Designing an Expert System for Internet Connection Problems Troubleshooting for wired network users

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ABSTRACT

Man, as we know today, is living in an era that one of it's obvious factors is vast amounts of data, information and knowledge on the one hand, and the rate of growth in science and technology on the other, in a way that the knowledge of man is estimated to be doubled in a relatively short time.

The fast rate of technology's growth in the rightly called century as: "Century of information", is caused by fast growth of communication technologies like the internet which has become one of the best tools for a quick, cheap, effective and vastly supported communication.

For an efficient and effective usage of tools and different advantages of the internet, its users are to be able to stay connected to it in an efficient way and have less losses of connection.

In order to reduce the time and duration of unwanted losses of connection, it is needed to act on diagnosing and fixing the ongoing problem(s) as fast as possible. Since today's telecommunication and computer communication have become full of varieties and complications, designing and running a system that can help the network professionals or the users in case of such problems taking place, is much appreciated or even necessary. According to the abilities the expert systems have, especially the rule-based ones, one of the best solutions for this matter, is to run an expert system in order to fix internet communication problems that is done by a full-time resident human expert.

This research is designed and defined as a pattern for the complex structures of large ethernet networks e.g. network of governmental organizations, big companies, data-centers and examples like these.

Keywords

Expert system, Internet, Rule-based, Connection troubleshooting, wired-network.

1- Introduction

The age of network communication based on information technologies is limited to the past few decades in the world and the age of such technologies in our country is barely three decades: but even though, it's difference with the technologies in the age of industry, is in its changing speed and flexibility. (Jowkar , 2011)

Today's man lives in an era that of its obvious characteristics, is its science and technologies growth speed: in a way that the amount of knowledge of mankind is estimated to be doubled in a short time. A noticeable percentage of it, is due to the growth of communication and connections of two or more people or organization with each other.

The fast rate of technology's growth in the rightly called "Century of information" to the century we live, is caused by fast growth of communication technologies like the internet which has become one of the best tools for a quick, cheap, effective and vastly supported communication and since, when the dependency of each person or organization to any tool (weather technical or non-technical) becomes more and more, the necessity of accessibility of it become more, for optimum and effectively usage of this phenomena, it is needed for its users to be connected permanently and effectively; and have not only a proper speed and access, but also have less connection problems.

To minimize the duration and frequency of unwanted connection problems, we have to be able to apply in order to identify and troubleshoot caused faults / defects as soon as possible, but because of the diversity and complexity of today's telecommunication and computer systems, designing and setting up a computer system that could fix problems faster and more accurately, and to assist the administrators or users to assist in case of such problems is not only highly desirable, but necessary.

Due to the features of expert systems, especially the rule-based types, it seems that the best option for this, is setting up a rule based expert system in order to troubleshoot Internet

connection problems as a full-time resident human Expert beside a network user, to handle the case.

The goal of this thesis is to answer the following questions: how can we store the knowledge of fixing network problems for future use? How can we add new problem's solutions to it? and how said knowledge can be restored in the future?

Since one of the most important words in this thesis is "Expert System", it is described in the following paragraph:

Expert Systems are computer programs designed with the goal of easing the accessibility of professionals' skills for the un-professionals. These programs intend to simulate the way of thinking and action of a human for further closeness of the Expert System to the professional's actions and responses. Different tools and concepts are used in more realistic simulations. (Mohsen Taheri, 2010)

The main field of studying expert systems or knowledge-based systems thanks to another series of study, namely Artificial Intelligence. Ideas of artificial intelligence as a new field of study and research which flourished in the 1940s, coincided with the emergence of the first generation of computers in research centers.

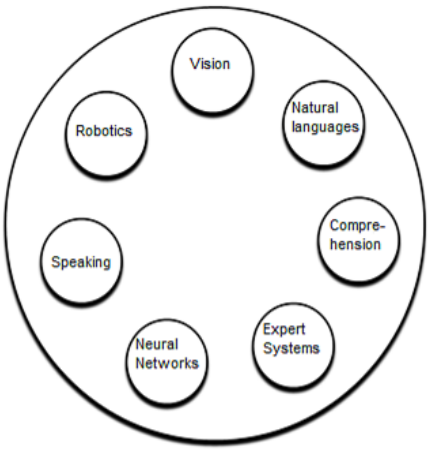
Because expert systems, are a subset of the category of machine / artificial intelligence, they are the first topic to be introduced briefly at first.

Basic principles of logic Machine (which was founded in Mathematics) were provided by Kurt Godel, Alonzo Church and Alan Turing efforts. (Darlington, 2000)

In 1950, Turing developed a machine which proved that a simple and normal processor can process signs as good as numbers (perfect and accurate), and apply them. He revealed this phenomenon for comparing the machine intelligence with human intelligence, which was used in a test called the Turing test. Despite the other works that have been done in this area until 1956, when for the first time, John McCarthy at a conference used the term "artificial intelligence", so-called artificial intelligence did not exist.

Artificial intelligence can be defined as: the study of how to make computers do things that people now do them correctly and well.

Artificial Intelligence is a broad field of application and has different domains, some of which are shown below.



Some fields of artificial intelligence [Ghazanfari and Kazemi, 2003]

One of the most major and noticeable applications of artificial intelligence is logic theory or theoretical science of Newell, Shaw and Simon which was introduced in 1963. This program was able to prove 38 cases of 52 Whitehead-Russell cases (1913) in basic mathematics.

2-1- Genesis of KBS (or knowledge-based systems)

Although artificial intelligence applications seemed to success in solving common problems, but because firstly: searching of problem(s) spaces became too big (so-called combinatorial explosion), and secondly, to express and display the daily problems of life became incredibly hard, it gradually passed the general strategy to focus on specific knowledge and build programs that were less public.

