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Analysis of Methodologies of Data Networks LAN

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Abstract— *Currently companies offering the service implementation of data networks have seen the need to apply any methodology, the same that can be adapted to the needs of both the client and the organization and also allow direct all processes in the development of the project.*

However, the use and application of these methodologies aims to reduce failures due to incorrect implementation of the network, it is important to stress that these methodologies provide excellent results as long as the indicated adoption and meet customer needs.

That is why the need to analyze the techniques used to implement a network, specifically a network (Local Area Network) LAN type arises; for which an analytical, bibliographical and documentary study, to obtain pertinent and relevant information within the framework of the research was conducted. In addition to the use of criteria for the evaluation of the methodology.

As a result, it has been possible to demonstrate that the CISCO methodology is the most widely used thanks to its easy adaptation and implementation projects; plus, it provides a wealth of information and support to users, thereby allowing correct application of its processes.

Keywords— Analysis, Benefits, CISCO, Methodology Network, Network Data, Network LAN.

I. INTRODUCTION

In recent years it has seen a growth in data traffic due to the popularity of internet, to the point that today has reached far exceed the data traffic. In the context of telecommunications networks, this leads to a predictable change in the technological paradigm that will support future networks; thus requiring the implementation of methodologies to develop data networks, which have high bearing capacity for intercommunication.

The design of a network, can become a very complicated process depending on the strategy used for implementation is therefore necessary to consider the application of methods, techniques and methodologies, to ensure project success and allow proper operation of the same. The non-application of a methodology increases the odds of problems.

There are a number of methodologies for implementing a network such as: Top Down, CISCO, INEI, and James McCabe, which are intended to guide a working group through phases or stages defined.

With the use of these methodologies have been able to significantly improve the processes of analysis, design and implementation of a network, particularly a network of LAN type (Local Area Network), in addition to fulfilling main goals such as sharing information and resources such as hardware and software. It should be noted that the implementation of methodologies is not completely eliminated the problems, but if the probability of reducing failures in implementing a network is increased, and with them to improve the efficiency of this.

The problem that arises is the need to know which methodologies mostly used in the implementation of a network both globally and in local companies, in addition to demonstrate the benefits granted their application, are for which a detailed analysis of each of the methodologies presented earlier analysis will be performed.

Because of this problem and based on reviews in different academic research articles that defined the main characteristics of the various methodologies, it proceeds to make the following assumptions:

H1: methodologies network represent benefits in the implementation of a LAN.

H2: The CISCO methodology is most often used to implement a LAN.

The objective pursued in this research is to analyze network methodologies, by applying techniques of data collection and evaluation criteria, identifying this form which is most suitable in the process of implementing a network.

II. THEORETICAL FUNDAMENTS

A. Data Networks

A data network or also known as computer network or computer network is a system of computers interconnected via a physical medium that allows you to send or receive information.

A data network is "a set of nodes and receivers emitting information connected by links which allow the

transmission of information of unidirectional, bidirectional or multidirectional way." [1]

Then a simple model or design of a communication system is presented

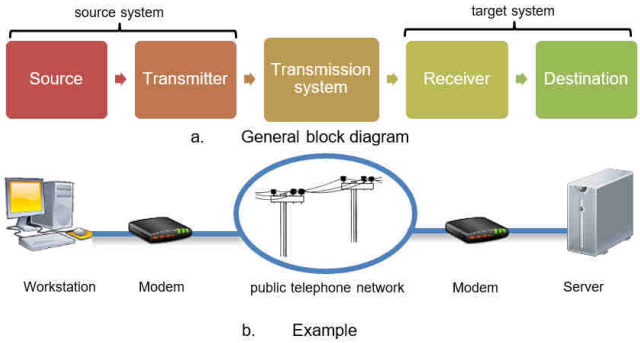

Fig. 1: Simplified communication model [2]

Source: the source is part of the source system consists of a computer that initially created the information to be transmitted. Example: computer, phone, etc.

Transmitter: You can not directly transmit the information generated by the source, for this there is the transmitter through which passes and information signals becomes (a modem converts digital signals or set of bits generated by the computer into analog signals) that they can be sent via a transfer medium.

