

Expert System for Troubleshooting A Local Area Network (LAN)

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Abstract: The present research work called "EXPERT SYSTEM TO DIAGNOSE AND PROPOSE THE SOLUTION OF FAILURES IN A LOCAL AREA NETWORK OF THE SECURITY AND NETWORK MANAGEMENT CENTER" will allow the development of a prototype of an expert system that will help to propose the immediate solution to failures at the level of connectivity hardware, interface hardware, communication software, and user failures in the LAN. This information was provided to us by the owner of the company where all network improvement activities will take place.

In this research work, surveys were carried out aimed at network technical personnel and users with basic knowledge of computing and telecommunications who work in the company at the Network Security and Management Center in order to diagnose failures in the LAN network and propose an expert system. Network specialists were consulted, questioned and interviewed and information was obtained that later allowed the knowledge to be processed in natural language, to then formulate the production and reasoning rules of the process using the java programming language for the design of the prototype that was finally submitted. to a simulation of tests on some computer equipment, as well as the development of an explanatory module, so that anyone with basic knowledge of networks and communications can use it.

Keywords: Expert System, LAN, Artificial Intelligence, Production Rules, Java Programming

1. Introduction

Local area networks (LAN – Local Area Network) allow communication between different devices, sharing resources (physical: printers, Internet access router, or logical: programs) to users of a certain area, such as a service center job. The use of LAN also facilitates the maintenance, management and security of the computer equipment included in the LAN network. The present research work, based on the area of artificial intelligence called expert or specialist systems, is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using the rules to arrive at approximate or definitive conclusions) and self-correction. The expert system prototype is a computer program developed using the Java programming language, which has been designed to diagnose and propose alternative solutions to problems presented in the LAN network of the Network Security and Management Center.

In railway transportation, the initial necessity emerged to develop intelligent systems for tele mechanical systems.

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There is currently an ongoing extensive modernization in automation and telemechanic systems, specifically in communication. The primary objective is to minimize repair time by promptly detecting malfunctions and facilitating their subsequent resolution. The utilization of microprocessor systems addresses issues related to identifying malfunctions at specific times, without consideration for the means to rectify such malfunctions. Despite this, most stations still rely on relay-type electrical interlocking, where station attendants provide indications of malfunctions that fail to offer precise data on the nature of the malfunction. This article explores the fundamental principles underlying the construction of expert systems for diagnosing malfunctions in the automation and telemechanic systems of railway transportation, specifically focusing on two-wire arrow systems. The expert system is designed to identify the malfunction in a particular component or circuit and provide intelligent recommendations for troubleshooting. A mathematical model and algorithm have been developed, and a program has been compiled to address malfunctions and eliminate them in two-wire arrow circuits (Tashmetov et al., 2022).

The implementation of comprehensive coverage of smart meters and metering automation terminals across the entire network presents significant challenges in terms of field operation and maintenance. In order to address the persistent issues related to on-site failures and maintenance of electric energy metering equipment, this study combines metering and collection of failure types to analyze the primary causes

of equipment failures. By utilizing the field's topology structure for fault reasoning, a fault diagnosis module is designed, with a fault knowledge base serving as its core component. Through practical validation, the expert system has demonstrated its effectiveness in diagnosing and resolving energy metering equipment failures. This approach proves beneficial in achieving on-site fault diagnosis intelligence and enhancing the efficiency of on-site maintenance for energy metering equipment, providing valuable practical insights (Xu et al., 2021).

The advancement of network technology has led to a significant consolidation and diversification of computer resources, including server resources. Consequently, server failures of various types and across multiple devices have become increasingly common. This necessitates higher demands in terms of the timeliness and accuracy of alarm information transmission, going beyond the scope of basic monitoring software services. To address this, there is a need to aggregate and analyze alarm information while providing expert-level solutions for fault information. In this article, a monitoring and alarm module is initially designed using the Flask framework, enabling it to uniformly receive and converge alarm information. The Vue framework is then employed to display the alarm information on a webpage. Additionally, the Python PyCLIPS library, based on CLIPS, is utilized to construct the inference engine for the server fault diagnosis expert system. Finally, the construction of the knowledge base is completed using the "production rules" expert system knowledge expression (Zhou et al., 2021).

2. Research Method and Design

Method

The present investigation used the inductive method, using the reasoning that starts from a series of observations to a sample population that allowed us to generate laws and general conclusions.

Goals

General

Develop a prototype of an expert system to diagnose and propose the solution of failures in a local area network of the network security and management center.

Specific

- Carry out a diagnosis of the current situation of the local network to propose solutions against failures in the local area network of the security and network management center.
- Define the requirements for the development of an expert system to diagnose and propose a solution to failures in the local area network of the network security and management center.

- Design the expert system for the diagnosis and propose the solution of failures in the local area network of the security and network management center.
- Development of prototype of expert systems for the diagnosis of failures in the local area network of the network security and management center.
- Validate and implement the prototype of the application to diagnose and solve failures in a local area network of the network security and management center.

Study variables

Dependent Variable

Development of an expert system.

Expert system development is the process of creating a machine that thinks and reasons like an expert would in a certain specialty or field. For example, an expert system in telecommunications diagnosis would require data on the network topology, the results of internal analysis and other relevant facts, and, using these, it would search a database for the information necessary to be able to identify the one corresponding to the failure.

Dependent Variable

Troubleshooting a local network.

The problems or failures that can occur in a local network are varied, but there are some that are more frequent than others. In principle, a distinction must be made between problems that are caused by hardware failures or software failures. Fault detection can be done through different mechanisms: By observation and review by technical personnel, by a report from an end user, or by specialized software.

Type

Applied research.

CommonKADS Methodology

CommonKads Methodology Life Cycle

CommonKADS is based on the spiral life cycle model that is widely used in Software Engineering and that provides a structure for the development of the computerized system:

- Development is divided into a set of phases with a predetermined order of execution.
- Within each phase, a different set of activities must be carried out.
- At the end of each phase, one or more tangible products (eg, documents, reports, designs, programs) are to be produced, usually as inputs to other phases.