For example, in the diagnosis of infectious diseases or locate mineral deposits in different geographic areas of the world and determining the chemical structure of unknown particles, great successes were reached. Because these systems were used to solve problems that required the services of a human expert, they were known as expert systems. Also, because these systems have knowledge of specific domains, are also called knowledge-based systems.

Experimental Expert systems (based on research) are in Table 2-1

Table 2-1- Some experimental expert systems [Darlington, 2000]

Name	Origin	Year	Working Domain
DENDRAL	Stanford University of America	1965	Discovers the molecular structures on components.
MACSYMA	Hit-America	1968	An extensive program attractive to different types of mathematical problems to solve and take calculus.
PROSPECTOR	Stanford Research Association	1974	Geologists in mineral exploration helps. It can also result in important areas geologists predict.
MYCIN	Stanford University of America	1976	A medical record system to help doctors choose Anti-Biotics for advanced and severe infections.
XCON	DEC	1980	Has usage At the Dec Vax mainframes.

2-1-1- The emergence of commercial Expert systems

Since the early of the 1980s, researchers began to convert their commercial laboratory systems. XCON system (McDermott - 1982) was among the firsts of these systems in the early 1980s, made by DEC.

The system is able to save the large sums of the capital of a company, you can calculate the return on investment and profits in the short term, is an example of a successful Expert system.

Successfully of XCON was the beginning of a business development for expert systems. In the late 1980s, large and small companies provided expert system capabilities, and were climbed.

In 1982, Japanese launched the massive and ten-year-old project of the fifth generation. A huge project with the aim of developing the fifth generation computer systems; computers that were designed and built based on artificial intelligence and parallel processing. The massive project includes topics such as intelligent software environments, parallel processing, hardware and other issues. The United States of America by running developed research projects (in Advanced Research Projects Agency-ARPA), paid a lot of attention to invest in two major programs of AI. These events triggered the commercial interests by using of artificial intelligence and expert systems at that time.

Lighthill from England, condemned artificial intelligence as a hobby and concluded that more artificial intelligence applications are so various that computers will be reduced to a combinatorial explosion.

The impact of the report in late 1970s was that the supports of artificial intelligence researches in the UK was actually ended.

Revitalize of the artificial intelligence in UK was because of the great benefits won in the fifth generation computer systems project.

From 1984, Japanese began a 5-year-long project in England which recommend a massive investment in the field of intelligence knowledge-based systems (IKBS). Japanese had chosen intelligence knowledge-based systems in order to avoid bad publicity in the report of Lighthill. The project was a collaboration between the sectors of trade and industry on the United Kingdom (DTI) and on the other hand the British universities on the one hand.

To obtain the capital required for the project as an industry - academia joint was introduced and for this reason, could receive 350 million pounds from the Department of Trade and Industry and several English companies.

More than 200 leading projects were presented from the heart of the main project that seemed at least half of them were successful in their work. Aires project that could demonstrate the final assessment of damage level of insurance companies was an examples of such systems. Another system was in medical and public health field called DHSS that Bramer had done in 1986.

Economic integration in 1980s, which occurred in Europe, paved the way for the leading European IT projects. Most highlighted project of them was namely ESPRIT (European Strategy Program for Research in Information Technology) which artificial intelligence and knowledge-based systems, were the regarding issues and subjects from them.

2-2-4- Artificial Intelligence in the XXI century

One of the most interesting projects within the artificial intelligence projects, was launched in 1984 by Lenat & Guha. CYC is obtained from the word Encyclopedia. CYC project was to supply a large amount of real knowledge. This project is one of the most ambitious projects undertaken in the field of artificial intelligence.

Table 2-2 shows a range of some of very successful advanced business systems that had been used since 1990. (Darlington, 2000).

Table 2-2- Development of Expert Systems since 1990. (Darlington, 2000)

Name	Developer	Year of completion	Description
GPSS	NASA, USA	1993	Expert a schedule that cycle operation between the two spacecraft flying shuttle, the timing.
NSSP	Nippon Steel, Japan	1992	Designing an expert system that is used for customer needs and acts on the basis of the argument.
FRAUDWATCH	Touche Ross, UK	1992	View Expert system to detect fraud by Barclays Bank identity cards are used.
DART	DARPA, USA	1990	Expert system that is used for logic programming.
LINKMAN	Blue Circle pic, UK	1991	Expert process control system to control energy used in production.

2-3- Expert Systems

Because of high costs of the services of human expert, and the services of specialist doctors and lawyers are not cheap, as a result, expert systems from 1980s onwards, have had a significant impact on today's human life.

An Expert System is a computer and intelligent program which is trying to imitate from a skilled person in the use of inference methods (for a certain form of knowledge which is called domain) and by using of knowledge, facts and reasoning methods, solve the problems that need the ability of a human expert.

An expert system, uses the rules about the data in a way that a human expert does, because a professional human uses heuristically achieved rules in order to determine and troubleshoot the problems and defects.

2-3-1- heuristic (mental discoveries)

Expert systems have been considered as a branch of artificial intelligence, because problem solving methods in them are mainly based on mental discoveries (heuristic), namely the same ways that people use them to solve problems. Heuristic, solves a problem by trial and error method, by relying on a number of resources for a pre-determined purpose. (Heuristic refers to the experience-based methods to solve problems, learn, and explore to find a solution that is not necessarily the best, but good enough for a given set of objectives.) There may be more than a solution for a problem in an artificial intelligence problem.

The main components of the expert system are: interface or user interface, knowledge base and the inference engine.