Transmission system: the transmission system is the medium that transmits from the source to the destination, and can range from a simple wiring to a very complex network.

Receiver: The receiver performs the opposite function of the transmitter. Receives information or information system signals converts them to signals that are acceptable by the destination signaling equipment (a modem converts analog signals to digital or set of bits).

Destination: is the team that finally receives the information from the receiver.

B. Classification of Data Networks

There are several classifications of computer networks, either depending on the scope, topology, connection type, directionality, functional relationship, among others.

In this case the classification of data networks described as the scope or geographic coverage, these PAN (Personal Area Network), LAN (Local Area Network), CAN (Campus Area Network), MAN (Metropolitan Area Network) and WAN (Wide Area Network).

1) PAN (Personal Area Network)

The Personal Area Network, uses "transmission technologies short range and usually are designed to serve one person, hence its name" [3], are small networks where devices are very close to each other and users allowing a simple and quick contact, for example, the printer and computer.

2) LAN (Local Area Network)

The local area networks better known as LANs "are privately owned networks that are in a single building or a campus a few kilometers long" [4], it computers or devices involved in the network are interconnected small distance and delimited in a particular area such as: office, home, building, etc. These networks are considered as blocks to implement larger networks.

3) CAN (Campus Area Network)

This is a set of LANs that are geographically within an area or field set such as a university, industry, etc.

4) MAN (Metropolian Area Network)

The Metropolitan Area Network or MAN, "refers to the interconnection within the geographical boundaries of a city or town"[5], due to the extension of the network becomes difficult to install the equipment therefore not sufficient to implement LAN networks, which is why the MAN networks consist of a set of LANs or CANs are implemented.

5) WAN (Wide Area Network)

It is a "technology physical network that is able to cover long distances" [6], includes several LANs interconnected at such distances or continents, are implemented by very large companies to provide better quality services at its plaintiffs.

C. OSI Reference Model

Because network equipment developed by different manufacturers, caused a complex communication between them, which was necessary to be subject to a standard. That is why the International Organization for Standardization (ISO) developed the OSI reference model, released in 1984.

The reference model for Open Systems Interconnection (OSI), "addresses the problem of data communications and computer networks by dividing it into levels" [4], most network vendors relate their products to this model, further estimated as the best tool to send and receive data through a network. Here it is presented and described each of the layers.

TABLE I: THE LAYERS OF THE OSI MODEL

Nº	Layer	Description
7	Application	It provides access to the medium OSI for users as well as distributed information services.
6	Presentation	It facilitates application processes freedom in respect to different data representation.
5	Session	Control of communication between applications, provides, manages and closes connections between cooperating applications.
4	Transport	Transfers data between endpoints fully and clearly provides the origin-destination control and

		error recovery flow.
3	Network	Is independent of the higher levels in relation to transmission and switching techniques manipulated to link systems, it is responsible for establishing, maintaining and closing connections.
2	Datalink	Its objective is to provide reliable transmission of electromagnetic and electrical signals from the physical level, it performs synchronization, flow and error control by sending block containing bits of messages.
1	Physical	It is responsible for binary transmission through a physical medium, involved transmitting and receiving equipment, etc.

D. Importance of Network Methodology

Networking experts are able to create a number of networks that can range from very simple to a very high level of complexity using their own judgment or reasoning design, despite this to be in circumstances where there have been problems in such networks, they are not in the capacity or easy understanding to address and resolve this problem with the same approach in which they were created.

Modification, renovation or improvement of a network is often become very complex due to the design plan with confusing or worse thoughts even if no methodology was applied to create the network, therefore, should not be surprised if it is a network not It ensures easy understanding or diagnostic troubleshooting.

This is why it is considered important to consider the application of a systematic and orderly methodology to anticipate any problems.

E. Methodologies Data Networks

To select a methodology for designing a data network does not involve life cycle that applies each of them, one should consider that this propose a structured and planned able to improve or redesign the same design.

In this paper four methodologies that can be used to develop information network projects described, then presented each of them:

1) Top-Down Network Design

According to Priscilla Oppenheimer [7] TOP-DOWN is a design methodology data network, as its name implies, begins in the upper layers of the OSI reference model before moving to the lower, ie, it is focusing on applications, and data transport sessions before selecting media involved in the lower layers.

