Optimization of the Qualification Process to Improve Products and Services in a Telecommunication Industry

Mellanie Santiago Dasta
Manufacturing Engineering
Jose A. Morales, PhD.
Industrial Engineering Department
Polytechnic University of Puerto Rico

Abstract *— This design was based on standardizing the qualification process, reduce the time to increase production and improve the process of updating the information on the server. The Kaizen event helped to solve different problems and conditions found in the qualification process to provide customers with high quality products and services. Also create a working group responsible for providing solutions and ideas. The value stream map and the elimination waste were performed to identify the value added and non-value added in each step of the process. The results with the plan implementation were favorable allowing savings to the company, reducing the time by 70% and increasing production by 41% in six months with the help of a staff committed to continuous improvement to compliance with the proposed objectives.*

Key Terms – *Kaizen for Telecommunication, Lean Manufacturing, Server Process Improvement, Telecommunication Systems.*

INTRODUCTION

The telecommunications industry is continuously growing and adapting to constant technological advancements which have allowed it to diversify its products, therefore expanding its offer and attracting more clients. This means that customers are more demanding because they expect better services and competitive products. These demands could not be satisfied without a process that verify the quality of the outside plant, identify and locate potential problems and check the network connectivity and performance to ensure service. An ineffective qualification process will have a negative effect on outside plant operations. For this reason companies need to optimize the qualification process with the necessary support of the employees for achieve in a specified time the delivery of the tests. Following the assessment and equipment to qualify lines, companies can determine the services that can be offered to customers, such as voice, video and Internet.

Research Description

The purpose of this investigation is to reduce the time factor for delivery of the tests. The qualification process allow to update client profiles more effectively on NetServer, which contains client's information such as the primary phone number and the line test results, analyze data obtained through NetDSL, the equipment responsible for collecting identification and testing the pair conditions. This information makes it possible to update the physical inventory of each pair in the distribution boxes and to determine which pairs meet technology standards like ADSL2 +, VDSL2, VoIP and IPTV to offer customers high-speed Internet, voice and video quality and new services that are being developed. By strengthening this process the company would be able to focus on periodical maintenance and running excellent operations.

Research Objectives

The objectives of the investigation is fulfill the requirements of the design project which are standardize the process of qualification, reduce the test time to increase a 50% of productivity in six months and improve the process of updating information on the server.

Research Contributions

The main contributions of this project are to analyze the data obtained to provide large-scale services and to identify areas that would benefit, helping the company to be more efficient and

competitive, identify the failures in the process, increasing sales, reduce customer service call complaints, attract new customers and retain existing.

LITERATURE REVIEW

The telephony is the main telecommunications network; it allows customers to talk to each other regardless of the distance. This network can be used for placing data communications equipment from analog to digital, allowing new services at a lower cost. The main mechanism responsible for greater capacity and speed in networking equipment is the commutation [1], which permits the conveyance of signals between defined termination points by wire, optical, to offer Internet services, video and voice.

The facilities of a telecommunications company are divided between external and internal. The internal plant refers to buildings where communication offices are. The central office is the place, building or container where the switching equipment and other equipment needed to provide services. The outside plant consists of elements that are installed on the outside of the central office. The external network is composed of distribution boxes, terminals, rails, poles and wires. The outside plant is divided into two segments: the link network and the subscriber network. The link network is constituted by the power circuits linking each other using different transmission media such as wires or optical fiber pairs. The subscriber network is the set of connecting elements between the subscriber equipment and the local exchange to which it belongs so that each is assigned a single circuit. This is illustrated in Figure 1.