2-4- Using rules in presentation of knowledge

Because of processing of knowledge, expert systems and common applications are different. The knowledge is displayed on a computer in the form of rules. The rules that contain Heuristic methods of a human expert. (Darlington, 2000)

2-4-1- Inference

The real art of an expert system is using its capacity to infer, and this is exactly what makes an expert system intelligent. In rule based expert systems, the inference engine defines that which rule's if clause

has been satisfied by the existing facts, and two major methods of inference, namely leading inference and backward inference, are used in expert systems as problem solving strategies.

According to the system designing type, inference engine may infer using leading or backward method.

Choosing inference engine depends on the type of problem. (the same resource)

2-5- Inference engine

Inference engine is a program that interprets the rules in knowledge base, in order to obtain the results.

2-6- Expert system creating tools

The programs that are called expert system shell (such as VP-Expert), are often used to make use of expert systems. These shells are expert systems that (only) there aren't rules in them, so developers only focus on the structure of the knowledge base and are not concerned about the other parts such as the inference engine.

2-6-1- User interface

The user interface of an expert system should be equipped with high exchange power so that the structure of the exchange of information, take place in the form of the dialogue between an applicant and a human expert.

2-7- The ability to learn

Another feature that distinguishes the expert systems from other systems, is their capacity to learn.

2-8- Research history

Here's where a few domestic and foreign written literature on expert systems troubleshooting or topics close to it, are pointed out:

- In 2012, an expert system to detect radar system faults in Tehran flight control center was designed to help to show in-time the imperfections of the system to prevent irreparable consequences.
- In this area and in other research, a rule based expert system, designed for advice on troubleshooting electronic circuits of missile sites.
- In the fields of medicine, veterinary and computer science, industry, banking, trade, and etc. expert systems have been designed and implemented.
- In 2010 in the field of geology in general, and exploration of hydrocarbon reservoirs in particular, a theses was developed because of the complexity of the issues and high costs caused by errors in the exploration of reservoirs, the purpose of using a computer system, such as an expert system that is capable of being integrated knowledge, while increasing efficiency, making accurate and fast results to save money and reduce the risk of an expert system to be used.
- Also two thesis, were developed by Abbas Toloei Ashlaghi as thesis advisor, and Alireza Poorebrahimi as consulting advisor; one entitled as: "To design an expert system for diagnosis and treatment of leukemia", by Soodeh Mohsen Taheri , and another entitled as: "Development of expert system for troubleshooting local area network" by; Roozbeh Shabani were developed.
- Among the most important projects that have been carried out abroad in the field of expert systems can include:
- DANTES, is an expert system designed to help troubleshooting of large local computer networks and help to the experts and operators of these networks in real-time, to be used as the supporter, in the maintenance and daily operations of large and complex today networks. [1]
- In 2010 a thesis was written in order to develop an expert system in such a way that even non-experts in the field of LAN networks would be able to use it in troubleshooting of LANs. Package produced by this project, can be installed / run on troubled network devices to find, demonstrate and resolve the problems. [3]
- In 2009, Wireshark company wrote an expert system for troubleshooting slow networks using an application namely Wireshark in order to find the network problems such as: Packet loss and the place of it, weak performance, delay source in network paths and solving or decreasing of it. [7]

3- Research Methodology

Obtaining of scientific achievements would not be possible, except when done with the right methodology. Due to this, in this part of the research, the expert system and the model will be introduced.

The aim of this study in terms of object is applying, because the aim of this study is to establish a functional system in order to achieve the benefits of expert system to eliminate communication errors and reducing the connection problems with Internet network, by software designing method.

The research data collection methods (study design) of the present study (non-test) survey, and the case is set in the field, through interviews and surveys, action.

Also, The study, in terms of data collection methods (study design), is a type of descriptive research (non-practical), and is from the case study set, which is done through interviews and surveys.

While the library information by reading articles, journals, theses, books, internet and prestigious publications have also been associated with the subject.

This study is a kind of model making, because at the beginning it proceeds to model making of troubleshooting system and then to provide a system of connection troubleshooting expert system in Our referent organization.

3-1- Data gathering method

The researcher must collect necessary data from the statistical population with using tools, and by analyzing, processing and transforming them into information, do test the hypotheses.

Interviews with users of the system, including managers, experts and other employees who are connected to the network via a wired connection.

Library resources (review of documents, books, articles, magazines, supervision and the use of Internet resources).

3-2- Implementation steps

Implementation of the survey include:

1) Data gathering from human expert using interview as a tool.
2) Making rules in the form of "If... Then..." And putting them in the knowledge base.
3) Use the inference engine to establish link between the rules and determining the priority of rules conditions satisfaction, by one of the existing softwares ready to do that.