TOP-DOWN is an iterative methodology, which is based primarily on gathering information or meet customer needs before creating the logical and physical design. Its main objectives are to obtain the customer's needs clearly a priority in the design and divide the project into modules.

The top-down methodology is divided into four phases for network design. These are:

Requirements analysis: this phase is to obtain, analyze and understand customer needs, technical and business objectives for creating or improving the network. This involves: Analysis of business objectives and constraints, determine the existing network and determination of network traffic.

Logical Design: This phase network topology is created, the routing layer and appointment, selection of interconnection devices, routing protocols and finally designated security tactics and network management.

Physical design: devices and technologies proposed in the logic for the creation or improvement of the network according to business requirements requested design are selected.

Testing, optimization and documentation: the last phase includes the selection and application of methods and assessment tools or tests for which it is recommended: tests application response time, performance, availability and regression. Optimizing network design, such as: the use of bandwidth, network performance QoS, reducing serialization delay. Documentation labor employed in the design of the network.

Then the cycle network design and implementation is as follows:

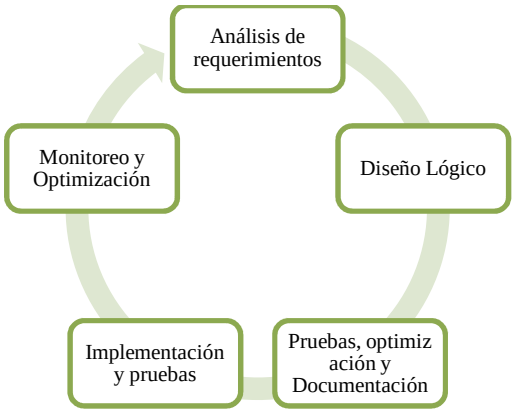

Fig. 2: Cycle Network Design and Implementation

2) CISCO

The company manufacture, sale and maintenance of network equipment, CISCO, presents a methodology for designing data networks. This methodology is based on the life cycle PPDIOO (prepare, plan, design, implement, operate and optimize).

According to Cisco, the focus of this life cycle defines the "minimum set of activities needed, by technology and by level of network complexity, to help customers deploy and successfully operate Cisco technologies" [8], that is to say is a method that allows the development or design

of a data network according to business requirements so that customers can increase productivity and efficiency through proper implementation of cisco equipment.

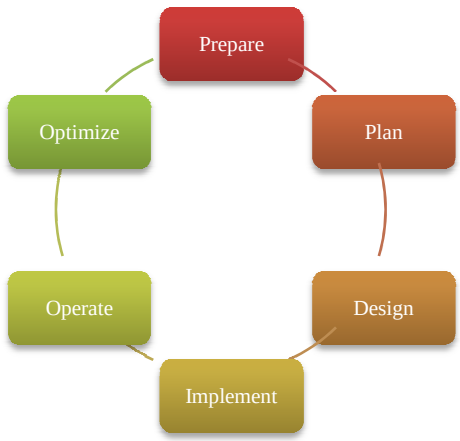

Fig. 3: Cisco Lifecycle network – PPDIOO [8]

According to Cisco Services [9], it describes each of these phases involved in the life cycle PPDIOO:

Preparation: As the top-down methodology begins with the collection and analysis of business requirements to provide an efficient solution that meets customer needs and be competitive in the market. This phase is mainly based on the study of business that implement or modify a network design to consider development techniques as well as technologies to ensure network support.

Planning: After the preparation phase, the analysis of the environment or area where the network will be implemented is done, available resources both technical, economic and human resources in order to determine whether these aspects are suitable for the implementation of network system raised. In itself, this phase takes the plan to be implemented for the development of the network, this plan includes the resources used, activities, time and budget estimate concerning the project.

Design: the creation of a specific and complete design is important for reducing costs, delays and conflicts in the implementation of the network. Such a design must be based on technical requirements and business goals, certifying a reliable, secure network, high performance and scalability.

