Systems & Management 11 (2016), pp 31-48

THE USE OF THE QUALITY FUNCTION DEPLOYMENT (QFD) FOR ANALYSIS AND IMPROVEMENT OF THE PUBLIC TRANSPORTATION SERVICE

Vitor William Batista Martins[a]; Hélio Raymundo Ferreira Filho[a]; Delcio Cravo Soares[a]

[a] State University of Pará

Abstract

The continuous improvement of the productive systems, services globalizations, and competitiveness among companies, are some issues, which has required the companies to pay attention for the new ways of producing, based on the satisfaction of a customer who is increasingly more demanding, in search of low prices, high quality, and less waiting time, among other basic requirements for the acquisition of a product or service. With this focus, in order to verify the quality of the service offer by the public transportation system in the city of Maraba (Southest of the state of Para, Brazil), a case study, based on the use of the Quality Function Deployment (QFD) has been performed. For this study, questionnaires have been employed, and then, the responses were converted into graphs to be analyzed. The results obtained were satisfactory, and, based on the most important issues cited by the customers, it was possible to make an ordered list with the decisions to be made. As a consequence, it is expected an increase in terms of customer satisfaction and its loyalty, and therefore, an increase in sales for the company providing the service, thus ensuring quality transport to the city's population.

Keywords: Public transportation system; quality; quality function deployment.

1. INTRODUCTION

The high rates of urban growth, and the high seasonal levels in Brazil in the last 40 years, has resulted in the highest need for man to move to different places, at long, medium or short distances.

According to Pereira (2001), the urban population growth led to the creation of new communities, peripheral to urban centers. These areas, unlike the urban centers do not receive sufficient investment to ensure the implementation of basic infrastructure such as schools, health clinics and even job offers, creating the need for large displacement of the population to have access to these services.

According to the National Association of Public Transport (ANTP, 2008), in 2008 500 million displacements were made, corresponding to trips made by motorized means; of these, 75% were made by public transport, and buses transported 94% of all people who used public transportation. Trains and subways were responsible for 5%, and ferries and ships for the remaining 1%.

In the 1960s, due to the coffee crisis and the eradication of millions of coffee trees in several Brazilian states, such as Espírito Santo and Minas Gerais, there was a major collapse in public finances, which led to a large migration from rural areas to the city.

In the city of Marabá, main city of the Pará Southeast, given the growing economic developments - such as the introduction of company Vale do Rio Doce, in the 1940s, and currently with the expansion of Railroad Carajás of the company Vale, and the implementation promise of ALPA (Steels Laminated of Pará) - the population has grown considerably, which is leading the municipality to go through the most radical urban transformation underway in the country: from 2009 to 2014, its population will have increased by 50% and will reach 306,000 people, according to study carried out by Vale.

PROPPI / LATEC
DOI: 10.20985/1980-5160.2016.v11n1.783

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

This uncontrolled growth, without prior planning, has negative effects on cost and quality of services and construction of the urban infrastructure, including public transport in the region.

The public transportation system plays a fundamental role in the integration of urban space, directly affecting the productivity of other economic activities, depending on their own quality and productivity. Thus, service quality should be improved, since there is a link between urban transportation and the quality of life of its members (Fernandes *et* Bodmer, 1995).

It is important to consider that, in order to be improvement in terms of the quality of this service, you need to rely on the government, with the operating companies and users, which, according to Pêgo (2006), are the three main sectors of the urban public transport system.

According to this context, it is clear that the implementation of systems and/or quality control tools, such as the Quality Function Deployment (QFD), is necessary. This tool can identify the most important items presented by customers and direct possible decisions to be made so that the providers of such services may, within their limitations, meet the expectations of their members. It is understood that this is a key service to society, since it deals with fundamental rights of individuals, as the right to come and go and the right to life, guaranteed by their safety and comfort. In this context, the case study described below becomes important as it addresses suggestions for improvements that can reduce the discrepancies between the service rendered today in the Marabá municipality and customer satisfaction in terms of the use of public transport.

The overall objective of the research was to evaluate the level of quality of public transport services in the Marabá municipality by means of QFD. The specific objectives are: to map the main needs identified by users, and propose possible improvements in service delivery.

