Then Action representation of the knowledge.
3. Inference Engine: The underlying executor that matches data and rules. The forward chaining is used as a main inference strategy for EXSCD.
4. Knowledge Representation Language: The representation grammar of data and rules.
5. Knowledge Component Objects: The packaging of rules and data into a component reusable entity for use by an application. A Visual Rule Studio package of data, rules, and inference engine is called a RuleSet Figure (7).

This system uses an integration of many computer soft wares like: Visual Basic, Microsoft Access, and Visual Rule Studio. The Windows environment involves Visual Basic Environment, Microsoft Access Database, and Visual Rule Studio. Figure (7) represents the architecture of the knowledge-based showing the relationship of system components with the different elements of the system development environment.

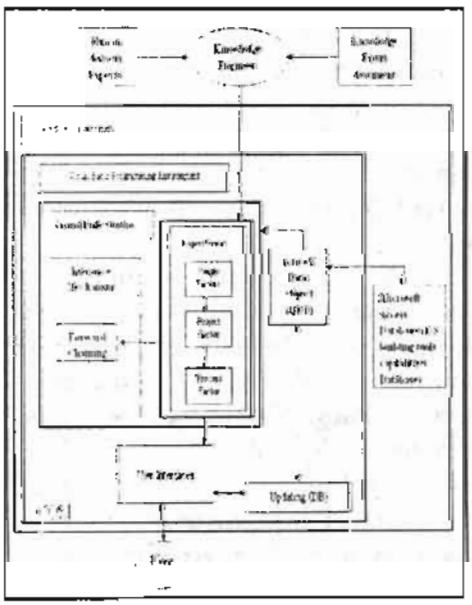

Fig. (7): Architecture of the knowledge-based system.

4. SYSTEM OPERATION

The proposed system was carefully designed to be easily operated. In other words, it has a friendly operating environment. Such operating environment includes a number of menu screens that works easily in a serial order. To get the proposed system, EXSCD, started the following steps should be followed:

1. Install the program.
2. Select EXSCD from programs from start menu > Programs.
3. The first screen will appear as shown in Figure (8). The user of this screen has three options.

The first option provides some information regarding system designers. On the other side, the second option provides the user with a brief definition for the EXSCD system. Finally, selecting the third option will permit the user to get the system started.

Selecting the third options, the user will be asked to enter some information regarding the construction project under discussion. Figure (9) shows the main elements of the project information required, such information include project code, owner, consultant, main contractor, tender price and finally, expected duration which stored in the database.

Having entered data regarding project information, the user will be directly asked to enter data regarding the different parameters that can be considered as disputes indicators. It has been previously indicated that these parameters were classified into three main categories; people factors, project factors, and process factors. Each of these categories include many sub-items. For instance, people factors include capable management, experience with type of project, owner type, etc.....

Each of the three main categories has a main screen that will be followed by a series of subsequent screens. For instance, Figure (10) is the main screen that list the different people factors. Selecting a single item within people factors will lead to another detailed screen. To elaborate more, selecting the first item in people factors screen that concerns the management capabilities will lead to another screen, Figure (11). This screen is divided into two main parts. The right hand side of this screen provide some information that can help the user to enter the required data. The lift hand side asked the user to answer some questions regarding the data item under discussion. This is shown in the form of "Yes" or "No" question. To summarize, the main data items regarding people factors will be entered through a number of menu screens. Such screens work in a serial order. Finally, the last screen will summarize the answers of the people factors questions.

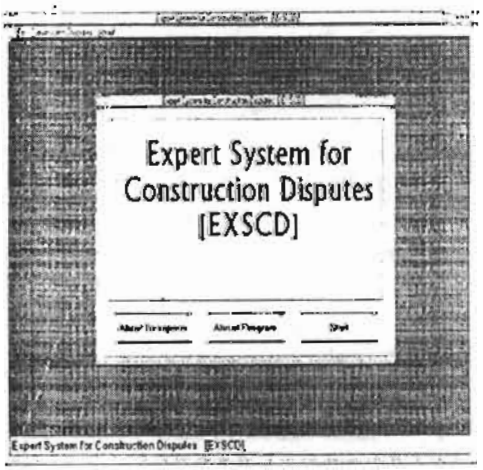

Fig. (8) Program First Screen.