Implementation: the implementation or the network itself, is developed based on the composition of the devices according to the design, this should provide services without hindering the current network, without altering the availability or performance of it.

Operation: This phase is related to the IT budget of companies (known as IT) and operation of the network, which is considered important to optimize network performance using different techniques such as management and proactive network monitoring to reduce interruptions and increase capacity, security, availability and reliability.

Optimization: This phase can detect errors that were overlooked which must be corrected, in the case of finding a large number of errors is necessary to redesign the network. It is important to evaluate the network concurrently with the aim of improving their performance and services.

3) National Institute of Statistics and Informatics (Instituto Nacional de Estadística e Informática INEI)

The National Institute of Statistics and Informatics (in spanish INEI), proposes a methodological framework for implementing information network projects, this consists of four phases: Organization, Development, Implementation and Evaluation.

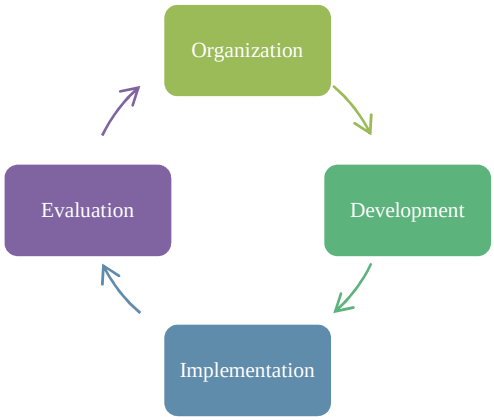

Fig. 4: INEI lifecycle

Then the phases are detailed, according INEI [10]:

Organization: This stage consists of the following tasks:

TABLE II: STAGES OF THE ORGANIZATION [10]

Organization	
Stage	Definition
Modeling Project	This activity is to define the objective and feasibility of the project, develop the schedule of activities and resources to carry out the development.
Modeling of the Institution	An analysis of environment where information network will be implemented, so must have the cooperation of business owners is performed. In this part the coherence between the project objectives with the strategic plan of technology and information systems is sought.
Modeling Requirement	An analysis of environment where information network will be implemented, so must have the cooperation of business owners is performed. In this part the coherence between the project objectives with the strategic plan of technology and

	information systems is sought.

Development: this should use the following steps:

TABLE III: STAGES OF DEVELOPMENT [10]

Development	
Stage	Definition
Modeling of the Organization	A solid organization able to plan, coordinate and direct the network project to be implemented is stable. This means: commission the project, technical and user groups.
Modeling Requirement	The requirements of the working environment so it is important to consider the use of systems for distribution or network configuration in the work area are determined.
Modeling Technology	This part describes in detail the equipment, devices, methods and technologies that will make up the network and which should be documented.
Construction	It refers to the design and documentation of network architecture, this involves: Plan hardware and software installation, training and personnel training.

Implementation: This stage involved the following instructions:

TABLE IV: STAGES OF IMPLEMENTATION [10]

Implementation	
Stage	Definition
Modeling of the Organization	This part based allocation of functions for members of the project organization, such as people who will be in charge of the service installation, hardware and software, staff training, etc.
Modeling of the Institution	It is to form teams and new methods for the performance of these devices.
Modeling Requirement	Due to the implementation of the network and the new structure of the work areas they can arise requirements that were overlooked during the project and which must be addressed.
Modeling Technology	The modification of equipment and forms of work can lead to the selection of new tools.
Construction	New technologies and requirements arising from the restructuring of the work areas is based.

Evaluation: This stage includes the following processes:

TABLE V: STAGES OF EVALUATION [10]

Evaluation	
Stage	Definition
Modeling of the Organization	This part based allocation of functions for members of the project organization, such as people who will be in charge of the service installation, hardware and software, staff training, etc.
Modeling of the Institution	It is to form teams and new methods for the performance of these devices.
Modeling Requirement	Due to the implementation of the network and the new structure of the work areas they can arise requirements that were overlooked during the project and which must be addressed.
Modeling Technology	The modification of equipment and forms of work can lead to the selection of new tools.
Construction	New technologies and requirements arising from the restructuring of the work areas is based.