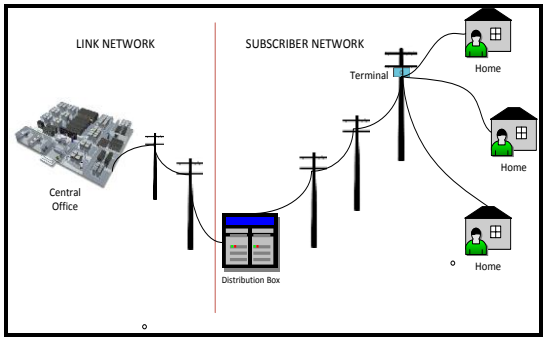

Figure 1
Link Network and Subscriber Network

The elements of the link network are [2]:

- **Main Distribution Frame (MDF):** Makes the connection between the external plant and communication equipment. Its aim is to connect outside plant pair cables to the communication equipment.
- **Frame:** Metallic structure that supports the rest of the elements of the distributor.
- **Vertical side:** A series of connecting elements, such as the strips placed in columns, where the copper pairs of the outside plant terminate.
- **Horizontal side:** Locates opposite to the vertical, where the termination is effected for subscribers of the Private Branch Exchange.
- **Jumper Bridges:** Copper pairs of isolated metallic conductors which are used to connect each external plant pair with its matching thread from the central line.
- **Interconnection Point:** An element that bridged by wire connects an input pair with any of the output.
- **Distribution Point:** Is the last point of the cable network from which individual copper pairs are distributed to customer's homes. This item consists of distribution boxes, terminals, poles and cables. This is illustrated in Figure 2.

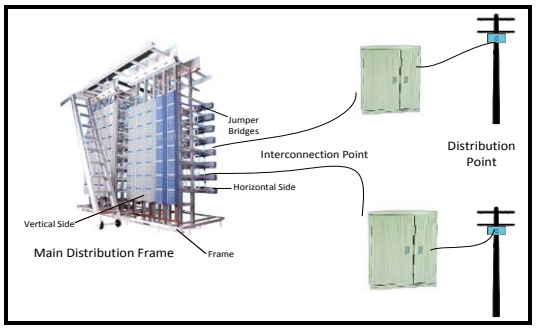

Figure 2
Main Distribution Frame, Interconnection and Distribution Point

The cables used are formed by the black wire two coppered steel. If more pairs of copper wires are used over the amount needed. The subscriber loop is two-wire and is used for transmission and reception. Three types of wires, these are symmetrical pair cables, pair cables and pair cables quads. Coaxial cables are used in telephony as a transmission medium for high binding capacity

plants. It consists of two copper or aluminum conductors inserted into one another and separated by an insulating material, preventing radiation losses [2].

Qualification process verifies the quality of the copper pairs, update the data in the server, identify and locate problems to ensure operation, check the network connectivity and performance to ensure services and meet customer expectations. The process begins when the DaVaR Test Technician connect two test heads, testing two copper pairs at the same time, either on the main distribution frame or the distribution box. Then connects the test heads to the two ETAMs. The ETAMs are a portable modules that add more capacity to test a large number of copper pairs. The NetDSL have a laptop that contains the software responsible for obtaining the data of the copper pairs. When the test is finished, the information is sent to Davar NetServer Data Management System and transferred to the loop record database, the person in charge is the DaVaR Server Operator. This information is can be accessed in a web interface where the reports and the information in the outside plant pairs are saved, the person who verifies this data is the DaVaR Program Manager [3].

The equipment used for qualification testing is the DaVaR NetDSL which provides bulk record purification, VDSL qualification and single pair testing applications. DaVaR means Data Validation and Reporting. The platform performs testing and sends result back to the DaVaR NetServer to store results and perform automated updates to the loop records database facilitating the management of the entire program. The equipment has the capacity to offer a fast and accurate qualification of the service level for busy and free lines to determine service levels POTS, ADSL2, ADSL2+ or VDSL.

These are the features and advantages:

- A system that performs through testing to detect mismatches and asses the overall quality of the pair including capacitive and resistive faults, joints, split pairs, impulse noise, longitudinal symmetry and loading coils for different services.
- Calculates in real time inbound and outbound bandwidth.
- Provides a user-defined profiles and selected electrical tests with results included.

DaVaR NetDSL comes in a small, lightweight and battery operated briefcase to carry out on any network situation. It is resistant and reliable. The equipment has a high performance for quick checks on several copper pairs. See Figure 3 [3]. By configuring up to four test heads to check two pairs simultaneously, DSL qualification testing performs a quick verification of records, up to 2,000 pairs a day (Main Distribution Frame) and 1,200 pairs a day (Distribution Box) for dual engine configuration.