The methodology is made up of a series of stages, each with associated tasks and products. They are:

The analysis

It is done to understand the problem from the point of view of the solution to be developed. It is formed by the specification of the external requirements of the knowledge-based system and by an analysis of the specific problem.

Design

In which a description of the behavior of the system (functional description) and a physical description in which each of its components is specified in detail.

Facility

It consists of starting up the system in order to begin operating in the company, beginning its production process.

The use

Activities related to the management of the system itself and the outputs or results it provides are proposed.

CommonKADS Structure

Organization Model

Opportunities to implement knowledge systems are analyzed. Its feasibility is established and the impact it can have on the company is determined.

OM-1: Identification of knowledge-oriented problems and opportunities.

Table 1. Organization model problems and opportunities

Organization Model	problems and opportunities
Problems and opportunities	<p>Problem:</p> <ul style="list-style-type: none"> -Difficulty for users to find faults in the local area network. -Technical personnel with little knowledge in the area. -Poor technologies for optimal development. -Deficiency in the design of the network topology. -There is no software for network management. <p>Opportunities:</p> <ul style="list-style-type: none"> - Information support provided by external personnel. - There are new technologies for ordering

	and network management. -Continuous updates from network management equipment.
Organizational Context	<p>MISSION</p> <p>Satisfy our clients by providing technological and telecommunications solutions to all sectors of our region, innovating and complying with updates; committing ourselves to the development of our society.</p> <p>VISION</p> <p>SIGJETEL EIRL's Vision for 2025 is to be the standard company in Internet service, with high-tech equipment that is intrinsically safe, offering excellent customer service and maintaining sufficient stock to meet customer needs.</p> <p>OBJECTIVES OF THE ORGANIZATION -To reach the right customers.</p> <ul style="list-style-type: none"> -Maintain or increase the profitability of the business. -Obtain greater productivity. -Offer excellent customer service. - Maintain the fundamental values of the company. -Have sustainable growth. -Optimize change management. - Stand out from the competition.
Other factors	<p>External factors:</p> <ul style="list-style-type: none"> -New technologies in telecommunications (-) - Satisfy the needs of customers according to the structure currently used (+) - Economic conditions (+) - Familiarity with innovations or new technologies by technical staff (-)
Solutions	<ul style="list-style-type: none"> - Provide a knowledge-based system that allows us to evaluate the continuous failures in the design of the local area

	<p>network, which allows us to improve the management of the local area network.</p> <ul style="list-style-type: none"> - Design a new network structure. - Remove existing hardware and replace it with new equipment based on the new network structure.
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	<p>area network through command tests.</p> <ul style="list-style-type: none"> -Evaluation matrix of collation of hardware equipment. -Experiences, learning acquired from external personnel taught in network management. - Table of classification by the levels of failure in the network. -Metacognitive evaluation in network management. -Measurement by means of a test on the flow in the network. - Detects conflicts coming from the firewall or the VPN.
Culture and power	<ul style="list-style-type: none"> - The network management team is in charge of ensuring. <p>For the control and security of the local area network.</p> <ul style="list-style-type: none"> - All staff uphold the concept of work in equipment. -Management is very attached to their areas subordinates.

Table 2. Organization model problems and opportunities

Organization Model	variant aspects
Structure	Organization chart
processes	Business process map
People	<ul style="list-style-type: none"> - General manager - Technical team - Network evaluator
Resources	<p>Technological resources:</p> <ul style="list-style-type: none"> Computer -Laptop - Internet with FTTH technology - Network administrator -Router -Physical and virtual servers <p>Gigabit Switch Economic Resources:</p> <ul style="list-style-type: none"> - Material goods - Intangible goods - External financing - Current assets - Own funds Resources Infrastructure - Electric power system - Computer process equipment - Network management room - The service distribution network - Data storage systems -Network monitoring and control system
Knowledge	Evaluation of the topology of the local

Task Model

The global disposition of the processes, their inputs and outputs, the relationships with the environment and the resources and response capacities of production are analyzed.

Agent Model

Describes the characteristics of agents. Agents are executors of a task. An agent can be a human, an information system, or any other entity that has the ability to perform a task.

Table 3. Telecommunications network analyst agent

AGENT MODEL	AGENT SHEET AM-1
Name	Telecommunications network analyst.
Organization	It is responsible for network data

	management.
Involved in	Internal analysis of the telecommunications network.
Communicate with	Supervisor and Technical Team.
Knowledge	Network management, Network analysis, Hardware control, Manage network traffic.
Other skills	Responsible for network management.
Responsibilities and Restrictions	You must manage the traffic and analyze the network data, to obtain a better quality in the data transport network.

Table 4. Supervisory Agent of telecommunications networks

AGENT MODEL	AGENT SHEET AM-2
Name	Telecommunications network supervisor.
Organization	He is responsible for monitoring data and configuration of software equipment.
Involved in	Data monitoring and configurations.
Communicate with	Manager, Analyst and Technical Team.
Knowledge	Network monitoring, equipment configuration.
Other skills	Responsible for monitoring the network and data.
Responsibilities and Restrictions	You must set up management teams, give permissions for analysts, Network monitoring.

Table 5. Internal Plant Technical Agent

AGENT MODEL	AGENT SHEET AM-3
Name	Internal plant technician.
Organization	Responsible for network maintenance.
Involved in	Network maintenance (Hardware. Structured cabling, software)
Communicate with	Supervisor and Analyst.
Knowledge	Structured cabling, Software configuration, Knowledge of OSI models.
Other skills	Responsible for the internal plant together with the external plant technicians.
Responsibilities and Restrictions	In charge of structured cabling and orderly connection between management teams.

Knowledge Model

It is to explain in detail the types and structures of knowledge used in the execution of a task within a process, as well as the reasoning processes used by experts to solve the problems presented in the processes.