4) James McCabe

James McCabe proposes a methodology for designing data networks, the same consists of two phases containing various processes that lead to the development of the project. These two phases are Requirements Analysis and Design.

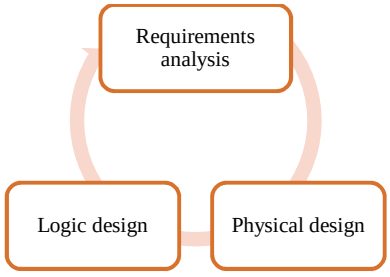

Fig. 5: Network Lifecycle James McCabe

According to James McCabe [11], then describes each of the phases:

Requirements analysis: the first phase is responsible for meeting the needs, requirements and business objectives. It also poses the following processes: application maps, descriptions flows, simple and compound.

a) Maps Application:

For each of the applications or services should be considered the respective location and the area of use of these applications.

b) Flow:

Descriptions of network performance, is constructed sequentially from the bottom up.

There are two types of flows that are simple and compound. Simple flow: in this part of the source and destination network capacity, delay and reliability is detailed. Compound flow: This flow is a combination between simple and compound and therefore specified: origin and destination, sum of the capacities that comprise the minimum time delay, minimum specification of reliability.

Design: This phase consists of the logical design and physical design of the network.

a) Logical Design:

To make the logical network design takes into account the objectives of the network, the requirements specification, flows and the budget estimate.

It should be diagnosed technologies that integrate the network such as: cost, reliability, speed, etc. and from this the respective selection. Apply connection components, methods of administration and network security. There must be a contingency plan considering possible risks within the development.

b) Physical Design:

This section evaluates and selects the wiring to be used, is located each of the computers or network devices, network design and routing flow is used.

III. METHODOLOGY

This research work is analytical, bibliographical and documentary. The same that allowed the analysis and interpretation of the bibliographic information obtained from various sources such as articles, books and magazines based on the problems presented.

As for the analysis of methodologies for implementing a network, according to the author Rafael Menendez Barzanallana Asensio [12] states that, to build, analyze or choose a methodology should take into account certain criteria which must be focused on compliance the objectives of both the company and the customer, also in benefits such as reduced costs, time and improved network performance, among others.

It is therefore important to use these criteria to thereby avoid problems or risks in implementing the data network, and in turn determine the methodology most widely used network in this process.

These methodologies provide excellent results as long as the indicated and one that meets the needs of organizations and is optimal according to the requirements requested by the customer is taken.

1) Selecting a pilot study area

The study area where this research was published were all active companies engaged in the implementation of networks in the city of Machala. Business data were taken from the Internal Revenue Service (SRI, 2016) Web portal. These are:

TABLE VI: COMPANIES IMPLEMENTING DATA NETWORKS LAN KIND IN THE CITY OF MACHALA

Nº	Companies	
	Name	Address
1	Infotecsa Computación	Rocafuerte y Vela.
2	Datos PC	Rocafuerte y Vela.
3	Red Access	Santa Rosa y Boyacá.
4	PuntoNet	Arizaga entre Juan Montalvo y 9 de Mayo.
5	Distrited	Av. Bolívar entre Junín y Tarquí.
6	Telnet	Sucre entre Páez y Juan Montalvo.
7	Telecom	Sucre y Santa Rosa.
8	Machala Net S.A.	Av. Ferroviaria (Urbanización las Acacias).
9	Sistel	Buenavista entre 8va norte y Marcel Laniado.
10	CompuTech	Rocafuerte entre Tarquí y Colón.

Additionally it took into account the criterion of independent professionals in the area.

2) Definition of indicators

a) Evaluation indicators

The indicators were considered for the analysis, evaluation and selection methodology data network, as the author Rafael Menendez raises Barzanallana Asensio [12] are:

TABLE VII: EVALUATION INDICATORS [12]