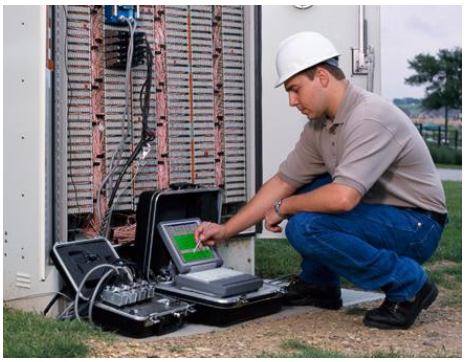

Figure 3
NetDSL

The most significant challenge is delivering “triple-play” services (Internet, Video and Voice) over copper facilities. The greater the distance a signal must travel through copper, the lower the available bandwidth. It demands the best performance of copper facilities since the amount of data you have to go through a twisted pair is greater.

ADLS2+ specified by ITU G992.5 which was approved on March 2003. ADSL2 + falls so that loops over 3km long converge with ADSL, ADSL2 and ADSL2 +. Such convergence is due to increased attenuation and crosstalk with distance, which particularly affects high frequencies representing the progressive deactivation of the band between 1.1MHz and 2MHz. For the 1.1MHz band there are variations of attenuation by

increasing distance but are similar to those of ADSL2.

ITU approved norm G.993.2, VDLS2, as a broadband access system via copper telephone wire that is several times faster than ADSL2+. It allows for bringing broadband services through fiber optic and distribute them by the building or office using copper cables, which is much cheaper to install and easy to manipulate. VDSL2 is expected to deliver 25MB at a 3,000 feet distance; for this clean, copper is required and when video is included, a sustained speed is required.

IPTV (Internet Protocol Television is the distribution of TV channels, movies, text, graphics, data, video and audio content on demand over a broadband IP network private. This system is used for digital TV services to registered customers. The sending of digital TV is via Internet Protocol using broadband connections at the client side.

Voice over IP (VoIP) has brought savings to telecommunications. VoIP requires only an IP network connection, a laptop with a sound card and software or an IP phone. VoIP supports voice, fax and voice message being conveyed by the IP network instead of using the conventional public network, fixed or mobile.

Lean Manufacturing helps to find the best solution to reduce the time and standardize the qualification process. Also helps companies stay competitive by serving its customers better and continuously reducing costs and improvement. Lean seeks to provide products or services at the highest quality at the lower cost in the shortest time. Implies reduce costs by eliminating activation that don't added value to the product. The goals of Lean Principle are eliminated wasted time, effort and material while improving throughput and quality [4].

Value Stream Analysis is the collection of processes and activities required to bring a product to the customer, from beginning to end, according to [5]. The Value Stream is not limited by boundaries between companies; that are the reason to strive to integrate suppliers, manufacturers, distributors and even retailers in the efforts to recognize and analyze the Value Stream.

A value stream map is lean technique used to analyze the various activities, the flow of materials and information that are performed to move the final product from supplier to customer. Many of these activities will be value added as well as non-value added (waste), which have somehow existed in the organization for a variety of reasons, according the Manufacturing Handbook of Best Practices [4].

Waste is another basic principle of lean manufacturing. Exist two fundamental types of waste must be considered: obvious and hidden. The obvious waste is easily recognizable and can be eliminated with little or no cost. The tools to be used in this investigation are the elimination of the "seven deadly wastes" and Kaizen. Eliminate the "Seven Deadly Waste" is the focus of Lean from the process, according to [6]. Either type of waste can further be classified into seven different types. These are overproduction, waiting, transportation, processing, inventory and defects.

The overproduction is doing any work that does not add value. The waiting is the biggest waste of craft capacity stems from waiting. Typical areas where this loss occurs are waiting to be assigned a job, waiting for permit approval and waiting for access to a computer to document. The transportation occurs when people are required to travel unnecessarily. This waste may be due to effective planning and poor coordination of work. The processing waste occur due to inefficiencies arise where repetitive steps and extra work. This may arise due to steps unnecessary or a poor design. The inventory waste is due to an excess of material that makes the cost and resource consumption increases. The motion occurs due to unnecessary movements on a specific task. The defects are numerous, may be missing or inadequate training, poor working tools and processes are not effective [7].

