

Design of a Quality Management in Operations of Metrotrans, Inc. using DMADV Methodology

Krizalis Encarnación Díaz
Master of Engineering in Manufacturing Engineering
Carlos Gonzalez, Ph.D.
Industrial Engineering Department
Polytechnic University of Puerto Rico

Abstract — *This research will be focusing on the design of a quality system in operations of transportation for the company Metrotrans, Inc. The design shall establish the timing of the operations related to the services offered by public transportation as a private company. The quality system ensures the customer satisfaction, reduced costs, competitiveness and minimization of failures. This is important for the continuous improvement as progress the services offered. The main focus is the satisfaction of the customer taking into consideration the factors of time and service. The quality of the service is to identify the primary needs of the customer, guidance to employees involved in the services, to establish channels of internal communication, internal/external evaluation of the service and determine areas of improvement. For the time factor, are set timetables of routes which include unexpected situations such as: accidents, floods, detour, among others. In order to implement the quality system, DMAVD (Defined, Measure, Analyze, Design and Verify) tool for organize the project will be used.*

Key Terms — *Customer, DMADV, Quality, Service.*

INTRODUCTION

Public transportation tends to adapt to a need of citizenship considering schedules and routes. The transportation service requires establishing a fee that may be accessible but can be profitable to pay for preventive maintenance of the buses, fuel and salary of drivers. In Puerto Rico, the public transportation system consisting of buses, buses "step on and run", train and boat. The components of the public transportation system do not have the

preventive maintenance required for which the service is not affected and profitable.

PROBLEM STATEMENT

Puerto Rico has a public transportation system inefficient and little synchronized. Government agencies have made efforts to ensure that the transport system take importance and that the service offered is of a high quality. However, the transportation system has multiple deficiencies that range from the inefficient management of the equipment and materials to the poor service offered. So, the majority of citizens opt to use private transportation. This was reviewed in the written "Alternatives that do not work" of the newspaper El Nuevo Día [1].

This research project is focused on the implementation of a design to help standardize the internal processes of the company and to offer a quality service to customers.

RESEARCH DESCRIPTION

The Metropolitan Bus Authority, by its Spanish acronym "AMA" was the government entity in charge to cover the public transportation routes in the metropolitan area. By means of a restructuring, the routes were transferred to the Authority of Integrated Transport, by its Spanish acronym "ATI". ATI realizes that operational costs are too high and the economic recovery of the agency on the routes ended annually in a deficit. As a result of this problematic, ATI begins the process of finding alternatives that improve the service and that are cost-effective. On 15 July 2015, through a press release Dr. Alberto Figueroa, executive director of ATI communicates the reorganization in

the service of collective transport. This reorganization included reduction in costs and improve the efficiency of the service offered to the citizenship [2].

Metrotrans Inc. agrees to establish public transportation service to established routes previously covered by the service of the AMA.

RESEARCH OBJECTIVES

The objectives of this research project are:

- Standardize internal processes.
- Provide a continuous service within the established timetables.
- Comply with the services requirements of ATI.
- Promote the use of public transport.
- Promote a reliable service.
- Generate incomes.

RESEARCH CONTRIBUTIONS

The contributions of this research project are:

- Synchronization of the services offered to the customer.
- Increase the employee base.
- Reduction of costs for ATI.
- Continuous Improvement.
- Organization of the company.

LITERATURE REVIEW

As is public knowledge, the collective transportation system in Puerto Rico has collapsed due to bad management and misuse of equipments. The principal means of written communication in the country have described hundreds of reports referring to the alternatives and collective transportation systems that have not had a good performance.

On May 22, 2011, the El Nuevo Dia newspaper exposes a writing called "Alternativas que no funcionan" where it explained how collective transport system works and what are the alternatives that affect the service [1]. At that date, this service had the participation of the Urban Train, AMA, Metrobus, AquaExpreso and porters

public. All these media outlets have a different function which shows the system is not synchronized, limited and primitive. The Urban Train has 16 stations and serves only to a part of the metropolitan area. The AMA offers service to 8 municipalities: San Juan, Trujillo Alto, Toa Baja, Guaynabo, Cataño, Bayamon, Carolina and Loiza. Is a service well used by the citizenship, but this brings wear to the service since the buses do not account with the appropriate preventive maintenance which limits the amount available to provide the service, timeout prolonging and discomfort in the clients. The Metrobus and AquaExpreso serves a smaller population so that service is limited. Public carriers have access to areas where the services mentioned above have limited access or do not have access.