Evaluation	
Indicator	Definition
Adaptability	Capacity of the methodology is to engage the changes occurring, just as with the objectives regardless of the type of network you want to implement.
Scope	This indicator establishes the ability of the methodology to cover the life cycle of the entire project.
Traceability	Progressive and regressive monitoring all phases of the lifecycle of the implementation of a network.
Security	It indicates the ability to possess methodologies for the protection of information on network traffic.
Tests	Assesses whether the methodology is able to detect and correct network errors.
Accuracy	Check whether it has complied with the specifications expected by the

	user and the client company.
Operability	It determines whether the methodology can still operate according to user-oriented dynamic environment.
Documentation	Specification of the processes performed at each stage of the methodology, and its leaders.
Usability	It is the level of commitment that the user must apply to take full advantage of the methodology.
Stability	Capacity of the methodology to support changes that occur in any form.
Profitability	Reduced costs, increased revenues and profits due to the application of the methodology.

b) Implementation of the evaluation criteria

To quantify the indicators in each of the methodologies LAN data network type, a Likert scale was carried out with the purpose of knowing the benefits that its application in the development of a project.

Then the scales of assessment presented:

TABLE VIII: LIKERT SCALE

Evaluation criteria	
Value	Definition
1	Very Deficient
2	Deficient
3	Regular
4	Good
5	Excellent

IV. MATERIALS AND METHODS

To evaluate the hypothesis in this research the following procedure was developed. the area or case study companies in the city of Machala implementing LAN data networks type, in order to obtain design methodologies most used by the companies and then evaluate each of these networks was considered.

To obtain the information necessary and relevant to research a plan for data collection, which consisted of the design of questionnaires and interviews with engineers and technical managers, who were applied the questionnaire designed executed. In the questionnaires a series of questions based on the methodologies of data networks used by companies established, these questions assessment methodologies were established according to the selection criteria for proposed methodology Rafael Menendez Barzanallana Asensio indicators were instituted evaluation to estimate the benefits that represent the use of methodologies and which mostly applies.

Finally, to evaluate the hypothesis methodology data network with the highest score resulting from the sum of the established indicators was considered.

V. RESULTS

By collecting information based on surveys of companies active dedicate to the implementation of data networks in the city of Machala, we could determine the method most commonly used in designing data networks LAN type.

In the process of research, the study population was 10 companies, of which 90% said that if they use methodologies for implementing a data network, only one company does not employ methodologies because through this process empirically based on their experiences in this activity.

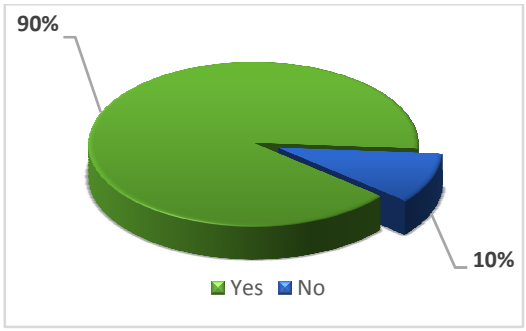

Fig. 6: Companies using methodologies

The 90% of companies equivalent to 9 full use methodologies for network implementation, while 10% say the opposite.

Then the evaluation results of the design methodologies for network data is presented. The table presents the abbreviations used to identify each of the companies is shown.

TABLE IX: COMPANIES AND ABBREVIATIONS

Companies and abbreviations	
Abbreviation	Definition
C1	Infotecsa Computación
C2	Datos PC
C3	Red Access
C4	PuntoNet
C5	Distrited
C6	Telnet
C7	Telecom
C8	Machala Net S.A.
C9	Sistel

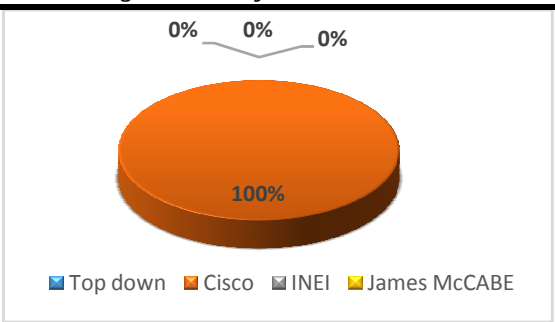

Fig. 7: Methodologies for implementing a data network

One can see that all companies that apply methodologies for implementing a network, use the CISCO, because it is the best known and is a standard, plus multiple facilities offered in the availability of information and training for implementation of this activity.