Another process besides Lean Manufacturing used to resolve problems and implement new ideas is known as Kaizen. Kaizen is "continuous improvement" and constant elimination of waste through bettering product quality, improving worker safety, and reducing costs, implemented

through the efforts of employees, according to [4]. Kaizen events are focused, intensive rapid improvement efforts using cross-functional teams targeted at a specific problem or opportunity, [4]. These events generate significant momentum and energy and get a lot of people involved in making improvements. The team analyzes the high priority failure modes to determine their causes and brainstorms solutions, according to [8]. The Kaizen event can be planned using a nine-step methodology over the course of the weeks, as shown in Figure 4 [4]. This methodology is used for generating and evaluating a variety of ideas that help a group of leaders and managers in the process. According to [8], the team uses a methodology to generate possibilities in order to find a viable solution to fix the process.

Figure 4
Generalized Kaizen Team Activity

METHODOLOGY

The methodology will be developed using an experimental investigation and a qualitative analysis. These two methods help to acquire information to reduce the time to increase production, obtain pair test results and update the books. The development of the research will focus on experimental analysis involved with the causes and effects of the qualification process. Furthermore, the analysis is to evaluate the impact of the bottleneck that is manually edited when the DaVaR NetServer information does not match the data are collected in the field.

A qualitative analysis will help to understand the different problems and conditions that can occur during the qualification process. In this study will interview one participant to analyze the process. The observation is directed to the elimination of waste and Kaizen analysis. The steps to be follow to meet the proposed objectives are the following:

- **Interview:** This evaluation method will help to evaluate and identify problems that occur when performing the qualification process. In this interview will know what the steps are unnecessary, verifies the percent of updating the books and tools that do not add value to the process.
- **Analyze the qualification process and the historical data of the number of copper pairs tested:** The objectives are to analyze each process step in order to test a large number of pairs thereby obtaining the results and update the books. In addition to investigate the time it takes the technician performing the process.
- **Create a Value Stream Map:** The value stream map represents the whole process of identifying activities, the time and the tools that are used to obtain the necessary information like as map of the process, identify waste that can be eliminated and the bottlenecks found in the process.
- **Define the time reduction magnitude**: It is essential to understand the importance of reducing the time factor for continuously improving processes, helping to increase production.
- **Develop the elements of Lean Manufacturing:** Lean Manufacturing to be developed is Kaizen. This event will help to identify goals, define the objectives and choose the person who performs in the qualification process. Of this manner, to conduct a brainstorming and identify the value added and non-value added in the process.
- **Implement solutions to improve the process:** In this step, analyze the best solution to help standardize the process, reduce the time and improve the process of updating the books on the server. Further, the process will continue looking to improve the current process and provide continuous improvement.

- **Analyze the recollected data:** The data collected will be analyzed according to the results of value stream map, seven ways for eliminate waste and the Kaizen Methodology. This analysis will implement a reduction or omission of unnecessary steps.

RESULTS AND ANALYSIS

The results analysis is based according methodology to achieve the objectives.

Establish Vision and Objectives

The vision is improving the qualification process for the quality, safety, productivity and efficiency of our products and services to deliver an excellent service. The objective are standardize the process of qualification, reduces the test time to increase 50% in six months of productivity and improve the process of updating information on the server.

Identify the process leader and team

The leader of the qualification process is the DaVaR Program Manager. He is responsible for completing the Kaizen event, has the authority to order the necessary tools, reduce costs and track the progress. The team consists of one DaVaR Server Operator and four DaVaR Test Technicians that will help provide ideas and solutions and have experience working with the equipment.

Define the scope

The scope of the project is to find the bottleneck to reduce the time and therefore increase production by 50% in six months. The activities begin from the monitoring of the travel time of the technician to the distribution box, check the test file that performs in NetDSL and the time that the technician upload the information and the NetServer update the books. Also train and clarify doubts technicians to perform better. The results and improvements will help to reduce the cost to ensure functionality and efficiency of the qualification process.