Communications Model

It models the communicative transactions between the agents involved in the development of the process and in the design model all the previous models are gathered, to conform the technical specifications in terms of the architecture of the computation mechanisms needed, to put the functions of the models of knowledge and communication.

Design Model

It is used to describe the architecture and technical design of the knowledge-based system prior to its implementation.

OSI model for fault location

The OSI - Open System Interconnection reference model is the way in which the ISO - International Standards Organization sees the stages in which a communications process is developed in data networks. The model has a history and can sometimes be complex to understand. To

understand the context of layered communication models, one must assume that when a new network technology appears, the devices that support it often use several protocols simultaneously. The clearest example of this is TCP/IP: any station that supports this technology inherently supports other protocols than TCP and IP (which are independent protocols from one another), for example, it must support UDP and ICMP among others. In this case, each protocol fulfills special functions within the full purpose of the technology or the particular communication needs, and that is where the models come in. A layered communication model defines the specific functions that a particular technology performs, groups them, and uses such groups to embed its protocols within them. Models are said to be layered because the defined functions complement each other and successive operations are performed on the information, in such a way that certain functions will always precede others when the information is sent and are executed in reverse order when is received, which evokes a stack (stack), that is, an accumulation of things one on top of the other where to remove what was put first before, you have to remove what is on top. () that is to say, an accumulation of things one on top of the other where to remove what was put first, you have to remove what is on top. () that is to say, an accumulation of things one on top of the other where to remove what was put first, you have to remove what is on top. () A layered communication model defines the specific functions that a particular technology performs, groups them, and uses such groups to embed its protocols within them. Models are said to be layered because the defined functions complement each other and successive operations are performed on the information, in such a way that certain functions will always precede others when the information is sent and are executed in reverse order when is received, which evokes a stack (stack), that is, an accumulation of things one on top of the other where to remove what was put first before, you have to remove what is on top. () Models are said to be layered because the defined functions complement each other and successive operations are performed on the information, in such a way that certain functions will always

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OSI Reference Model

The OSI Reference Model is a model of the protocols proposed by OSI as open protocols interconnectable in any system, basically the OSI protocols were intended to be the industry standard, in fact, only a few of the original OSI protocols remain. used, for example, IS-IS, a routing protocol. Of the OSI protocols, only the model remains and since there are no protocols in use it is called the reference model, because it is so well defined that almost all technologies use it so that users know what exactly it does. So what this model does is define the communications process completely, divide it into clearly demarcated functions and name those functions.

The OSI model has different layers:

- Physical Layer
- Link Layer
- Network Layer
- transport layer
- session layer
- Presentation Layer
- Application Layer
- Failures in a data network

Table 6. Causes of failures in a data network.

Cause	Description
Conflicts with IP addresses	In general, DHCP services incorporate mechanisms to prevent the assignment of duplicate IP addresses to devices on the network. Nevertheless, there are instances where two computers may end up having the same IP address, particularly if one of them is statically configured. This situation is commonly referred to as Duplicate IP. It is important to maintain a well-organized network to avoid complications and promptly identify any potential failures.

	<p>Additionally, it is advisable to verify that there are no two DHCP servers running simultaneously. For example, it is common for the data server, which also functions as a DHCP server, and the router, which typically assumes the role of the DHCP server in its default configuration, to be the potential sources of conflict.</p>
Failures in switches or routers	<p>In some cases network failures have no apparent cause. For example, our machine can send and receive emails without problems but it does not have internet access, or it can be calmly surfing the net when at any moment access is lost and after a few minutes there is internet again. When the connectivity problems are local, the problem can be solved by rebooting the access switch or router. If these problems are repeated too frequently, it is necessary to check the quality of our power source, changes in the power supply can cause stuck equipment or even damage to Routers or switches. After all these checks, maybe it would be good to try another switch, since maybe the one you have is damaged and everything you do will not correct the problem.</p>
Connect equipment without order	<p>The need for connectivity tends to grow too fast, and this causes you to end up simply connecting equipment to the "nearest switch" or connecting a switch to the "nearest switch" and so on infinitely. When this happens, the data must travel long distances before reaching its destination, in addition to increasing the places that could cause failures. A good Practice is to anticipate growth and avoid these patches in our network by new users, or reorganize trying to consolidate what is dispersed in a powerful and stable system.</p>
NetBIOS problems	<p>etBIOS is a protocol utilized by Windows to facilitate communication among computers within a network. However, it often encounters issues that can lead to network slowdowns, errors when accessing shared files, and occasional service interruptions. One possible</p>

	<p>solution is to identify computers that are experiencing conflicts and rename one of them. Tools like AngryIpScanner can be employed to analyze network names. It is worth noting that peculiar behavior with network resources can arise when multiple computers share the same name. Disabling the WINS/NetBT name resolution service might prove effective in resolving this problem.</p>
faulty network cards	<p>A common problem is the presence of this type of failure. When a computer produces sporadic or intermittent errors, especially when they are related to a particular workstation. A very easy way to verify the operation of our card is to pay attention to the green or white LED that comes on each of them, which should blink or remain on, if not, you should verify that the cable is connected correctly and in good condition.</p>
Insufficient Bandwidth	<p>It is possible that the available bandwidth may not be sufficient to meet the network's demands, whether it is for local usage or from the Internet. In such cases, it is advisable to make investments in the communication network. While a Cat5e cable may be suitable for lower demands, higher demands may require the utilization of Cat6 or even Cat7 cables within the network. Additionally, the quality of switches and routers can impact the bandwidth within the local network. For example, a single 10/100 switch can potentially slow down a 10/100/1000 network.</p>
DNS errors	<p>Basically, DNS servers play a crucial role in name resolution. When you enter a website like google.com in your browser, the system resolves the name to its corresponding IP address, allowing you to view the webpage. However, there are instances where Windows may report an error stating "NAME NOT RESOLVED" when you have internet access but cannot access a specific website. In such cases, it is advisable to check your DNS settings.</p>
Spyware	<p>In essence, a virus of this nature transfers</p>

infections	information from the computer to an external entity without permission. This can potentially overload the network by unknowingly sharing data. Therefore, it is important to exercise caution and ensure that your antivirus software is always active and up to date.
virus infections	At this point, the rules or policies of the company regarding the Using the internet, discipline can save a lot of trouble. before a sudden failure, never hurts to have a virus scan on every terminal of the network. A single infected terminal can be generating thousands of SPAM emails that congest our network.
Too many applications operating over the network	In many cases, programs are installed from the Internet that connect to internet, P2P (peer to peer) software, etc. that uselessly overload our network. Identifying them and disabling the non-essential ones is critical.