TABLE X: CISCO INDICATORS EVALUATED ON METHODOLOGY

Metric / Indicator	CISCO									
	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	Total
Adaptability	5	5	5	5	5	5	5	5	5	5,0
Scope	5	5	5	5	5	5	4	5	5	4,9
Traceability	5	5	5	5	5	5	5	5	5	5,0
Security	4	5	5	5	5	5	5	5	4	4,8
Tests	4	5	4	5	5	5	4	5	4	4,6
Accuracy	4	4	5	4	4	5	4	5	5	4,4
Operability	5	4	4	5	5	3	4	4	5	4,3
Documentation	5	5	5	5	5	5	5	5	5	5,0
Usability	5	3	4	4	4	5	5	5	5	4,4
Stability	5	5	5	5	5	5	5	5	5	5,0
Profitability	3	3	4	4	5	4	5	4	4	4,0

According to expert opinion indicates that among the methodologies: TOP-DOWN, CISCO, INEI and James McCabe the best known and implemented in the environment are methodologies TOP-DOWN and CISCO, since the other two are not applied because of the small content that exists in research sources and in turn little knowledge on the part of individuals who develop design projects data networks.

From this the result obtained from the evaluation of the TOP-DOWN, which was considered methodology is presented.

TABLE XI: CISCO INDICATORS EVALUATED ON METHODOLOGY

Metric / Indicator	TOP-DOWN
Adaptability	5,0
Scope	5,0
Traceability	5,0
Security	4,0
Tests	4,0
Accuracy	4,0
Operability	4,0
Documentation	5,0
Usability	4,0
Stability	5,0
Profitability	3,0

To make a comparison between both methodologies evaluated the following statistical graph is presented.

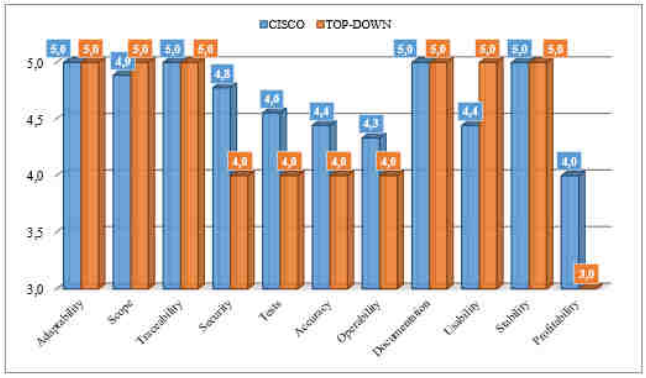

Fig. 8: Comparative between the methodology CISCO AND TOP-DOWN

According to the indicators evaluated and according to the score obtained can state the following:

Both CISCO as the TOP-DOWN methodology can be adapted quickly to any changes occurring, both network design and implementation, likewise with the objectives of the company and the customer who requires this service. These methodologies are able to integrate into any project regardless of its size, it should be emphasized that this methodology can be applied not only within a LAN, but also various types of data networks. Allow monitoring or control activities carried out in the course of development ensuring that the network to be implemented successfully meets the requirements of business that have been requested.

Between the two methodologies can be seen that one of the aspects that can be obtained through its application is the facility that offers companies to implement security measures, although there is little difference between the two, but it is remarkable the advantage offered in the design of data networks, also testing for verification of network performance data and more accurate approach to customer needs. With regard to documentation and again, let out in detail each of the stages and responsible life cycle that involves the implementation of the network. The CISCO is a methodology that unlike the TOP-DOWN provides users with training and information

regarding not only about its methodology is one of the most applied worldwide, but also about their products and metrics in general.

With regard to profitability indicator you can show that the use of these methodologies allows reducing costs and increasing profits as their primary focus is to try to define the lows activities required, both technology and the complexity of the network.

VI. DISCUSSION

By the results of research in the various entities that implement communication networks or data in the city of Machala, you can justify the importance of applying design methodologies networking implementation projects based on their own opinions expressed experts working in this field.

All entities that make use of these methodologies apply CISCO, validating the second hypothesis that this methodology is the most widely used due to the characteristics and advantages of and therefore can be given precedence over others when design a network.