Document the current situation

The current situation was documented by an interview with the DaVaR Program Manager. In this interview obtain the importance of updating the books, the tools they use, problems that cause delays and analyze the file of the NetDSL to find the bottleneck of the process.

The process begins when the DaVaR Test Technician reaches the work area, call DaVaR Server Operator to send the current data stored in the NetServer, which has data pairs found in the distribution box. If the DaVaR Test Technician doesn't find the address needs to call an employee that works in that area and ask for directions. Arriving verifies that the distribution box and the test heads are compatible and have enough space to connect them. Place the four test heads, one ETAM and begin testing 100 pairs, one pair at a time. Then start the car to have power in order to connect the inverter to the NetDSL. Start self-tests which begin to get electrical testing and reporting of all pairs. At the end of the first 100 pairs, the technician removes the test heads to begin testing the next 100. After the tests, manually start editing what NetDSL could not recognize using a telephone test set. This way you get the phone number and position of the pair, but no electrical testing. Elapse of 4 to 5 days the tests are completed, the time depends on the number of pairs having the distribution box. The maximum copper pairs that can be found in the distribution box are 2,400 pairs. After, completing these tasks is directed to the work area to send the updated file via company local area network. The DaVaR Server Operator located in the office makes a download of information through the technician and the data is automatically updated. The data that was not updated is done manually. The DaVaR Server Operator uses the Excel program and looking at all the information systems is correct to perform the manual work.

The importance of updating the book is based on a system that maintains an inventory of hardware and software of the pairs to avoid losing customers. The systems to have be 100% accurate with the distribution box.

According to the DaVaR Program Manager typical problems are weather, equipment malfunction damaged inverters, vehicle problems, lack of vehicles and Internet connectivity.

NetServer indicates that has been updated a total of 139,221 pairs in seven months. This is illustrated in the Table 1.

Table 1
Total Copper Pairs in Seven Months

Month	Year	Total Copper Pairs
September	2010	16,604
October	2010	9,317
November	2010	14,144
December	2010	20,364
January	2011	14,162
February	2011	20,601
March	2011	44,029
TOTAL		139,221

Table 2 shows how much information technicians perform manually and how much was done automatically using NetServer and NetDSL to update books.

Table 2
Information made Manual and Automatically in Seven Months

	Automatic (%)	Manual (%)
NetDSL	60	40
NetServer	20	80

Table 3 shows the number of employees working in different areas, the approximate cost per hour and hours worked weekly.

Table 3
Employees, Cost and Working Hours in Seven Months

	Employment	Cost ($/hr)	Hours/wk
DaVaR Test Technician	12	15	40
DaVaR Server Operator	3	15	40

Estimated cost about 139,221 pairs made in the first seven months. See Equation (1).

$$Estimated\ Total\ Cost = 36{,}000\frac{\$}{mo} * 7\_mo = \$256{,}000 \quad (1)$$

Table 4 shows the number of vehicles and tools used by DaVaR Test Technician to perform their jobs.

Table 4
Inventory

Inventory		
Tools	Operating	Damaged
Cars	8	
NetDSL	12	3
ETAM	28	12
Test Heads	36	12
Rain Coat	4	
Inverters	8	5
Awnings	0	
Batteries 10V	5	
Safety Shoes	0	

Conduct the Kaizen Event

Kaizen Event permits monitor and identify the steps to implement an alternatives for improve the qualification process.

- **Value Stream Map:** Presents the steps of the value qualification process since DaVaR Test Technician leaves the work area until update the information in the NetServer, in which time was measured and analyzed the tasks performed in each step.
- **Define the times of each step involved in the qualification process:** The time of arrival and departure from work is 8:00 a.m. to 5:00 pm. The time to get the file current information NetServer is 1 hour. The travel time from the workplace to the distribution box is 30 minutes to one hour and a half. Time to check and fix the distribution box to make room for the test heads is 30 minutes to 4 hours. Time to place the NetDSL, ETAM and four test heads are 15 minutes. Time it takes to test each pair the NetDSL is 90 seconds. Time it takes to DaVaR Test Technician in manually fix information was not obtained from the distribution box and NetDSL is one day to two days. Time to send the updated file to NetSever is 15 minutes but it is delivered the next day in order to complete all tests. Time it takes to DaVaR Test Technician to complete the update NetDSL are 5 days. Time it takes to DaVaR Server Operator in the books manually update the data that cannot be performed automatically

between NetDSL and NetServer are 5 days. Total time to complete the qualification process is 7.6 days. The time to test 100 pair is 90 minutes.