The article is structured as follows: Section 1 presents the chosen study subject and makes a relevant context, citing the objective and quality tool to be used. Section 2 aims to provide grounds to the research through the study of the art, seeking a theoretical basis on which the history of public transport in Brazil and in the city of Marabá, and the QFD method are exposed, by debating their concepts, origin, benefits and different approaches over the years. Section 3 explains the research method used for the study, showing step by step the development of the research and performing its classification. Section 4 highlights the results achieved and, finally, section 5 describes the conclusions reached from the comparison of the results with the theoretical framework and provides suggestions for the development of future work.

2. THEORETICAL FRAMEWORK

2.1 Collective Public Transportation System

The collective public transport in Brazil in 1955, was composed basically of modest carriers (mechanicians, intercity vehicle drivers, owners of vehicles or police service stations), which, in their spare time, operated 12-40 seats buses, minibuses with 12 seats, pick-ups, trucks, Kombis and vans (Brasileiro, 1996).

According to Pêgo (2006), from 1955, the mayors of each municipality took responsibility for the organization of public transport, until then in charge of governors in each Brazilian state. However, the constitution of 1946 had established municipal autonomy; thus the public transportation service became a responsibility of the mayors of each municipality.

The first contract signed between a City Hall and transport owners was the type of permission on a provisional basis, per bus line, so that they could operate the service, which suited the realities of the institutional politics of the time; firstly, because the municipalities did not have financial resources or sufficient material to impose the most stringent and effective rules on the carriers; also, because these contracts were based on political criteria, friendship, kinship, or electoral favors (Brasileiro, 1996).

Also according to Brasileiro (1996) in several Brazilian cities regulations prohibiting small vehicles were implemented in the central areas and the owners were pressured to group together in bus companies, through a professionalization process, in which the management, operation, and maintenance activities were separated.

In the mid-1970s, as the Brazilian municipalities did not have the human and financial resources to manage and regulate a transportation demand that functioned poorly, there was a centralization at the federal level; therefore, the metropolitan areas were created, the Brazilian Urban Transport Company (Empresa Brasileira de Transportes Urbanos - EBTU), the Development Fund for Urban Transport (Fundo de Desenvolvimento dos Transportes Urbanos - FDTU), the Metropolitan Company of Urban Transport (Empresas Metropolitanas de Transportes Urbanos - EMTU's) and Superintendence of Urban Transports (Superintendências de Transportes Urbanos - STU's) (Superintendence of Urban Transports) (Brasileiro, 1996).

From 1976 to 1984 the federal policy was geared towards the reorganization of the private bus sector, proposing, for this, the rationalization of itineraries, the bus stop, and bus stations, the regulation of individual owners of transport companies, establishing a minimum fleet for the company

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

to continue operating, the adoption of financing for the renewal of the bus fleet and human resources training policy (Brasileiro, 1996).

Furthermore, they defined new types of contracts, the famous "conditional permission" contract, in which the municipal government defined a period, ranging from five to seven years, so that companies could operate in monopoly, not including isolated lines, but sectors of operations defined by the cities. In these contracts there were also parameters and operational indicators to be met by the companies, forcing them to recruit top-level technical personnel, strengthening the managerial modernization (Vera, 1999).

In the 1990s, with the extinction of EBTU, began the disengagement process of the Federal State as regards the organization and financing of urban public transport, as well as the strengthening of the private sector in urban buses, which began to take notoriety after the creation of the National Association of Urban Transport Companies (Associação Nacional das Empresas de Transporte Urbano - NTU) (Brasileiro, 1996).

After the 1987 Constitution, control and coordination of the public transport sector returned to the hands of the municipalities, as the constitution states that public transport is a local issue that should be managed by the municipality. Another relevant factor to the recovery of the transport system under control of the municipality was the return to direct elections for mayors in 1985, where transport regained a prominent place in the municipal government programs, as in the 1950s (Pêgo, 2006).

2.2 QFD (Quality Function Deployment)

The QFD method was first introduced in 1966 by Yoji Akao, when Japanese industries, specifically the automobile (sector expanded rapidly between the 1960s and 1970s with the sudden changes in car models), went through a moment of implantation tools for quality assurance.

The QFD technique can be broken down into two basic elements: quality deployment (QD), and quality function deployment in the restricted sense (QFDR). According to Cheng *et al*. (1995), the quality deployment searches and translates customer requirements of product quality characteristics through systematic developments, beginning with the determination of the customer's voice, through the establishment of functions, mechanisms, components, processes, raw material, extending to the establishment of the process control parameters. Also according to Chen *et al*. (1995), the deployment of the function quality, in the restricted sense, is a systematic process of labor deployment focused on the management action of quality planning in managerial and technical procedures to be completed by the functional areas of business.