DMADV - General Concepts

DMADV is part of Lean Six Sigma tools. It in used to design a new process. The DMADV objectives are:

- Define customer needs and project's goals.
- Measure specifications.
- Analyze the problem
- Design to meet customer needs better.
- Verify the project progress.

DMADV METHODOLOGY

DMADV is a tool to design a new process. This tool define and verify the project's goal. DMADV helps to reduce errors and cost of quality.



Figure 1
Design for Six Sigma - DMADV

The DMADV application refers to: Define the problem, Measure performance and specifications, Analyze actions and alternatives applied, Design for alternatives and Verify project operations. The application helps focus on the development of new methods, identify the problem and obtain acceptable results for the business operations [3].

Define

Identify the problem purpose, customer needs and goals. The customer needs is the objective in this phase. It's necessary to identify the information sources of the customer. The problem definition helps develop strategy such as: quality, reduce costs, service and company responsibility.

Measure

Metrics, data and specifications are collected and can be utilized to understand the process. Effective approach can be taken and begin the process. Determine the metrics are critical to the stakeholder and the customer requirements. Critical to Quality are characteristics measurable of the process. CTQs is to understand the needs of the customers.

Analyze

This phase helps to identified what cause the problem and analyze the actions taken during the process. Develop alternatives, identify the requirements, improvements the selected option to resolve the problem.

Design

Design is develop the selected alternative. The design have priorities with indirect and/or direct impacts. The result of internal tests are compared with customer needs. Necessary modifications are made and implemented.

Verify

When the process is being applied, the customer reviews it and makes observations to the process. The process may be adjusted. The metrics are develop for a continuous customer feedback on

the process. This phase includes validate, ensure the operation is stable and sustainable.

RESULTS AND DISCUSSION

The development of the DMADV methodology for the design is presented below:

Define

In this phase, works the definition of the problem statement, identify project scope and customer requirements. The Project Charter (See **Table 1**) and Customer Requirements (See **Table 2**) are shown below.

Table 1
Project Charter

Project Charter	
Problem Statement	The problem statement is focused on the development of a design to help standardize the internal processes of the company and to offer a quality service to customers.
Project Scope	Improvement actual service with the private transportation services.
Goal Project	Standardize the transportation service offers to users from Metrotrans Inc Company.

Table 2
Customer Requirements

Customer Requirements	
Quality Service	Equipment availability. Improvement in the service. Preventive maintenance. Service-oriented.
Cost Service	Adjusted cost.
Time	Greater number of trip per hour. Service hour: 5 am - 7 pm (Monday to Saturday) 7 am - 5pm (Sunday)
Safety	Trained drivers in safety standards and traffic.
	Offer a quality service and efficient.

Company Responsibility	Document all events. Submit reports to ATI. Make changes and/or adjustments according to the need of users.
-------------------------------	---

Measure

In this phase, the data collected shows the problem existing in the service offered by what is identified and analyzed critical parameters of design such as CTQ's (See Figure 2). After analyzing the customer needs, develops the Cause - Effect diagram known as Fishbone Diagram. This diagram help to identify possible cause for a less efficient transportation system. (See Figure 3).

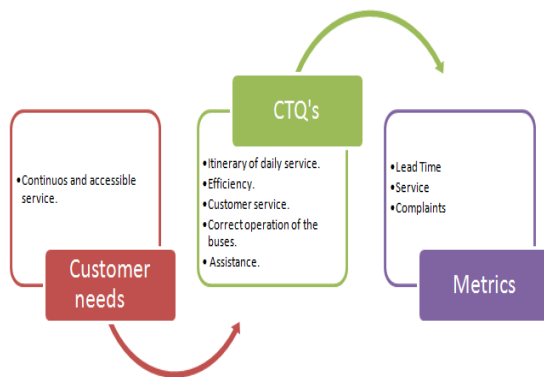


Figure 2
CTQ's Diagram

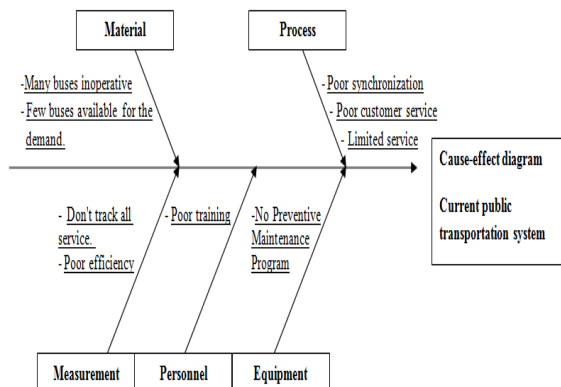


Figure 3
Fishbone Diagram

Analyze

In the previous phases, was able to identify the problems and customer requirements. The design

alternatives shown will help us to select best option that meets both needs. (See Table 3)