- **Eliminate Waste**
  - **Overproduction:** DaVaR Server Operator have an accumulation of printed documents to complete the manual since updated information on the NetServer pairs tested.
  - **Waiting:** DaVaR Test Technician waiting for the file to be send to begin to work. DaVaR Server Operator waiting for the Davar Test Technician for them to send the updated file to synchronize with the NetServer. DaVaR Program Manager waiting equipment was sent to fix. Waiting for the DaVaR Server Operator update the books to complete the process.
  - **Transportation:** Looking where are located the distribution box with the help of the area technician. Getting on the site and find that it is not suitable to work and return to their base area to download a new file.
  - **Processing:** Verify that the distribution box is suitable and the heads are compatible.
  - **Inventory.** Each DaVaR Test Technician has one NetDSL, one ETAM and four test heads to test 100 pairs at time.
  - **Motion:** Manually update the errors obtained from the distribution box that did not understand the NetDSL. Also manually update information that not updated the NetServer to update the books.
  - **Defects:** DaVaR Server Operator doesn't have knowledge of Excel.
- **Value Added & Non-Value Added.** Table 5 shows the value added and non-value added in the first seven months for the qualification process.

Table 5
Value Added & Non-Value Added in 7 months

Value Added	Non-Value Added
Support to the DavarTechnician Test when he have doubts using the NetDSL	Find how to get to the site or call a technician in the area to explain how to arrive.
Having a test phone in case of not getting the results through the NetDSL.	Verify that the distribution box is suitable and test heads function correctly.
	Fix the cables in the distribution box to place the test heads.
	Back to the workplace if the distribution box is not suitable, to download another file to work.
	Test a one pair at a time until complete 100.
	When you get an error you can only get the information from the port but not the electrical tests.
	Manually update the information the NetDSL doesn't found.
	Manually update when information of the books could not be done for any error or lack of information NetServer.

Solutions to Perform in the Qualification Process

The DaVaR Test Technicians must enroll in and out to prevent and control over time. Give to the DaVaR Test Technician a Global Position System (GPS) coordinates of the sites to work to avoid wasting time looking at arrival and departure. Fix test heads and ETAM and fix NetDSL to have more than one in spare in case they damaged.Direct supervision to keep them in their work area either personally or by placing the cars GPS monitoring system. Internet access from the distribution box port in case the file is corrupted or need to move to another distribution box to access information rather than return to their workplace. Choosing a DaVaR Test Technician to verify every Friday which distribution box is ready to test. Buy tools and keep spares. Check and edit the profile from NetDSL to test only the seven most important tests. Continuous checking of vehicles using by technicians. Getting two more vehicles for two technicians who have not. Place 10 technicians working in the field to make a greater number of sites. The other five technicians work in the office. Increasing the amount DaVaR Server Operator to update as many pairs as possible.

Developing the Plan

This is the plan to develop the best results of the qualification process.

- **The bottleneck is in the manual edited technician performs NetServer.** Move two field employees.Send to take Excel training for the DaVaR Server Operator.
- **The other bottleneck is in the manual edited information that is not obtained NetDSL.** Training for DaVaR Test Technician about the use of the NetDSL Check that all machines have the latest software and check that performs tests NetDSL.
- **Improve the times at each step.** Send to DaVaR Test Technician every Friday with the priority list to work next week to check if the distribution box is fit, if the test heads are compatible, fix jumpers and get the coordinates. Change of time goes from 7:00 am to 4:00 pm. Punch in and out. Give each employee a Global Position System (GPS). Indicate the test port that has Internet access for connecting a modem. Configure computers to access the company's local LAN.
- **Inventory.** Fix damaged equipment. Give one NetDSL, two ETAM, eight test heads and a modem to each technician. Buy the tools such as: inverters, rain coat, awnings, batteries 10V, safety shoes and get two cars. Direct or indirect supervision to keep you in your work area. Put a GPS in the car to monitor. Visit your workspace.