Reasons Akao began to develop QFD:

- Lack of clarity in determining project quality, though its importance was so proclaimed at the time;
- Failure to instruct the production lines regarding the priority issues that should be considered to ensure the quality of the project, even before the product entered the fabrication;
- There were still questions concerning the Process of Technical Standard, because, although it clearly defines the items to be checked during the manufacturing stage and has been used since the second half of the 1950s, even at the time when new products began to be developed, it continued to be drawn up after the start of production, with resources found on the factory floor (Akao, 1996).

The various studies conducted subsequent to AKao's on QFD involved directly the emergence of new versions/extensions of this quality assurance method, such as QFD of four phases, QFD extended, QFD of four emphases and Matrix of Matrices, which have the same guidelines of the genuine QFD and serve to aid the users of this method so effective.

The Makabe method, broadcasted by the American Supplier Institute (ASI) is the simplest and most common among Brazilians due to the easy access to American bibliographies. This method covers four phases, ranging from consumer requirements to manufacturing, as shown in Figure 1 (Carvalho, 1997).

Chen *et al*. (2011), in his work entitled "Applying GRA and QFD to Improve Library Service Quality", used QFD along with the GRA to identify techniques to improve the services provided by an academic library, considering the reader's needs and their importance based on interviews and structured questionnaire. As a result, it was possible to identify the top five needs to be improved according to the views of users.

Kamvysi *et al*. (2014) in his article "Capturing and prioritizing students' requirements for course design by embedding Fuzzy-AHP and linear programming in QFD" highlight that customers play a vital role in designing products and services and that QFD is a method widely used popular to help translating customer needs into design specifications.

Carnevalli *et al.* (2010), in the research "Axiomatic design application for minimizing the Difficulties of QFD usage", address a technique to minimize the difficulties

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

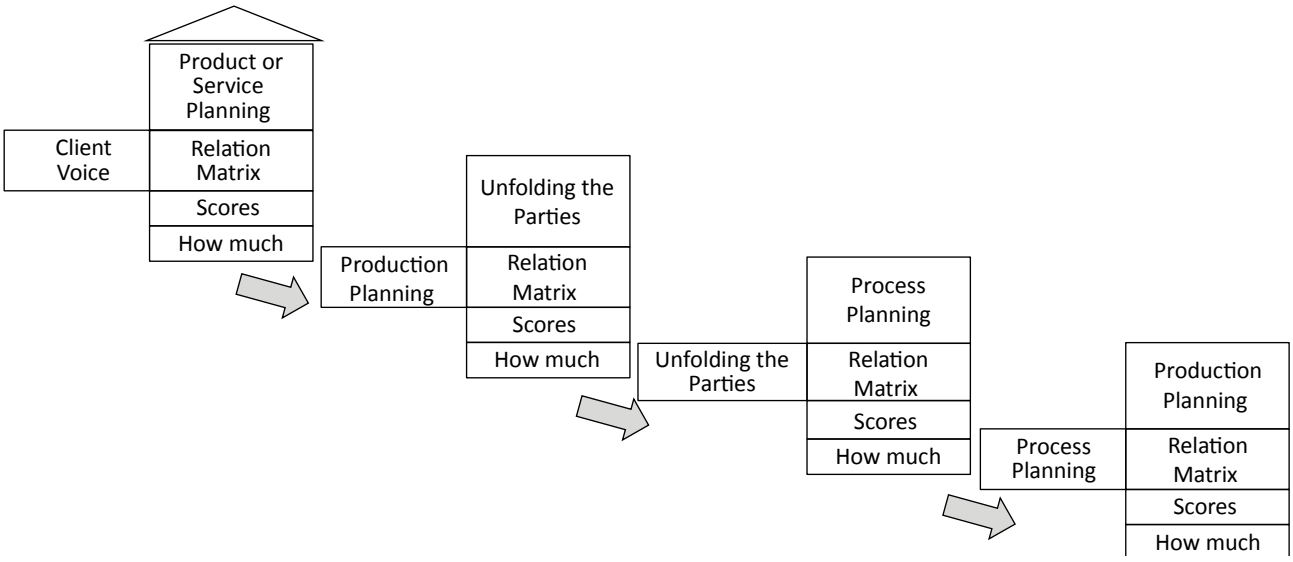

Figure 1 - Makabe method Matrix
Source: Carvalho (1997).

of using QFD. As a result, it was identified that the main difficulty in the use of the method is the construction of quality matrix, which will be better detailed in the next section.