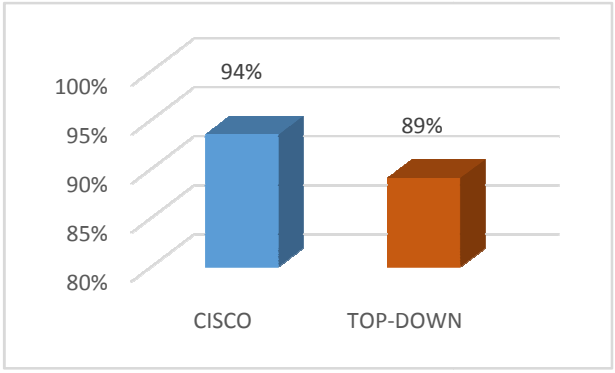

Fig. 9: Total percentage according to the assessment indicators.

The CISCO methodology meets 94% according to the assessment indicators, not far is the percentage of TOP-DOWN which is 89%, therefore, can ensure that the use of any of these, is very favorable since certify effectiveness in developing networks and multiple benefits such as adaptability, scope, traceability, safety, testing, accuracy, operability, documentation, usability, stability and profitability.

The manager of PC data (respondent company dedicated to the implementation of data networks in the city of Machala), supports positive change that arises by applying a network because of its benefits as improved stability and network security, return on investment and increase the value of the network in project management and marketing strategies that will enable the company to deliver solutions according to time and within budget.

That is why through the information obtained based companies engaged in the implementation of data networks in the city of Machala, criteria for professionals in this field and according to studies the hypothesis is approved, considering of great importance to network design methodologies for obtaining benefits within implementation projects. It would be important to future cover other data networks in this way to make comparisons and see how the methodology adapts depending on the size and type of data network.

VII. CONCLUSIONS

- The use of a methodology for network design largely benefit the implementation and success you will have.
- It can show that use of methodologies especially the CISCO methodology are made because it is the best known and standard, plus multiple facilities offered in the availability of information and training for the implementation of this activity.
- In most companies prefer choose to use this methodology because it allows them to adapt quickly to any changes occurring, both network design and implementation, likewise with the objectives of the company and the customer It requires this service.
- All companies determined that the CISCO methodology was one of the improvements that they used it as not only allowed them to work in the design of a LAN, but also other types of data networks.
- In addition, the use of CISCO methodology provides a cost-cutting a large increase in profits as it focuses on defining the minimum activities required both technology and the complexity of the network.
- Through the results observed which is the most used and in turn the most used by companies in the city of Machala tool.

REFERENCES

[1] C. Pérez y S. de los Cobos Silva, «Diseño óptimo de redes y enrutamiento de computadoras: Caso Práctico,» *Revista de Matemática: Teoría y Aplicaciones,* 2009.

[2] W. Stallings, Comunicaciones y Redes de Computadoras, Séptima edición ed., Madrid: PEARSON EDUCACIÓN, 2004.

[3] G. M. Bogdan Ciubotaru, Advanced Network Programming - Principles and Techniques, Springer, 2013.

[4] J. Arora, S. Pal y R. Bhatt, «Computer Communication Networks: Use of Modern Information Technologies for Information Retrieval & Dissemination».

[5] T. Andrew, Redes de computadoras, Cuarta edición

ed., México: PEARSON EDUCACIÓN, 2003.

[6] D. B. Peterson Larry, Computer Networks a systems approach, San Francisco: Elsevier, Inc, 2007.

[7] P. Oppenheimer, Top-Down Design, Tercera edición ed., USA: Cisco Systems, 2011.

[8] Cisco, «An Introduction to the Cisco Lifecycle Servicies Approach,» 2008.

[9] Cisco, «El mundo está Cambiando ¿Está su Red Lista?,» 2006.

[10] INEI, « Instituto Nacional de Estadística e Informática,» [En línea]. Available: https://www.inei.gob.pe/.

[11] J. McCabe, Practical computer network analysis and design, San Francisco, 1997.

[12] E. Menéndez Nava, «Modelo de evaluación para metolodías de desarrollo de software,» *Academia*, vol. I, nº 1, pp. 1-50, 2006.