Table 3
Design Alternatives

Alternatives	
1	Focus on the synchronization of the services by using the circle quality.
2	Integration of the ISO 9001:2008 to standardize the management system and service.
3	Create a plan of quality management using ISO 9001:2008 specifying the importance of each person involved in the project.

In accordance with the customer requirements, service improvements and the efficient operation of the company, the best alternative is the creation a plan of quality management using ISO 9001:2008 by specifying the function of each member. PDCA cycle helps us to identify the different areas that must be impacted to meet those needs. (See Figure 4).

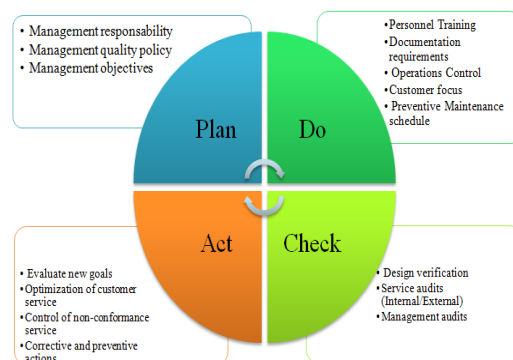


Figure 4
PDCA Cycle

Design

In this phase is the development of the design of quality management which will help to standardize and improve the service offered by Metrotrans, Inc. ISO 9001:2000 is a quality tool that sets the minimum requirements and must be done to implement a quality design including the documentation, processes and the role of each member [4].

For the development of design is used as guide ISO 9001:2008 Quality Management System Design [5]. Below presents the development of each stage. (See Table 4, Table 5, Table 6 and Table 7).

Table 4
Plan Stage

Management Responsibility	Management Policy	Management Objectives
<ul style="list-style-type: none"> • Metrotrans Inc. has the responsibility to provide a quality service where the users are satisfied. As an important part of the process, Metrotrans Inc. is responsible for all necessary action prevent the service affects, inform users of changes that may affect your routes with time and maintain effective communication with their employees and ATI. 	<ul style="list-style-type: none"> • Customer focus <ul style="list-style-type: none"> • Comply with the user requirements and demands while preserving the Metrotrans Inc. and ATI rules. • Responsibility and authority <ul style="list-style-type: none"> • Ensure that each member must comply with the responsibilities of the assigned work. Keep everything documented and visible. • Process <ul style="list-style-type: none"> • Establish written procedures to standardize the service offered to users, conduct evaluations of service and document any corrective actions performed. 	<ul style="list-style-type: none"> • Standardize internal/external processes. • Provide a continuous service within the established timetables. • Comply with the services requirements of ATI. • Promote the use of public transport. • Promote a reliable service.

Table 5
Do Stage




<p>Quality Manuals (Tier I)</p> <p>Focus on quality in the service and maintain the order and constancy in the internal process according to the established with ATI.</p>
<ol style="list-style-type: none"> 1. Corporate 2. Divisional 3. Departmental
<p>SOP's (Tier II)</p> <p>Operational processes by written must specify effective date, signature/date of employee trained. If there is no record of the training, the employee cannot perform any function in the workplace. Respond to what, when, where, who and why. This helps to maintain the operations control.</p>
<ol style="list-style-type: none"> 1. Process documents 2. Departmental operating procedures 3. Trainings (weekly, monthly, annually)
<p>Work instructions (Tier III)</p> <p>The work instructions must be discussed on a daily basis. The preventive maintenance program to the equipment must be performed according to manufacturer or specialists. Everything must be documented with date and signature of the employee who performed maintenance and employee who verify the work done.</p>
<ol style="list-style-type: none"> 1. Preventive Maintenance Program