2.2.1 Planning the Product or Service (House of Quality)

The Quality Matrix, or House of Quality is the initial matrix of QFD, and it is the most important of all, since it is composed of the quality deployment table required and of the quality characteristics of deployment table in which the first has the customer requirements and the second contains the technical requirements of the product that are extracted from the first table.

According to Cheng and Melo Filho (2007), the quality of the house plays a key role in the product development activities, and such implementation requires cooperation of various functional areas of the company, since it provides organization and greater visibility to information.

According to Akao (1996), the main purpose of this matrix is to identify customer requirements, prioritizing the items that maximize their satisfaction, and to relate these requirements to the quality characteristics of the product that translates them. It is this matrix that the goals for product quality characteristics and the deployment strategies that will guide the remaining steps of the method are established.

In Figure 2, you can check the arrangement of the quality matrix, which shows all the steps for its edition.

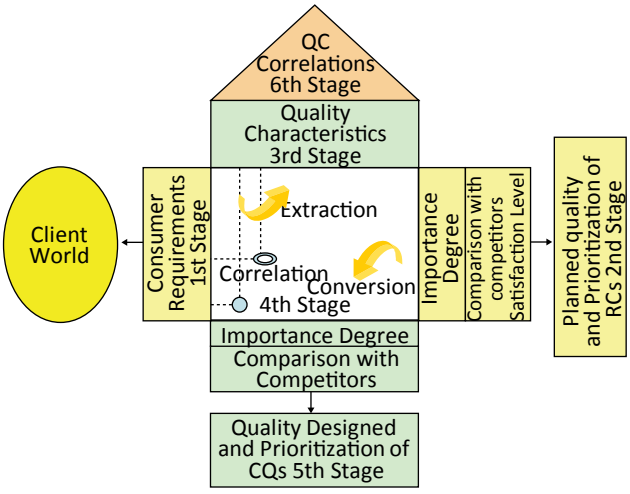

Figure 2 - Quality matrix
Source: Pêgo (2006).

2.2.2 Table of Consumer Requirements Deployment

In this table, the consumer demands are expressed by cultivating the language used by them. In most cases, this information is found in large quantities, thus a filter to identify priority items is needed, considering the degree of interest shown by customers and comparing company performance with the competitors (Akao, 1996). It is important to note that similar items can be grouped in order to reduce the number of consumer requirements.

This first stage is part of the customers's world, and this information can be obtained by the companies th-

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

rough records of complaints and suggestions; however, Akao (1996) says that in this type of collection companies should pay attention to collect not only information from the commercial area and those relating to complaints that are negative qualities, but also the true requirements of customers, that is, the positive qualities. Akao (1996) also emphasizes that the best way to collect customer requirements is the conversation with them, and, for that, one of the most effective tools is the market research with direct application of questionnaires (open or closed), and a clear definition of the research objectives and the target audience is essential.

Akao (1996) states that these requirements must be prioritized in primary, secondary, and tertiary levels, according to the need.

2.2.3 Planned quality and Prioritization of Consumer Requirements

The second stage is the classification of consumer requirements, in which customers rate the requirements according to the degree of importance. There are several ways to rank the consumer requirements; the most common occurs by applying a closed questionnaire, in which the customer indicates a score within a range according to the importance.

After obtaining the degree of customer satisfaction, the company can implement an improvement plan or goal, in which the company will assign a value to the improvement. From the improvement plan, the improvement index is created, which is simply the value of the division assigned in the improvement plan for the value assigned by the customer to the product/service of the company.

Based on the improvement rate analysis and the degree of importance assigned by the consumer, the consumer's requirement as a selling argument or not is determined. According to Akao (1996), an important sales argument is indicated by a double circle and it receives value 1.5; and a normal point is shown by a simple circle and receives value 1.2.

The prioritization of customer requirements is performed by calculating weights for each Consumer Requirement. The weights of the RCs are found as follows:

(Importance Degree) x (Improvement Index) x (Sales Story)

After performing the vertical summing of the absolute weights of each consumer requirement, we search for the RC relative weight (%). This method is based on empirical law (Akao, 1996 *apud* Pegô, 2006, p. 42).