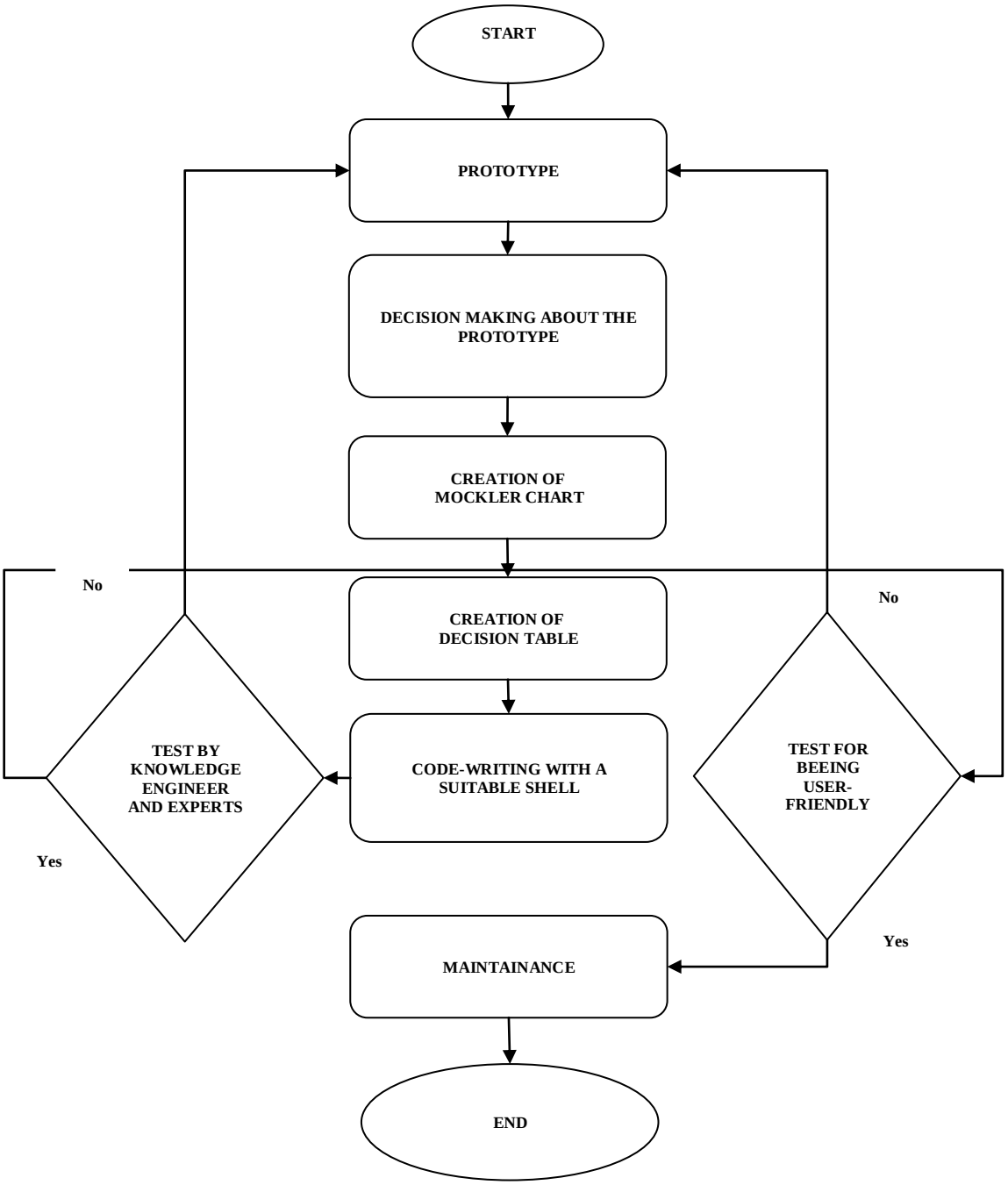


Figure 3-1- Main functioning concept of an Expert System [Elahi, 2003]

3-5- Conceptual model of the research

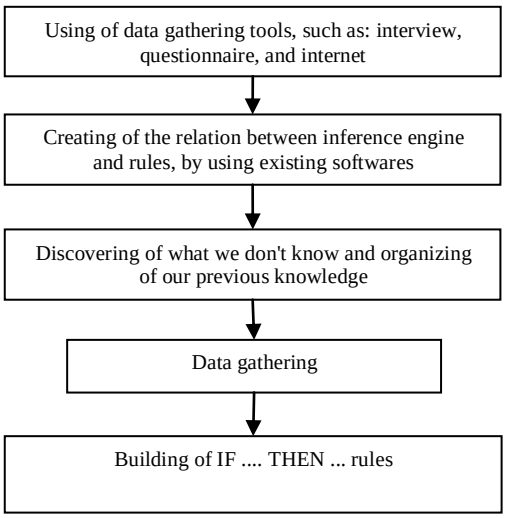


Figure 3-2- Conceptual model of the research [Ghazanfari, 2008]

As mentioned before, the method of information gathering in this research, is in the form of field and also librarian, because: when the knowledge base is written, we need to the knowledge of experts (field method), and when the expert system is going to be designed and developed, we need the librarian information that has been created before. Many internet articles were used for gathering information as well.

3-7- Expert system model

As a definition, an expert system is a computer program, and is designed in such a way that models the ability of an expert individual in solving problems, and has two parts:
- Knowledge of the expert individual.
and
- inference,
So two corresponding modules would be seen:
- Knowledge base
and
- inference engine

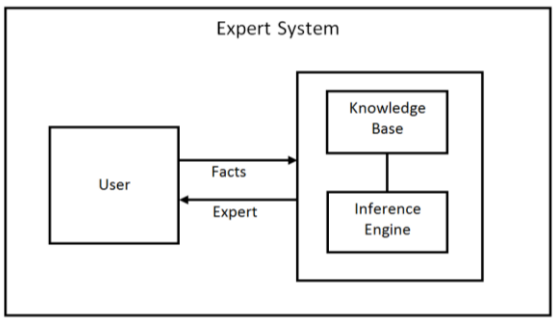


Figure 3-4- Main functionality concept of an Expert System [Elahi, 2003]

3-9-1-3- Creating of Mockler chart

Block diagram is a useful method for describing and discussion about the relations between subjects and object, but it is not enough for building an Expert System, because it has not the details; a mockler chart or relation chart is suitable for this job.