<i>Forms (Tier IV)</i>
<p>The development of these forms helps obtain results the focus in the Tier I, II and III. This monitors the service instantly internally and externally. Helps focus on continuous improvement and external compliance.</p>
<ol style="list-style-type: none"> 1. Customer services survey 2. 5S 3. Services Specifications 4. Complaints

Table 6
Check Stage

Design Verification	Services Audits	Management Audits (first-party audit)
<ul style="list-style-type: none"> • Specifications development • Customer Requirements • Quality compliance • Verify Non-Conformance Design • Design Validation 	<ul style="list-style-type: none"> • Evaluate if complying with the customer requirements and what is established with ATI providing a continuous service and efficient. • Internal audits <ul style="list-style-type: none"> • Check requirements such as time, service, examine the equipment, procedures work instructions, employees training documented and effectiveness process control. • External audits (Second-party audit) <ul style="list-style-type: none"> • The services audits offered to users considering the work itineraries, preventive maintenance on the equipment compliance with state and federal laws are made by ATI. 	<ul style="list-style-type: none"> • Prepare checklist based on Internal Quality Management System Audit Checklist ISO 9001:2008: • Scope (1.0) • Quality manuals (4.2.2) • Management responsibility (5) • Customer focus (5.2) • Work environment (6.4) • Provision of resources (6.1) • Documentation requirements (4.2) • Control of documents (4.2.3) • Control of non-conformance (8.3) • Customer satisfaction (8.2.1) • Design and development review (7.3.4) • Control of design and development changes (7.3.7)

Table 7
Act Stage

<ul style="list-style-type: none"> • Based on the user needs and the company always must improve the approach. • Analyze the results of the audits and maintain the quality level with updated goals. <p style="text-align: center;">Evaluate new goals</p> 	<ul style="list-style-type: none"> • Identify customer needs always. • Improve operational process. • Measure customer satisfaction with surveys. • Competitive and efficient service. <p style="text-align: center;">Optimization of customer service</p> 	<ul style="list-style-type: none"> • Management review (ISO 9001 - Clause 5.6.2) • Customer feedback • Results of audits • Status of preventive and corrective actions • Changes that could affect the service and quality management. <p style="text-align: center;">Management review and updated</p> 
---	---	---

Verify

In this phase it helps to have a clearer concept of the operation of the design before being implemented. The most important steps are detailed below. These steps will ensure that the design to be efficient and stable in the company.

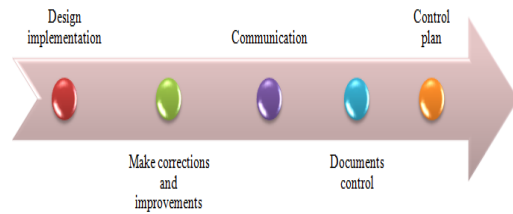


Figure 5
Verify Steps

CONCLUSION

The development of a design of quality management helps standardize existing operations and provide a quality service. The focus of this design is provide a efficient service and synchronized with other existing transportation service in Puerto Rico. In this way, the people have access to a service accessible and continuous. With a successful design and continuous improvement helps to promote the use of public transportation. It is important to keep all actions documented and preventive maintenance of the equipment in order to maintain the service.

The main goal is to able to comply with the customer requirements and be able to maintain the service in optimal level. Metrotrans, Inc. wishes to maintain a continuous improvement and effective.

REFERENCES

- [1] El Nuevo Día Newspaper (2011). "Alternatives that do not work", *El Nuevo Día Newspaper* [Online]. Retrieved from <http://www.elnuevodia.com/noticias/locales/nota/alternativas-que-no-funcionan-972318/>.
- [2] Governor's Office: The Fortaleza. (2015). Guide on reorganization in service of collective transport. *El Nuevo Día Newspaper* [Online]. Retrieved from <http://www.fortaleza.pr.gov/content/orientan-sobre-reorganizaci-n-en-servicio-de-transporte-colectivo>.
- [3] Methodology Six Sigma (2016). *What is DMADV?* [Online]. Available: <http://www.sixsigmadaily.com/what-is-dmadv/>.
- [4] J. Jay Schlickman. (2003). *ISO 9001:2000 Quality Management System Design*. Boston: Artech House, Inc.
- [5] International Organization for Standardization. *ISO 9001:2008* (2008). [Online]. Available: <http://www.iso.org/iso/home/standards.htm>.