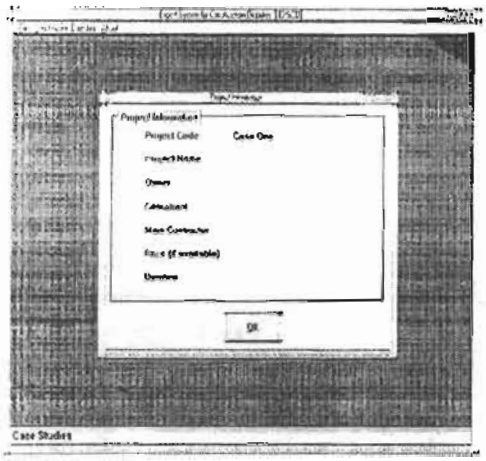

Fig. (9) Project Information.

Fig. (10) People Factors Elements.

Fig. (11) "Capable Management" People Factors.

The same is also true for both project factors and process factors. Data regarding those two items can be easily entered through a group of screens worked in a serial order, Figure (12) and Figure(13).

Fig. (12) Project Factors Elements.

Fig. (13) Process Factors Elements.

Having identified the main factors that can be considered as dispute indicators. Now, it's the stage of data processing. Through this stage, the system can use the rules that have been previously fed to relate the main dispute indicators to the different causes of the construction disputes, using a forward chain process. Consequently, the expected causes of construction disputes can be clearly identified. Such causes represent the main output of the proposed system.

A graphical plot for a sample of these outputs is shown in Figure (14).

Fig. (14) Expected Causes Of Construction Disputes.

5. SYSTEM VALIDATION

Heretofore, the main features of the proposed system were deeply investigated. The operating environment of the system was also discussed. The next section will be slanted to shed a great deal of light on the system validation. The objective of this section is to check the validity of the expert system. Validation can be defined as the process of making sure that the system operate as desired. Stated differently, it is the process of making sure that the system has a proper level of reality.

Five construction projects were selected as a test-bed for the proposed system. After providing some general data regarding the first case study such as project type, owner, and contractor. The main inputs are concerned with the three main factors that have been identified as disputes indicators; people factors, project factors, and

process factors. The results of the first case study application is shown in table (1). The table shows a comparison between the expected causes of disputes and the actual disputes occurs during the project construction. This can give clear picture regarding the validity of the proposed system.

A review of Table(1) clearly shows that five causes, were identified as expected causes for construction disputes. On the other side, four causes were observed as actual causes for these disputes. One can also see that three of the actual causes of disputes were identified by the proposed system. This may be considered as a good indicator regarding the validity of the proposed system. For instance, a good agreement was observed between the suggested and the actual causes of disputes. To elaborate more three of the four actual causes were suggested by the proposed system, about 75%.

Table (1) Case One Outputs.

Expected causes of disputes	Actual causes of disputes
1. Government Regulations. 2. Accidents. Disasters. Unforeseeable Physical Conditions. 3. Work In Congested Areas And Over Crowding. 4. Delayed Possession Of Site. 5. Delays Caused By Authorities.	1. Work In Congested Areas And Over Crowding. 2. Delayed Possession Of Site. 3. Delays Caused By Authorities. 4. Delay In Payment By Owner.

Table (2) summarizes the results of the five case study applications. The table shows a comparison between the number of expected causes of disputes and the actual causes of disputes. The table also shows the percentage of the actual causes of disputes that were listed in those causes predicted by the proposed system. For instance, the first case study has four causes for the actual disputes that have been observed during project construction. Three of the four causes were successfully predicted by the proposed system. This may be considered as a good indicator for the system validation. The same is also true for the other four cases that has a degree of accuracy ranged from 80% to 100%. So, the average percentage of the overall system validation about 83.6%. Finally, it is safe to say that the system can describe the real situation of the construction disputes in Egypt at an appropriate level of confidence.

Table (2) Summary of Results.

Case No.	Number of expected causes	Actual dispute causes	Actual dispute causes predicted	Degree of accuracy
One	5	4	3	75%
Two	6	6	5	83%
Three	5	5	4	80%
Four	4	5	4	80%
Five	2	2	2	100%

6. CONCLUSION

This study has attempt to shed a great deal of light on the problem of construction disputes in the Egyptian construction projects. First, the main causes of construction disputes were clearly identified through direct interviews with many experts. Investigation of the available disputes documents in some construction projects were also considered. Next, based on a careful analysis of the collected data, the main features that can be considered as dispute indicators were also identified. Such indicators were categorized into project factors, people factors and process factors. Finally, an expert system has been developed to compile past experience

regarding construction disputes in Egypt. The output of the proposed expert system is a reliable prediction for the expected causes of disputes for any construction project. The process of the system operating environment was also investigated. Finally, the validity of the proposed expert system was evaluated using five case study applications.

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