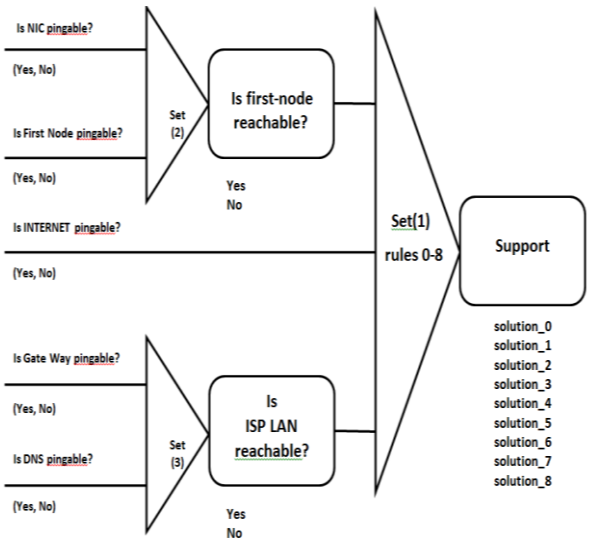


Figure 3-5- Complete mockler chart for connectivity part of the connection of the internet network

3-9-1-4- Decision making table

The final step before creation of rules in the knowledge base, is making decision making table. A separate decision making table is needed for each factor of the Mockler chart. For making of this table, we should start from the main decision and continue in a reverse format from up to down. Each decision making table creates a rules-set and each rules-set should get numbered and written in a specific triangle in Mockler chart (figure 3-5).

Row	Is NIC pingable?	Is GW pingable?	Is INTERNET pingable?	Is DNS pingable?	Are other Services Accessible?	Summary description of rule result and the expert system output	Rules
1	y	y	y	y	y	There isn't any connection problem	Rule 1
2	y	y	y	y	n	Ports and protocols must be investigated, but there is no connection problem	Rule 2
3	y	y	y	n	y	DNS Server doesn't answer to ping, but there is no connection problem	Rule 3
4	y	y	y	n	n	At 1st DNS, and then network services and protocols should be checked	Rule 4
5	y	n	y	y	y	Although the GW cannot be pinged, but there is no communication problem	Rule 5
6	y	n	y	y	n	Ports and protocols must be investigated	Rule 6
7	y	n	y	n	y	There is no communication problem, but GW and DNS do not respond to ping	Rule 7
8	y	n	y	n	n	At 1st DNS, and then network services and protocols should be checked	Rule 8
9	y	y	n	y	y	Internet doesn't respond to ping, but there isn't (really) any connection problem	Rule 9
10	y	y	n	y	n	Internet is disconnected	Rule 10
11	y	y	n	n	y	Internet services hold but DNS and Internet doesn't ping	Rule 11
12	y	y	n	n	n	Internet and LAN are disconnected from Gateway to upward	Rule 12
13	y	n	n	y	y	Internet is connected, but icmp port of the Gateway is closed	Rule 13
14	y	n	n	y	n	Internet is disconnected, and icmp port of the Gateway is closed	Rule 14
15	y	n	n	n	y	Internet services hold, but the icmp port for DNS, GW and Internet are closed	Rule 15
16	y	n	n	n	n	Internet and LAN are disconnected	Rule 16

3-9-1-5- Writing of rules for VP-Expert knowledge base

After purifying the primary decision making table and creating of final decision making table (table 3-1), we can write our primary sample rules. Most of the rule-based expert system shells (including VP-Expert), show the knowledge by using "IF . . . . THEN . . . . "rules, which means that a rule starts with an IF keyword and evaluated with several conditions. The conditions could be combined to each other by and/or logical operators.

3-10- Building Expert Systems

This section describes the most important steps in building an expert system. Most of the time it is not possible to design the whole system at the first time and then just implement the design. Instead, it is needed to build a prototype, then use this prototype to get more knowledge from the human experts and re-implement the prototype. This process should be repeated until there is a final system that is able to do what the users are expecting it to do.

- **Knowledge Engineering**

One major part is the Knowledge Engineering. Usually there are human experts who know much about their specific domain, and application developers who have a lot of knowledge in programming but don't know much about the domain where the expert system is used in the future. In the process of Knowledge Engineering both groups are involved and try to find an efficient way to encode the human experts knowledge in the expert system.

- **Assessment**

During the assessment phase, studies are made to determine the feasibility and justification of the candidate problem. After this process, the overall goals of the project have to be defined. These goals together with the information gathered by the process of Knowledge Engineering are then used to identify the sources of needed knowledge.

- **Knowledge Acquisition**

Knowledge Acquisition is the process of acquiring, organizing, and studying the knowledge from human experts. In the early stage of expert system development, the objective of this step is to uncover key concepts and general problem-solving methods used by the expert. In a later stage, the results of the tests are used to explore for more detailed information. Knowledge Acquisition hast long been recognized as the bottleneck in expert system development.

- **Design**

After the knowledge acquisition, the design phase is used to define the structure and overall organization of the system's knowledge. Methods for processing the knowledge are defined and the appropriate software tool will be chose. After this step, an initial prototype system is built, which serves as the focal point for further interviews with the human experts. As mentioned above, this task is repeated several times until a final design is reached.

- **Test**

The Testing phase is not a separate task; it is rather a continuous process throughout the whole project. After every step in building the expert system, it is tested and new knowledge is added to it. These tests should not only be done by the programmers, but also by the end-users, because it is very important that the end-users be able to use the system and that the system be well adapted to the user's needs.

- **Documentation**

The Documentation addresses the need to compile all of the project's information into a document. The Documentation must also support the knowledge engineer activities during the development of the system. It should also contain a knowledge dictionary that provides a well organized representation of the system's knowledge and the included problem solving procedures.

- **Maintenance**

Because of the highly iterative process in developing an expert system, it is also important to periodically maintain the system. The system's knowledge may need to be refined or updated to adapt the system to the actual circumstances. (Strittmatter, 2003)

4- Data analyzing and representation of the results of research

In this section, written rules which were presented in 3rd chapter, upon decision making table and Mockler chart, will be expressed and executed, and after primary executing of the rules by VP-Expert shell, exactness of them will be tested and probable needed improvements will be done.

4-1- Why VP-Expert?