2.2.4 Table of Quality Characteristics Deployment

At this stage, there is the conversion of consumer demands in technical requirements, namely, the transformation of customer requirements into quality characteristics of a good or a service. According to Carvalho (1997), a quality characteristic may be related to more than one Consumer requirement. So there is the conversion of the requirements into quality features, a team of professionals from various sectors (commercial, quality control, marketing, etc.) of the company selects the quality features that are directly related to customer requirements, and these characteristics should be measurable, as they will be controlled and compared to the values set as goals.

As the consumer requirements, quality characteristics may also be hierarchical into primary, secondary and tertiary (Carvalho, 1997).

2.2.5 Correlation Matrix

In the stage concerned, Consumers' requirements are related to Quality Characteristics, based on the experience of their executioners, who should seek consensus for their definition. The correlation between requirements and features may be non-existent, weak, medium and strong according to the symbols of Figure 3. The correlation Process aims to identify the relationships of cause and effect between items based on two different tables that form a matrix, and enable prioritization of these items according to the assigned weights.

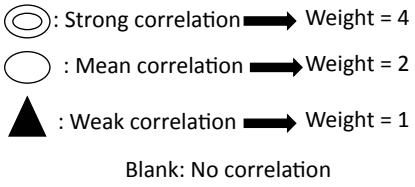

Figure 3 - Correlation Symbology
Source: Pêgo (2006 *apud* Carvalho, 1998).

According to Pêgo (2006), the absence of symbols, or most signs of "weak relationship" indicates that, for a particular consumer requirement, the quality characteristics, capable of translating that need expressed by consumers into project parameters, are not assigned . After the thorough analysis of this matrix, you can change or add to the quality characteristics to meet all customer requirements properly.

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

2.2.6 Quality Designed and Prioritization of Quality Characteristics

According to Akao (1996), the projected quality is determined so that the Quality Characteristics are classified according to the degree of importance, also in the Planned quality. For determining the degree of Projected quality importance, a conversion from the weight of consumer requirements for quality characteristics is required, using the correlations identified in the correlation matrix; thus, it is possible to consider both the importance indicated by consumers and the correlations identified by the team of the company.

A method for converting the degree of Consumers' Requirements importance into degree of importance of Quality Characteristics is the Method of Independent Point Distribution, which consites in calculating the degree of importance of Quality Characteristics, obtaining the sum of product Quality Requirement weights of the respective numerical values of the correlations (Akao, 1996).

The absolute and relative weights of the quality characteristics are calculated according to equations (1) and (2).

Equation (1)

$$w_j = \sum_{i}^{m} r_{ij} \cdot w_i^{\%}$$

In which

$w_{j:}$ absolute weight of $CQ_{j;}$

$w_{j:}^{\%}$ relative weight of RC_i

$r_{ij:}$ relationship of RC_i and CQ_j

i varies from 1 to the total number of RCs (m)

j varies from 1 to the total number of CQs (n)

Equation (2)

$$w_j^{\%} = w_j \cdot 100 / \sum_{j=1}^{n} w_j$$

In which

wj% relative weight of CQi

After calculating the relative weights, the Quality Characteristics Prioritization is made by arranging them in descending order, and those of larger relative weight are the ones with higher priority for the company.

From the definition of the projected quality, it is possible to drive the quality project, with the development of improvement plans for the final characteristics of the product/service, so that they are superior to those of their competitors, thus allowing so with the company to be more competitive on the market.

2.2.7 Correlation Matrix of the Quality Characteristics

The matrix of correlation of the Quality Characteristics, or House of Quality roof, aims to indicate the dependence of the Quality Characteristics and to identify the characteristics for which the joint optimization is difficult in relation to customer satisfaction, in addition to identify those that interact positively with the matrix (Pêgo, 2006).

This correlation is also expressed by symbols, which determine the intensity and type of correlation, as shown in Figure 4.

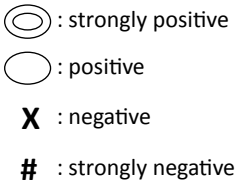

Figure 4 - Symbology of correlation of the Quality Characteristics
Source: Pêgo (2006).

Upon completion of all the steps correctly, the Quality Matrix is ready, and it is an essential tool within an organization, as it provides information on the wishes of consumers, and the priorities of these needs and the their conversion to the business language, making the company know which sector should act to meet the needs of its customers and thus achieving an increase in its market share.