The application will have alerts in the form of notifications so that the network user is always informed of the functionalities and activities carried out during the day.

Table 8. Non-functional requirements

non-functional requirements
It must include security mechanisms, user-friendly interface.
Only the system administrator will be able to change the required information when required.
The application will restrict people who have access to perform actions within the security control system.
The system will have a welcome notice when the user is correctly identified.
The system will be understandable to any user who is provided with a username and password.
The application will allow you to upload and update files to the database.

3. Work Methodologies

Requirements elicitations with the REM tool

Table 7. Functional requirements

Functional requirements
The application will have access to the LAN administrator's profile, which will be accessible through a password.
It must contain the roles of the LAN network administrator in the application: "administrator", "mail server", "notifier".
The application will provide notifications regarding failures identified in the LAN network.
The application will have a quick and efficient reaction to the detection of failures in the network.

Choosing a Declarative Programming Language

There is no recognized and endorsed method to choose a programming language, since most of these are made to meet specific needs of a market for projects with specific needs. It is true that there are some proposals on the criteria that should be taken into account, but this depends on the type of development that is going to be done. Therefore, for the development of this project, a series of parameters were chosen that must be taken into account to develop the expert system prototype. Some of these parameters will be taken into account for the specific needs of this system 42 and will be mandatory. Other parameters, more general for any type of system, will be taken into account as described by Lawlis in his proposal of parameters to take into account when choosing a programming language. It is important to mention that the programming language is not the only tool to choose when developing a system, although it is generally one of the most important. Other aspects that may be crucial are the database engine, the facilities to interoperate, the hosting service provider, among others.

Table 9. Programming Language Selection

Prolog	Java	python
structured objects	object oriented	object oriented

Language Selected for Implementation of the Expert System
JAVA: Java is a programming language computing platform created by Sun Microsystems in 1995. It has evolved from humble beginnings to power much of today's digital world as a trusted platform in which many services and applications are created. New and innovative digital products and services designed for the future also continue to be based on Java.

Table 10. Actor programmer

ACTOR	PROGRAMMER	IDENTIFIER: A02
Description	It is the person who develops the program to automate the storage, allowing users to enter and register the different tourist places.	
Characteristics	Analytical capacity to understand the problems that arise by applying logic and using skills to solve different problems taking into account the capabilities and limitations of the system.	
Relationship	He will be in charge of developing and executing the system according to the administrator's specifications.	
Reference	The programmer will be able to modify any aspect of the system.	

4. Results

Knowledge engineering with CommonKADS

OM-1: Identification of knowledge-oriented problems and opportunities.

Table 11. OM1 Form

Organization Model	Form OM-1: Problems and Possibilities for Improvement
Problems and opportunities	<p>There are a large number of problems regarding the identification of failures in the network, and the company does not have personnel available to meet the daily demand.</p> <p>Workers are not trained to fix network failures. The low duration of technologies limits the efficiency of the network service. Inadequate network designs due to lack of knowledge and training in up-to-date improvements of modern technologies. Lack of custom software design for the local area network.</p>
Organizational Context	<p>Mission:</p> <p>"Guarantee the functionality of the local area network and the development of telecommunications to all sectors of the region, innovating and complying with updates"</p> <p>Vision:</p> <p>"To be an effective organization in terms of telecommunications, creating a culture of quality and sustainable development that allows us to achieve the highest standards based on the needs of the regional and national sector."</p>
Other factors	<p>External factors</p> <p>A telecommunication engineer is very important to facilitate all the features and weaknesses of the network's functionality.</p>
Solutions	<p>Solution 1:</p> <p>Expand the coverage area of the LAN network to WAN that will allow reaching more users and hiring more specialists in each area so that they can attend to all the clients' requirements.</p>

OM-2: Description of the aspects of the organization that have an impact on or are affected by the chosen problem.

Table 12. Form OM-2: Variable Aspects

Organization Model Description of the key area of the organization	Organization Model Description of the key area of the organization
Structure	The organization chart of the company SIGJETEL, in which the departments of interest are detailed, the telecommunications area is located. The structure of the organization, where it is located.
processes	This staff's mission is to diagnose failures within the LAN network, evaluating connectivity, evaluating the results of the best functionality of the system.
People	General Manager: in charge of the Logistics area. Technical team: in charge of providing solutions to network failures that occur within the company. Network evaluator: he is in charge of providing maintenance in his specialty.
Resources	Technological resources: There is a system that stores and controls network failures, generating a database of the most continuous failures within the LAN network system. The diagnostics of each area that is detected are stored in the file.
Knowledge	The specialty of networks and telecommunications.
culture and power	The company is in compliance with the provisions of the International Network Standardization Organization. Network specialists are continually trained on the latest discoveries in technology. The telecommunications area is governed by the provisions of the International Organization for Network Standardization.

OM-3: Description of the process from the point of view of the tasks in which it is composed and its main

characteristics.

Table 13. Form OM-3: Decomposition of the processes.