Programming in expert systems is mainly done by famous shells as: VP-Expert and CLIPS.

In this research, because programming in VP shell, compared to CLIPS, doesn't need the definition of inference engine and also has a better graphic media, has been chosen. The biggest problem of users in programming medium, is the execution of that program without any errors. In this research, we want to help the user to reach the complete execution of the program with the least possible commands in this medium.

4-2- Knowledge Base

Each knowledge base is consisted of three main parts as a whole:

1) Actions
2) Rules
3) Statements

4-3- Decision table

The final stage before generating the rules in knowledge base, is building a decision table. For each factor in Mockler chart, a separate decision table is needed. Each decision making table generates a rules-set and each rules-set should be numbered.

4-4- Coding with a suitable shell

There are suitable expert system shells such as: VP, CLIPS and JESS. In this research, as mentioned before, because VP-Expert doesn't need the definition of inference engine, it has been used.

4-5- Test of software by knowledge engineer and human experts

In this stage, the generated software will be assessed by knowledge engineer and human expert. The content of the software was agreed by experts and the software executed the coded commands correctly as well.

4-6- Maintenance

In this stage, the existing knowledge in knowledge base is improved and updated according to the future needs of the system; for doing this manner, knowledge engineer enters the new knowledge into knowledge base with the help of human experts. New ideas could be mentioned if they are effective on the efficiency of the system.

4-7- Evaluating of the knowledge acquisition tools

In order to evaluate the written program, the generated expert system was presented to human experts of this domain

and they agreed the value of created expert system after studying it. (It should be regaeded that in this discussion, the terms "Packet loss" and "Slow traffic" are not mentioned.)

4-8- Model executing

In designed expert system which is mentioned, after getting the answer of the questions from each user, they will be compared with the rules written in knowledge base and on the basis of that, the result is announced to him/her. For definition of efficiency rate and being assure of rightness of written rules in knowledge base, output of rules numbered 0 and 10 will be written down and will be investigated in advance.

```
ACTIONS
DISPLAY "Welcome to My Expert System (EMH 2.0)"
FIND Trouble
DISPLAY "I propose {Trouble} for your condition."
DISPLAY "Please press any key to continue.~";
RULE solution0
IF  solution = Rule#0
THEN Trouble =
You_should_first_solve_your_NIC_problem;
RULE solution10
IF  solution = Rule#10
THEN Trouble = 10th_Rule;
RULE Rule#0
IF  Is_NIC_pingable = no
THEN solution = Rule#0;
RULE Rule#10
IF  Is_NIC_pingable = yes
AND Is_GW_pingable = yes
AND Is_Internet_pingable = no
AND Is_DNS_pingable = yes
AND Are_Other_services_accessible = no
THEN solution = Rule#10;
ASK Is_NIC_pingable: "Please check if NIC is pingable, and
enter it into the system.";
CHOICES Is_NIC_pingable: yes, no;
ASK Is_GW_pingable: "Please check if GateWay is
pingable, and enter it into the system.";
CHOICES Is_GW_pingable: yes, no;
ASK Is_Internet_pingable: "Please check if Internet is
pingable, and enter it into the system.";
CHOICES Is_Internet_pingable: yes, no;
ASK Is_DNS_pingable: "Please check if DNS is pingable,
and enter it into the system.";
CHOICES Is_DNS_pingable: yes, no;
ASK Are_Other_services_accessible: "Please check if Other
services Are accessible, and enter it into the system.";
CHOICES Are_Other_services_accessible: yes, no;
```

And the output of VP shell for the rules mentioned in the above are:

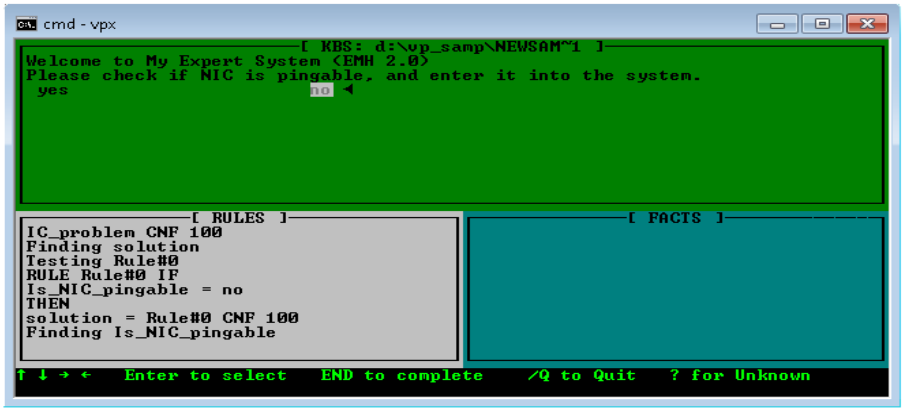


Figure 4-1- VP-Expert Shell Output

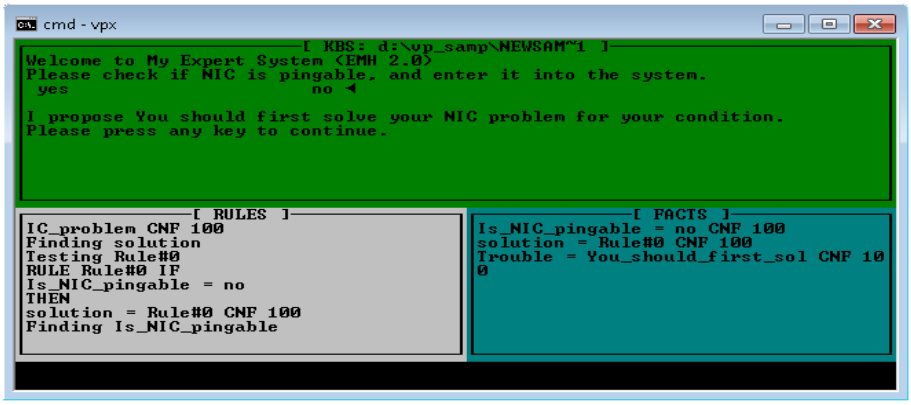


Figure 4-2- VP-Expert Shell Output

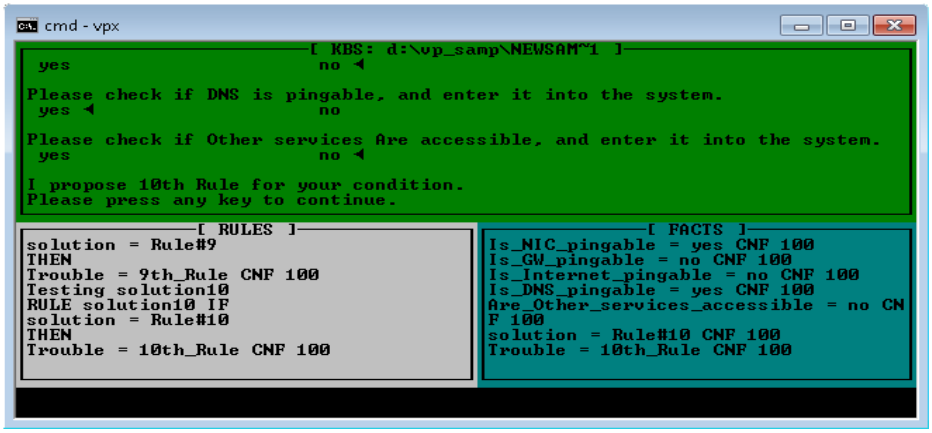


Figure 4-3- VP-Expert Shell Output

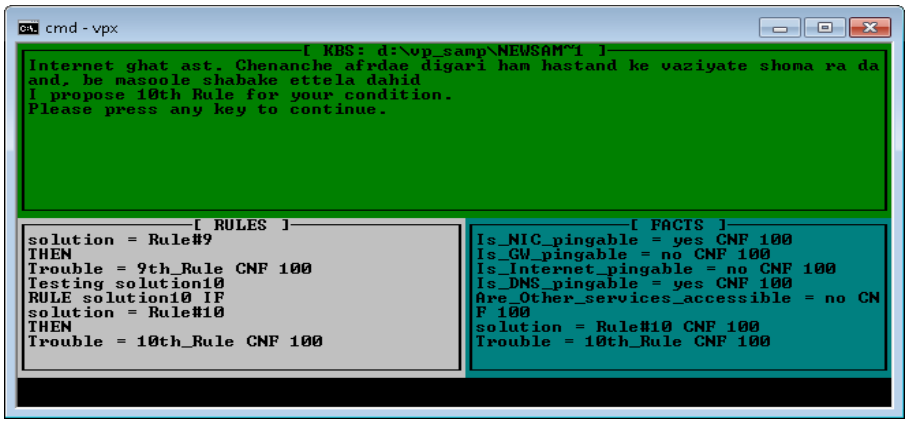


Figure 4-4- VP-Expert Shell Output

4-10- Analysis

According to the answer presented by VP shell, it turns out that the rules have been executed properly. Similarly, one can show that all the rules written in the knowledge base of system, operate properly.

4-11- Assessment

According to the non-statistical structure of this research, and relying of it on human experts, the validity of this research can be based on the opinions of human experts reflected in the documents found through interviews, internet and field (librarian) researches.

In this context, it is referred to the internet documentations and human expert opinions and after analyzing of the achieved results and presenting them to experts of this matter, the validity of documents and their compliance with subjected expert system of this thesis, was confirmed.

So without referring to the questionnaire or tests such as Cronbach's alpha test, which are provided based on the statistical information and use of softwares such as SPSS, we could make sure ourselves from the validity of the rules and operation of the system proposed in this thesis (at a high percent) by referring to human experts opinions in the different contexts on the one hand, and the experts involved in the field of Internet connections actively for many years on the other hand.

5- Conclusion

From designing of expert system for troubleshooting of the internet connection problems for wired networks users, we reached to this conclusion that: by using the knowledge of human experts in the field of network and Internet communication, and using a rule-based expert system shell, a computer system can be designed and implemented in order to help each internet user in case of their communication problems, whether they can help themselves to solve the problem quickly, or to fix it more quickly with the help of the network experts.

In response to this main question that: "How an expert system could be designed and implemented for the elimination of defects linked to the Internet for users who connect through the wired communication networks", and secondly questions like: "What are the main parts of such a system? and How do they work in organizations connected to internet?" we began a series of research on different systems for this purpose. According to the structure of our problem, in the first phase we found expert system as the best solution for this purpose and by choosing an appropriate shell for our research, we extended a rule based expert system so that in the end, with the help of human expert guides and rules

entered into the knowledge base of the system by them, we were able to categorize and systematize communication problems for each of these problems, and try to separate legislation. As a result, when the connection of users to the Internet fails, they can implement the selected shell of knowledge engineer (VP-Expert), and by answering its questions, determine the communication problem, and by The expert system guidelines as a substitute for the human expert advices, start to troubleshoot the problem or refer the items that exist in uppercase management domain to them in order to quickly track and fix the problem as a result.

The important result of this study is proving that: the combination of expert system and fixing network problems leads (opposite the uncommon procedures at the HelpDesk of local and Internet networks that because of existing emergencies, when you need to quickly solve existing commonly recurring problems), there is usually nothing to be documented, and also do not refer to previous documents;

Given that the Internet HelpDesk of companies and organizations were interacting with the business, commercial, political, cultural, social and other aspects of their partners for many years, were mainly to deal with the everyday and routine problems of their users, without documentation, identifying, classifying and reviewing of these problems, and seek solutions to them and saving and organizing the answers for later uses, the main consequence of this is that it is possible to lose some parts of the network troubleshooting knowledge by going each of these organizations HelpDesk experts out of reach.