Implement the Plan

By implementing the plan we found:

- **Improvements in time.** Changing the time of entry and exit of the technicians avoid peak hour traffic. Enrolling the in and out time decreased delays and excessive overtime was avoided. On Fridays DaVaR Program Manager sends a DaVaR Test Technician with a list of cases that have priority, ensuring that the distribution boxes are free of ants, rats and weeding. The test heads are also compatible with the distribution box, arrange the jumpers to make space for the test heads and take the coordinates of each site .It gave the Global Position System (GPS) to avoid losing or call technical area to explain how to get to the site with the coordinates the DaVaR technician arrive faster to the work area and spend more time on the site because they know how to get back to their workplace to complete the task of the day is more time. Identified the test port to connect the modem. DaVaR Test Technician can download the NetServer file in case that the distribution box cannot be performed or switch for this priority. All machines were configured to access the company intranet.
- **Bottleneck in the manual work that make the DaVaR Server Operator.** Two employees were placed from the field as they have experience with the system to update books. DaVaR Server Operators were trained for 5 days in Excel, to improve skills and make the edit more easily instead of printing the documents.
- **Bottleneck in manually edit the information that is not obtained NetDSL.** Errors that reflected was due was because the NetDSL not have the latest software. Choose more experienced technicians to give them training to the newest to clarify doubts and questions.The eleven tests performed with the NetDSL only were used the seven tests more important. These are: the distance from the central office to the distribution box and distribution box to the customer's home, capacitance, resistance, inductance, ground, tip and ring, telephone number and the port number. The results are used for various projects and other areas to identify sites that have fewer breakdowns or do not have pairs available. It was told to the manufacturer to make change for the profile of the NetDSL reducing the testing time for each pair of 90 seconds to 75 seconds.
- **Inventory.** The equipments were sent to repair. A technician was given a NetDSL, two ETAM, eight test heads and a modem to test two pairs at a time for complete 200 pairs in 42 minutes. The purchase of tools helps the productivity. For example, the use of the inverter is kept lit NetDSL when the batteries only lasted 4 hours. Also the rain coat and awnings helped with

inclement weather and safety shoes to prevent accidents. Two additional cars to have 10 employees working 10 distribution boxes at a same time. Thus complete 20 sites 13 more than before. Direct or indirect supervision to keep employees in their work area. Remote monitoring with GPS was found that some employees did personal things and said they were in their work area when they were not, so the time was controlled to keep your workspace in performing the task.

Results

Eliminating non-value added in the new process was completed in three days from 2.8days. Times improved considerably evidenced by the following Table 6:

Table 6
Time Before and After

	Time	
Activities	Before	After
Working Hours	8:00am – 5:00pm	7:00am – 4:00pm
Receive the file	1 hour	20 minutes
Travel	1 hour	30 minutes
Connect NetDSL, ETAM and Test Heads	30 minutes	15 minutes
Verify and fix the distribution box.	40 minutes	0 minutes
Start Testing (2,400 copper pairs)	25 min/100 pairs	42min/200 pairs
Pick the equipment	25 min	25 min
Lunch	1hr	1 hr
Edit manual information	1 a 2 days	1 day
Sent information to the NetServer	30 minutes	30 minutes
Update the books	30 minutes	30 minutes
Edit no update information	5 days	1 days
Total time of the process	7.6 days	2.8 days

The manual process performed with 20% decreased for NetDSL and 10% for NetDSL with the help of the trainings. See table 7.

Table 7
Information Made Manual and Automatically in Six Months

	Automatic (%)	Manual (%)
NetDSL	80	20
NetServer	30	70

The improvements in the process, increased copper pairs tested for the month of August and September (Figure 5). The total of six months pairs was compared to 249.451 pairs the first 7 months of 139.221.