No.	Task	Made by	Where	knowledge resources	intensive	Importance
1	Resource management	Management	Company	Knowledge in the specialty of networks and telecommunication is	Yeah	Half
	R&D	call center	Company	network management	No	Low
	quality management HR	commercial management	Company	network management	No	high
		Administrative Management	Company	Network topology	No	Low
2	requirements	Management	Company	network operation	Yeah	lousy
	Attention and delivery	commercial management	Company	network identification	Yeah	Half
3	accounting administration	Counter	Company	Use of instruments and materials	No	high
	purchase and warehouse	Secretary	Company	Management of technological equipment	Yeah	Half

OM-4: Description of the knowledge component of the organization model and its main characteristics.

Table 14. Form OM-4: Knowledge Assets

Knowledge Resource	Belonging to	Used in	Shape	Place	Time	Warm
Management of internal regulations to obtain evaluation results	Management	1, 2, 3,4 and 5	Yeah	Yeah	No	Yeah
administrative management	administrative management	2, 3 and 4	Yeah	Yeah	Yeah	Yeah
system management	computer operator	1, 2, 4 and 5	Yeah	Yeah	Yeah	Yeah
Basic knowledge in LAN network	administrative management	1	Yeah	Yeah	No	No

OM-5: List of technical teams for the decision feasibility document.

Table 15. Form OM-5: Feasibility Analysis

organization model	Form OM-5: Feasibility Analysis
Viability business	This is due to the difficulty faced by said institution and the administrative management that the expert system must carry out for each person in charge of the network. The resolution of this problem is out of the reach of a telecommunications specialist and thus carry out and verify, most of the time 31% to obtain the diagnosis with a time in that task of 26%. Given that the

	work has focused on reducing response times by telecommunications specialists, taking into account that the process of carrying out connectivity tests is influenced by the physical contact that the device has with the network, it is logical to focus on the diagnostic task. However, the response time of the diagnosis can be speeded up if we use an expert system.
Technical viability	The knowledge of the diagnosis is available and has the difficulty of development, although the problem of diagnosis is widely studied, as mentioned in the background described above.
Project viability	Technical viability can be combined with the expected benefits, we observe that: Developing an expert system would imply a reduction in the time spent by specialists. The task of diagnosing the knowledge involved depends on expert knowledge, willing to provide the information. Being the diagnostic task of the telecommunications specialty, the development of an expert system for this task would serve as a prototype to carry out the evaluation of the local area LAN network.
Proposed actions	Based on the above, it would be advisable to have an application where it will be possible to model and store the knowledge of telecommunication in the LAN.

TM-1: Refined description of the tasks within the objective process.

Table 16. Form TM-1: Task analysis

task model	Form TM-1: Task Analysis
Task	Check LAN (1 of OM-3)
Organization	It is carried out in the company SIGJETEL, the personnel in charge is the specialist in the local area network.
objective and value	The objective is to carry out a review of the entire network connection to obtain a previous data of the results.

Dependenc y and flows	Next tasks: perform network performance analysis (2 of OM3) architecture and design review (3 of OM-3). Both require specific information in this area (only for the telecom nutritionist to reference the network data.
Manipulate d objects	Input Objects: Data identified from the network prior to the query. Output objects: analysis of the results.
time and control	Frequency: Analysis of the network is continuous and daily. Duration: 3 to 5 per hour
agents	Human Agents: Network specialist: as an agent that interacted with the system and the power centers of the network as part of the knowledge and as agents that will use the information provided by the expert system. Information Systems: Company database.
Knowledge and ability	The knowledge resources established in OM-3.
Resources	A database with greater capacity is required to safeguard the digital copy of the network operations.
Quality and efficiency	The task must follow some internal regulations of the company.

AM-1: Agent Specifications

The purpose of this form is to analyze the roles and competencies of each agent involved in carrying out each task, which is especially useful when it is carried out in a shared manner. The term agent refers not only to the organization's personnel, but also to other information systems that may play a role in carrying out the task.

Table 17. List of agents. Form AM-1: Agents

task model	Form AM-1: Agents
Name	Company manager
Organization	The SIGJETEL company: verifies if there is any type of inconsistency in the diagnoses issued by the expert system.

Involved in	Audit Diagnosis on the network.
communicates with	Preceding tasks: Diagnostics issued by network analysis.
Knowledge	Input objects: Selection of a database. Knowledge management of network and telecommunications specialists. Output Objects: When finding inconsistency in database storage failures
Other skills	Human Agents: Systems engineer, telecommunications network engineer. Information Systems: Network analysis registration database.
Responsibility and Solutions	Continuous analysis of the network in relation to the tasks to be fulfilled within the development of the expert system's functionalities.

OTA-1: Analysis list for decisions on impact and improvements.

Table 18. Form OTA-1: Documents on Impact and Improvements.

task model	Form OTA-1: Documents on Impact and Improvements
Name	Company manager
Impacts and changes in the organization	The development of an Expert System is proposed in this work, in order for the company to be analyzed more efficiently and effectively in the diagnosis of the results of the company's network.
Impacts and changes in tasks and agents	Have an application where you can model and store data. This tool would generate the diagnosis of the network of each area, allowing the specialist to streamline decision-making in terms of failure identification programs to analyze, reducing response times in serving an area and allowing greater

	capacity for daily attention of users.
involved in	Areas of the company.
communicates with	Previous tasks: Diagnoses issued by the analysis of the specialist.
Knowledge	Input objects: Network selection. Output objects: Network diagnostics.
Other skills	Human Agents: Systems engineer, telecommunications network engineer. Information Systems: Network analysis registration database.
Responsibility and Solutions	Continuous analysis of the network in relation to the tasks to be fulfilled within the development of the expert system's functionalities.

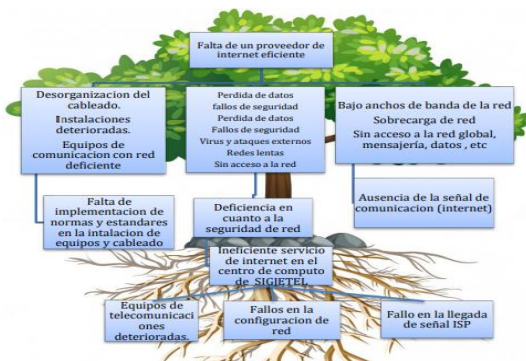
5. Conclusions and Recommendations

Conclusions:

In the present investigation, the faults diagnosed by the expert system prototype were solved, these problems that arose were solved through the classification of rules by problems presented, at the level of connectivity hardware, interface hardware, communication and management software. of users.