3. RESEARCH METHOD

According to Gil (2008), this research is classified considering the following points: According to the problem approach, it is qualitative, as it considers that the data involved may be eligible, which means translating opinions and information to classify and analyze them. From the point of view of its objectives, the article was considered descriptive, as it aims to describe the characteristics of a phenomenon and involves the use of techniques and data collection with systemic observation. From the point of view of technical

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

procedures and research strategy, the product was classified as a case study.

For this research, it was possible to count on the support and participation of the Municipal Department of Traffic and Urban Transport (DMTU) in the city of Maraba, Pará State. This organ is responsible for the management, control and surveillance of the public transport network in the city. Firstly, the information necessary for the beginning of the study was requested, such as: basic project of the new public transport system in the municipality and the municipal general law of transport No. 17,344 of June 22, 2009, which regulates the Municipal Transport and Circulation System in the city of Marabá, which suits municipal legislation to federal, especially the Brazilian Traffic Code, and other provisions.

With this information, QFD was applied, considering the views of users and the municipal urban public transport system. A priori, a group of ten people was gathered, and it included university students, civil servants, high school students, and private company workers, aiming to hold a brainstorming to raise the largest number of complaints, suggestions, and reviews on the current public transport system of the municipality.

Subsequently, a structured questionnaire was prepared, and it contained a synthesis of the ideas raised in the brainstorming. This questionnaire was applied to a sample of 196 respondents (service users), and it included four urban and one rural neighborhoods of the city. This sample was defined based on the total population and in the estimation of the number of users of the public transport service. According to the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE), in 2013 there was a population of two hundred eighty-one thousand, eight hundred, and eighty five inhabitant in the city of Marabá (281,885). Based on research by the Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada - IPEA), we considered the average margin of 44% of the population as public transport service users for the municipality, thus totaling one hundred twenty-four thousand and 28 users (124,028). For the definition of the valid sample, the mathematical formula for calculation with finite population, involving variables such as sampling error of 7%, the level of confidence of 95% and the total population of users was used.

The survey was conducted on January 30 and 31, 2014, with the application of qualitative and quantitative interviews in order to listen to users regarding the general expectations and measure the degree of importance of each quality requirement demanded. The questionnaire recorded the profile of men and women aged 16 to 65 with various levels of education and household income. The requirements evaluated are in Table 1.

Table 1. Quality requirements demanded evaluated by customers

Requisites
Waiting time at stops
Structural conditions of the vehicles
Training and friendliness of the employees
Itinerary
Vehicle Capacity
Bus Stops
Integration Terminal
Bus Fare
permanence time within Vehicles
Obedience to signaling
bus stops adapted to people with special needs
Bus quantity per fleet

Source: authors (2014).

Data processing began with the preparation of the deployment table of Quality Requirements Demanded by customers, created based on the degree of importance and the level of satisfaction of each required item. From this, we calculated the quality planned to obtain, respectively, the absolute and relative weights for priority analysis of the quality demanded by citizens. Subsequently, the deployment table of Quality Elements extracted from the verification of the Quality items required by customers was created.

After this stage, there was a correlation between the Elements of Quality and Quality Demanded items, in order to identify those that relate to strong, medium, and weak intensity and establish a relationship of cause and effect. Finally, the projected quality, determined from the correlation matrix in order to obtain the absolute and relative weights of Quality Elements and enable prioritization criteria had better weights assigned, designating, thus, the main needs of the market (public transportation system).

4. ANALYSIS AND RESULTS

4.1 Quantitative perception of the user

According to what was explained in the previous section, a quantitative research with the application of a closed questionnaire was carried out in order to measure the degree of importance and the level of satisfaction the customers assign to each quality demanded item. The questionnaire was divided into three parts: Profile of the Interviewed, importance Degree, and Satisfaction Level. The levels defined for the process are given in Table 2 below:

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

Table 2 - Importance Degree Scale

Importance Degree	Description
1	No Importance
2	Little Importance
3	Some Importance
4	Important
5	Very important

Source: Silva and Pereira (2012 *apud* Cheng; Melo Filho, 2007).

The satisfaction Level was measured on the following scale: excellent, good, fair, poor, and very poor, with weights 1, 2, 3, 4, 5, respectively. The calculation of the Priority Index or absolute Weight was based on the model applied by Pêgo in his master's thesis on urban public transport of passengers in the year 2006. To calculate the I.P., the crossing between the Importance Degree, (ID) and the satisfaction level (SL) was made.