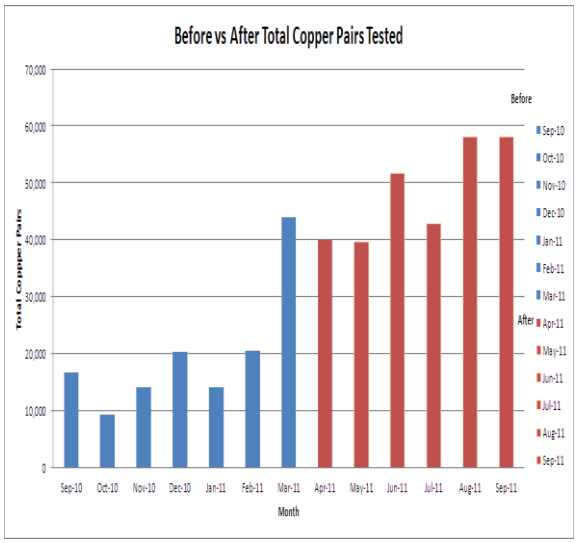

Figure 5
Total Copper pairs Tested: Before and After

The estimated costs of 249.451 pairs in these six months of implementation of the work plan. See Equation (2).

$$Estimated\ Total\ Cost = 36{,}000\frac{\$}{mo} * 6\ mo = 216{,}000 \quad (2)$$

It is shown graphically in Figure 6 the comparison of pairs of copper versus the cost savings within six months of the implementation of the plan.

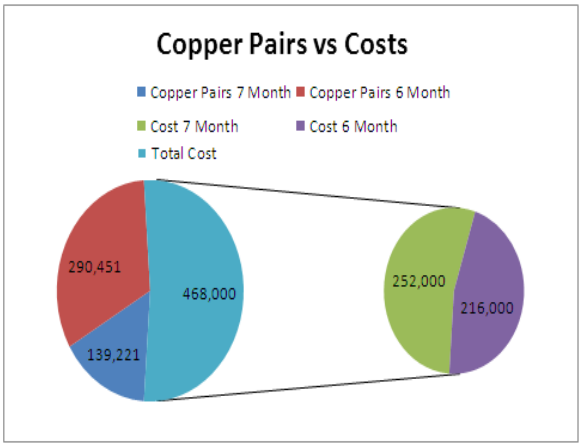

Figure 6
Copper Pairs vs Costs

Table 8 shows the value of the T-Distribution where the hypothesis was fulfilled in the time factor having a significant change in the six months for the qualification process.

Table 8
T- Distribution

Hypothesis	A= after & B=before
H_0: $\mu_B = \mu_A$	$\overline{X}_A$ =7.6 days $\overline{X}_B$ =2.8 days
H_1: $\mu_B > \mu_A$	σ_A= 0.33 σ_B= 0.47 V=8.9
Texp>Tcrit.	204>1.86
If significant change	

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the reduction in the time factor was 70% allowing the production increase to 41% in six months of productivity. No compliance with the 50% outlined in the objectives at the beginning of the design project but a significant change in the total process time which decreased from ten days to three days. This was due to staff movements in the different areas, by having ten people working directly on the field, the monitoring employees and the changes of the profile NetDSL tests, reducing test time of each pair. In the office five people updating and editing the information, to complete twenty sites weekly compared of the seven sites that were performed. The updating data on the server increased only by 30%, where 70% are still doing manual. In this part of the process require a continuous improvement to reduce the information manually to exceed targets.

The achievements were to form a unified group in order to find new solutions and ideas with the help of Kaizen event. Also determined non-value added to the process for standardize and a control of the expenses and resources. The cost savings in these six months was an investment to cover the repair of equipment, purchase of GPS, training and tools essential for the qualification process.

Recommendations to maintain 100% updated the books are add in the process when the customer want a service and the technician identify if the port is available or damaged. The priority immediately is report the information and update to avoid lose customers. Also seek help to the manufacturer to improve automatic update and verify the data with the most current system. All these improvements were made and the continuous improvement of the qualification process that would lead to a reduction in maintenance costs in the future, avoiding double dispatches, reducing re-works to give the customer quality products and services.

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