It was possible to know the theoretical basis of expert systems to diagnose and solve failures of a local area network.

Through the expert system, the problems and network models presented in the network data transmission were



resolved immediately. – The diagnosis of the network was immediately and effectively presented with a current model of the network and its different failure nodes.

Recommendations:

The expert systems in telecommunications are of great help, since you can identify problems and solve them immediately, and for them the different existing companies should prioritize them, with the purpose of optimizing the data transmission service. – Improve the performance of the LAN network, for this it is necessary to add or change both hardware and software components and use Gigabit speeds for an optimal network. – Measure the degree of user satisfaction and analyze the variation that occurred when applying the expert system within the organization.

6. Annexes

Annex 1: Problem tree

Annex 2: Questionnaire

1. Do you think that the network of the Computer and Telecommunications Center of the SIGJETEL Company is organized?

t). If b). No

2. Do you consider that the installation of the LAN network for the Computer Center and

Telecommunications is correctly installed?

t). If b). No

3. Can you print or share resources over the network?

t). If b). No

4. Does your office have a computer for the development of your daily activities entrusted by the company?

t). If b). No

5. Is your computer connected to a company network?

t). If b). No

6. Are you satisfied with the data transmission provided by the Computer and Telecommunications Center in your office?

t). If b). No

7. Do you have connectivity failures on your computer?

t). If b). No

8. What is the most common failure that occurs when you use the network on your computer?

t). No network connection b). Slow network c). address conflict

IP d). Others

9. When a data transmission failure has occurred, what do you do immediately?

to). You solve it yourself b). Request support to solve the problem. c). Turn to CIT technical support d). turn to others

10. In which cases do you think data transmission is slower?

to). Wired Network b). Wireless network

11. Have the problems generated by data transmission failures in your system affected your work performance?

to). If b). No

12. Do you consider it important to have a tool that helps diagnose and offers a solution proposal for network failures, self-help or a prevention proposal in your data transmission?

to). If b). No

13. Is there specialized and trained personnel to attend to failure problems?

network in the company SIGJETEL?

to). If b). No

14. Do you know if the Computer and Telecommunications Center has an environment

for the data center hosting the network cabling?

to). If b). No

Annex 3: Result of the questionnaire

1. Do you think that the network of the Computer and Telecommunications Center of the SIGJETEL Company is organized?

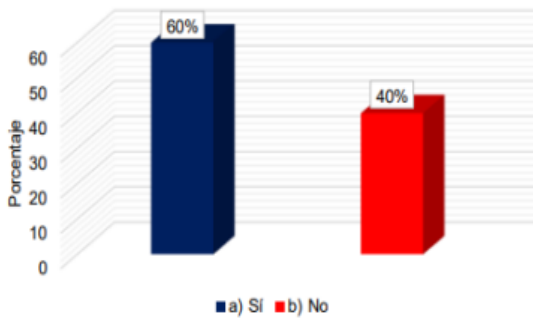


Illustration 2: 60% of the personnel surveyed indicate that the CIT - SIGJETEL network is correctly organized.

2. Do you consider that the LAN network installation for the Information and Telecommunications Center is correctly installed?

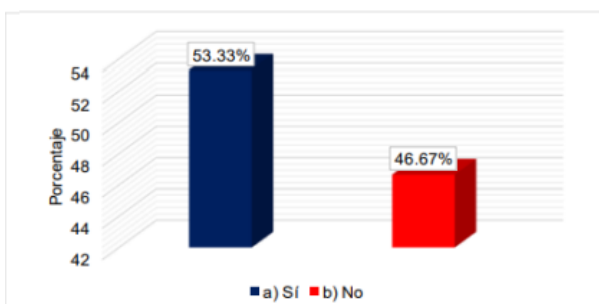


Illustration 3: 53.33% of the surveyed personnel state that the CIT - SIGJETEL LAN network is correctly installed.

3. Can you print or share resources over the network?

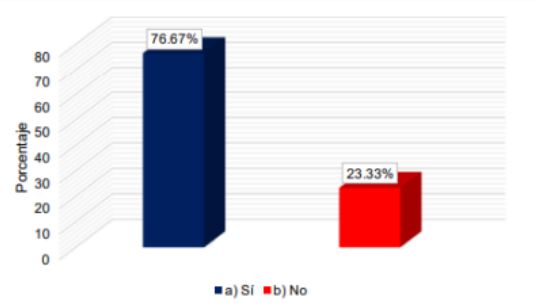


Illustration 4: 76.67% of the people surveyed state that they can print or share resources through the CIT - SIGJETEL network

4. Does your office have a computer for the development of your daily activities entrusted by the company?

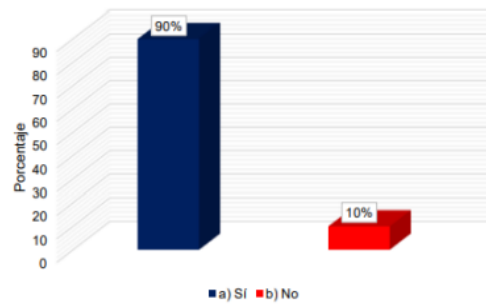


Illustration 5: 90% of the offices of the surveyed personnel have a computer for the development of the daily activities entrusted to them.