So, it is recommended that In direction of gathering and organizing information related to fix the defects associated with the Internet in the country, define a project at the National Center of Cyberspace and approve it in the form of sufficient information on the various problems of the Internet users in the country it collects and organizes his face and finally, using a system similar to the expert system subjected of this thesis, simply can respond to the needs of many users of the network at the national level and solve their problems easily and quickly.

References

1. DANTES - An Expert System for Real-Time Network Troubleshooting. Mathonet, R., Van Catthem, H., Vanryckeghem, L. Available from: http://ijcai.org/Past%20Proceedings/ VOL1/PDF/105.pdf (Accessed 08 Aug 2014)
2. Investigation of a Web-based expert system shell. Peer Reviewed Article Vol.3(2) September 2001 Available from: www.sajim.co.za/ index.php/ SAJIM/ article/ viewFile/ 130/127 (Accessed 08 Aug 2014)
3. Network Troubleshooting Expert System. Marcel Strittmatter. Diploma Thesis DA-2003.21 Available from: ftp://ftp.tik.ee.ethz.ch/pub/students/2002-2003-Wi/DA-2003-21.pdf (Accessed 06 Sep 2014)
4. EXPERT SYSTEM FOR LOCAL AREA NETWORK TROUBLESHOOTING. ARINZE KINGSLEY, C. (2010) THE DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING, FACULTY OF ENGINEERING, NNAMDI AZIKIWE UNIVERSITY, AWKA Available from: naulibrary.org/dglibrary/admin/book_directory/Thesis/10179.pdf
5. Expert System Based Network Testing. Vlatko Lipovac (2011) Expert Systems for Human, Materials and Automation, Prof. PetricÄƒ Vizureanu (Ed.), ISBN: 978-953-307-334-7, InTech, Available from: http://www.intechopen.com/books/expert-systems-for-human-materials-and-automation/expert-system-based-network-testing
6. A Veterinary Diagnosis Expert System for Remote Use. Carse, S. J. (2013) (Thesis for the degree of Bachelor of Science) Rhodes University, Available from: http://www.cs.ru.ac.za/research/g12B4353/presentations/thesis.pdf, (Accessed 10 Aug 2014)
7. Troubleshooting Slow Networks with Wireshark. Chappell, L. (2009) Expert Reference Series of White Papers. GlobalKnowledge. Wireshark University and Chappell University. 2009 Global Knowledge Training LLC. Available from: http://www.packetech.com/attachment/WP_Chappell_WiresharkTroubleshooting.pdf, (Accessed 10 Aug 2014) Persian resources:
8. Jowkar, B. (2012). Preparation of information technology strategies in civil registration organization of Tehran province. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
9. Mohsen Taheri, S. (2010). Designing an expert system (ES) for diagnose and propose about the style of treatment in blood cancer. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
10. Darlington, K. (2000). The Essence of Expert Systems, Michigan: Prentice Hall
11. Ghazanfari M., Kazemi Z. (2003). The principle of expert systems, Tehran: Iran University of Science and Technology
12. McDermott J. (1982) R1: A rule-based configurer of computer systems. Artificial Intelligence 19:39-88.
13. Elahi, Sh., Rajabzadeh A. (2003) Expert Systems: Intelligent Counselor of Decision Making, Tehran: Commerce Printing and Publishing Company
14. Eftekhari, A., Akbaripoor, H., Amin Naseri, M. R. Development of expert system for troubleshooting of radar information automation network.
15. Pasandideh, Sh. (2010) Measurment of Information Technology level and presenting a model for its assessment. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
16. Ghasemi motlagh, N. (2009) The effect of implementing information technology on time saving and satisfaction of national iranian oil products distribution company employee in tehran region. M. A. thesis.
17. Shabani, R. (2009) Development of expert system for Local Area Network (LAN) troubleshooting. . M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
18. Esmizadeh, R. (2004) Preparation of Master IT Plan. . M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
19. Mehdilooy, A. (2011) Preparation of fuzzy expert system in order to measuring the credit risk factor of the customers in bank. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
20. Nazar Ali Kalhor, S. (2011) Diagnosis of Urine incontinent in women. Expert system approach. M. A.

thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
21. Akhavan Kharraziyan, M. (2010) Designing of an expert system for outsourcing research projects. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
22. Javani Dizaji, B. (2009-2010) Developing of an expert system for recognition of hydrocarbon reservoirs. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
23. Salmani Mojaveri, H. R. (2009-2010) Designing and developing of an expert system in order to strategy preparation in national iranian oil company. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
24. Poordarab, S. (2008-2009) Designing of expert system in order to presenting of consultation in decision making of Mainframe console operator. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
25. Banijamali, S. A. (2008-2009) Designing of a fuzzy expert system for analysis of financial ratios of iranian manufacturing organizations. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
26. Moosavi, S. R. (2006-2007) Transforming of the web pages information to the usable knowledge in expert system. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
27. Naji, N. (2005-2006) Designing and implementation of consulting expert system and education needs assessment. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
28. Jalilvand, A. (2004) Setting up PID controlling parameters using case-based expert system. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
29. Dadkhah, F. (1998-1999) Selecting of projects using fuzzy expert system. M. A. thesis, Islamic Azad University, Science and Research Branch, Tehran, Iran.
30. Shamani, E., Moghaddaskhah, M., Designing of consulting expert system in repairing and troubleshooting of electronic circuits of rocket site