5. Is your computer connected to a company network?

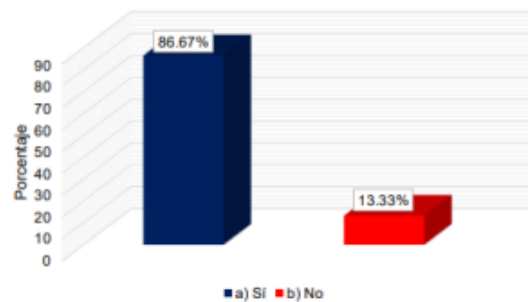


Illustration 6: 86.67% of the computers of the surveyed personnel are connected to the CIT - UNP network

6. Are you satisfied with the data transmission provided by the Computer and Telecommunications Center in your office?

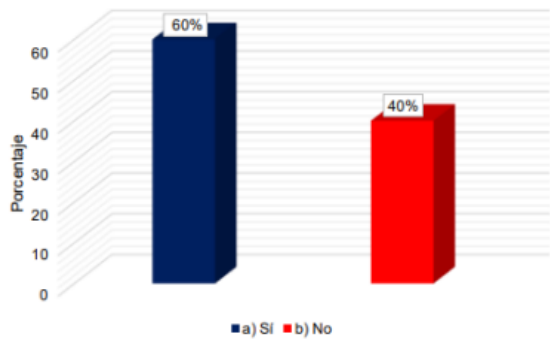


Illustration 7: 60% of those surveyed are satisfied with the transmission of data provided by the CIT – SIGJETEL in their offices.

7. Do you have connectivity failures on your computer?

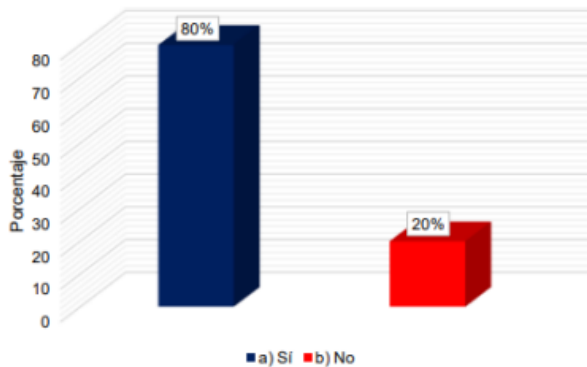


Illustration 8: 80% of the people surveyed indicated that at least once they have presented connectivity failures on their computer

8. What is the most common failure that occurs when you use the network on your computer?

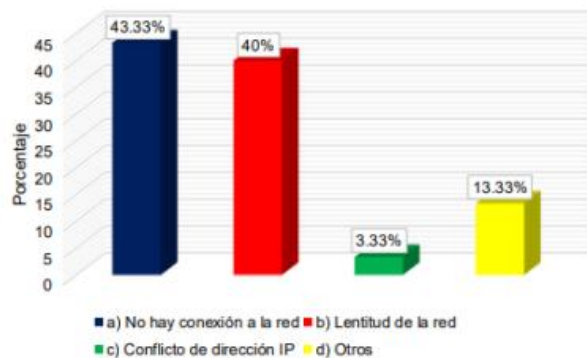


Illustration 9: "Not having a connection to the network" is the most common error when using the CIT - SIGJETEL network on the computer. 43.33% of those surveyed state that they have had this inconvenience.

9. When a data transmission failure has occurred, what do you do immediately?

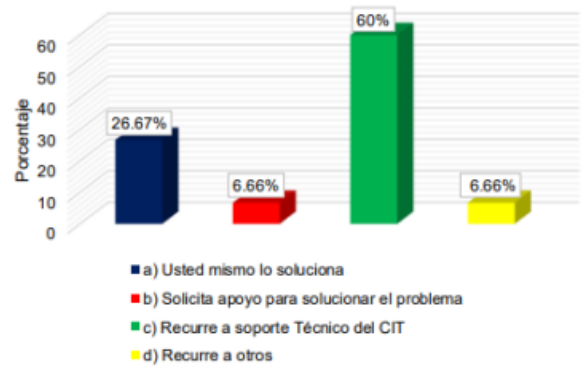


Illustration 10: 60% of the personnel surveyed state that when they have problems in data transmission, they immediately turn to CIT Technical Support - SITGJETEL

10. In which cases do you think data transmission is slower?

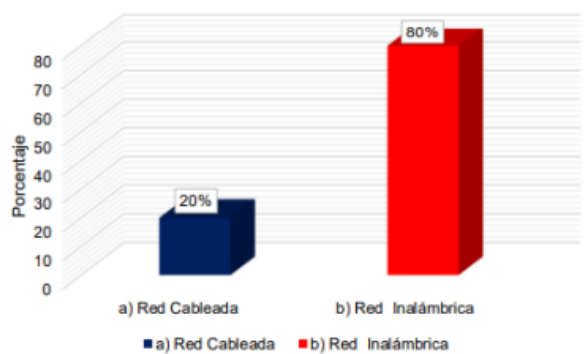


Illustration 11: Data transmission is slower in the wireless network according to the opinion of 80% of the personnel surveyed.

11. Have the problems generated by data transmission failures in your system affected your work performance?

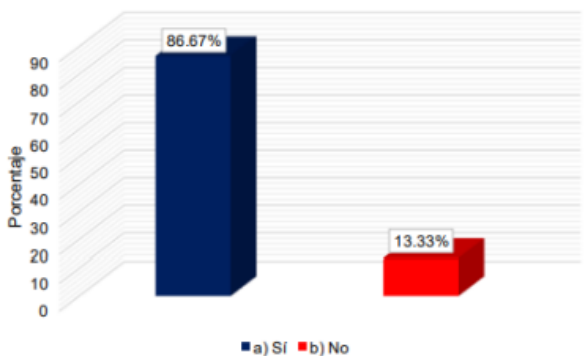


Illustration 12: 86.67% of those surveyed indicate that data transmission failures in their systems have affected the performance of their work.

12. Do you consider it important to have a tool that helps diagnose and propose a solution to network failures, self-help or a prevention proposal in your data transmission?

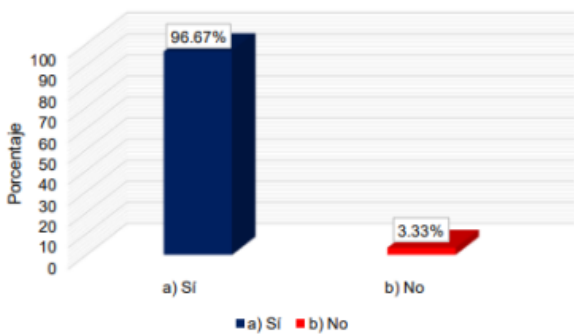


Illustration 13: 96.67% of those surveyed consider that it is important to have a tool that helps diagnose and offers solutions to failures in the CIT – SIGJETEL network

13. Is there specialized and trained personnel to attend to network failure problems in the SIGJETEL company?

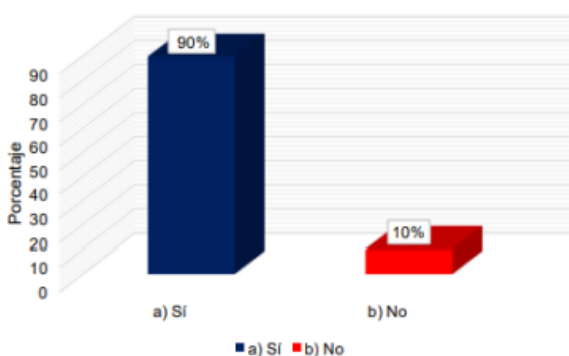


Illustration 14: 90% of those surveyed state that the CIT has specialized and trained personnel to attend to network failure problems.

14. Do you know if the Information and Telecommunications Center has an environment for the data center housing the network cabling?

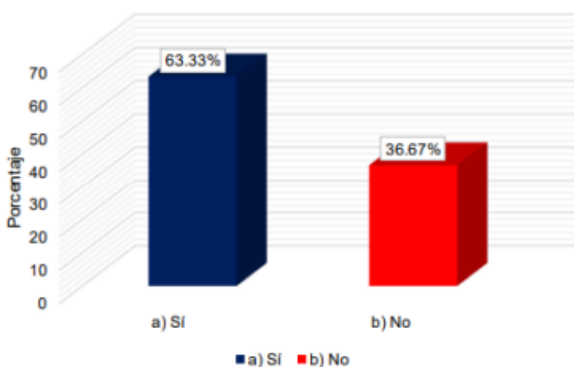
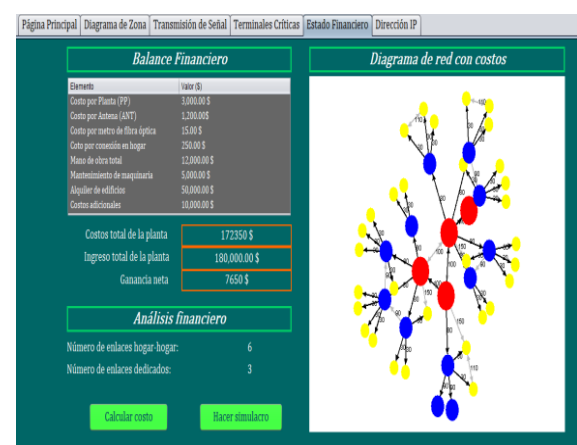
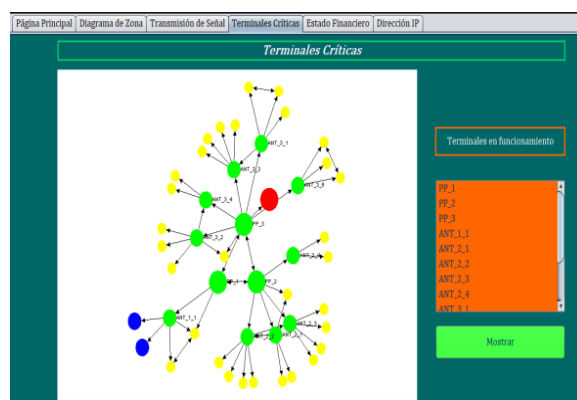
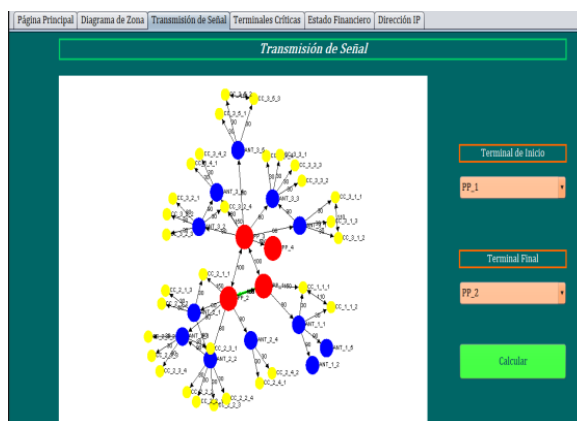
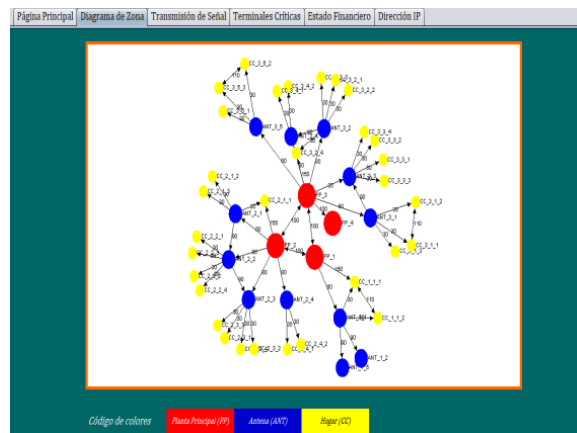


Illustration 15: 63.33% of those surveyed know that the CIT - SIGJETEL has a data center hosting the network cabling, which allows maintaining the connectivity of the offices and other environments of the National University of Piura

Annex 4. Development of the system.



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