Taking into consideration that the current system, started just over a year, is in transition, the proposed mathematical model will show the user's priorities in the face of the new system under implementation, that is, the more important and unsatisfactory the item is, the more its priority in relation to others. Therefore, we take into account only the correlation with the DMTU, as it is the main responsible for the Public Transport Network of the municipality.

After compiling the data in this study, the results were analyzed and transformed into the weighted arithmetic average in order to obtain an evaluation of the best strategies to be taken. Table 3 shows these aspects.

Table 3 - Importance degree average and quality satisfaction level required

	MEAN	
	IMPORTANCE DEGREE	SATISFACTION LEVEL
Bus Stops	7,4	6,73
Integration Terminal	7,07	8,13
Bus Fare	7	4,93
Bus stops adapted to people with special needs	7,8	7,73
Bus quantity per fleet	7,87	7,07
Structural conditions of the vehicles	7,47	6,33
Waiting time at stops	7,67	7,47
Training and friendliness of the staff	7,8	6,6
Vehicle Capacity	8,27	7,4
Obedience to signaling	6,87	5,73
Permanence time in vehicles	8,53	7,13
Itinerary	6,4	5,67

Source: authors (2014).

4.2 Planned Quality

The quality was planned based on the information obtained in Table 3. From it, we calculated the absolute weights, and by converting it in percentage terms, the relative weights were found.

The relative weights allow a better comparison and easy prioritization between the qualities of items demanded. The items with high weight should receive the greatest attention because, if met, they will effectively contribute to customer satisfaction (Drumond, 1995).

Therefore, following the conceptual model in the Table 4 below, we can observe the highest priority requirements among the users of the public transport.

The analysis of the Planned Quality table shows the quality demanded items that are priorities for users. Pareto's chart, shown in Figure 5, supports this analysis.

After the analysis of the data, it was observed that the items 9, 11 and 4 form a group of three quality requirements that are more relevant in terms of degree of importance and satisfaction regarding the public collective transport service. Item 9, vehicle capacity, had the highest weight: 10,01. This shows how important is the capacity of the vehicle to users and how they feel dissatisfied with the current capacity. This circumstance is also explained by the fact that the majority of respondents in the survey revealed that they use the collective transport mostly to go to work, hence they use it more frequently in times of larger passenger demand peaks.

Item 11 (**Permanence time inside the vehicles**) was the second largest weight: **9.95**. During the interviews, we noticed a large frequency of this item regarding complaint, because currently the travel time is equal to two hours and can, in some cases, go beyond this time. Thus, the priority of this criterion shows the high level of dissatisfaction demanded by customers.

Item 4 (**Bus stops adapted to people with special needs - PNE's**), weighing **9,86**, also reveals to be more urgent since the current situation of the bus stops in the city to show deficiency or inadequacy.

Item 2 (**Integration terminal**) was in 4th place as a result of lack of knowledge on the part of some respondents on this criterion; however, it could be better assessed if 100% of the sample had knowledge in terms of the new model of collective transport system. Nevertheless, the item has a high level of priority, and if met, it will allow the optimization of the waiting time at the bus stops, the

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

Table 4 - Planned Quality

Prioritization of required quality requirements				IMPORTANCE LEVEL	SATISFACTION LEVEL	ABSOLUTE WEIGHT	RELATIVE WEIGHT %
QUALITY REQUIREMENTS DEMANDED	OUTSIDE THE OPERATING SYSTEM	1	Bus stops	7,40	6,73	49,80	8,14
		2	Integration Terminal	7,07	8,13	57,48	9,40
		3	Fare price	7,00	4,93	34,51	5,64
		4	Bus stops adapted for people with special needs - PNEs.	7,80	7,73	60,29	9,86
		5	Bus quantity per fleet	7,87	7,07	55,64	9,10
		6	Structural condition of the vehicles	7,47	6,33	47,29	7,73
	INSIDE THE OPERATING SYSTEM	7	Waiting time at stops	7,67	7,47	57,29	9,37
		8	Training and friendliness of the staff	7,80	6,60	51,48	8,42
		9	Vehicle Capacity	8,27	7,4	61,20	10,01
		10	Obedience to signaling	6,87	5,73	39,37	6,44
		11	Permanence time inside the vehicles	8,53	7,13	60,82	9,95
		12	Itinerary	6,40	5,67	36,29	5,93

Source: authors (2014).

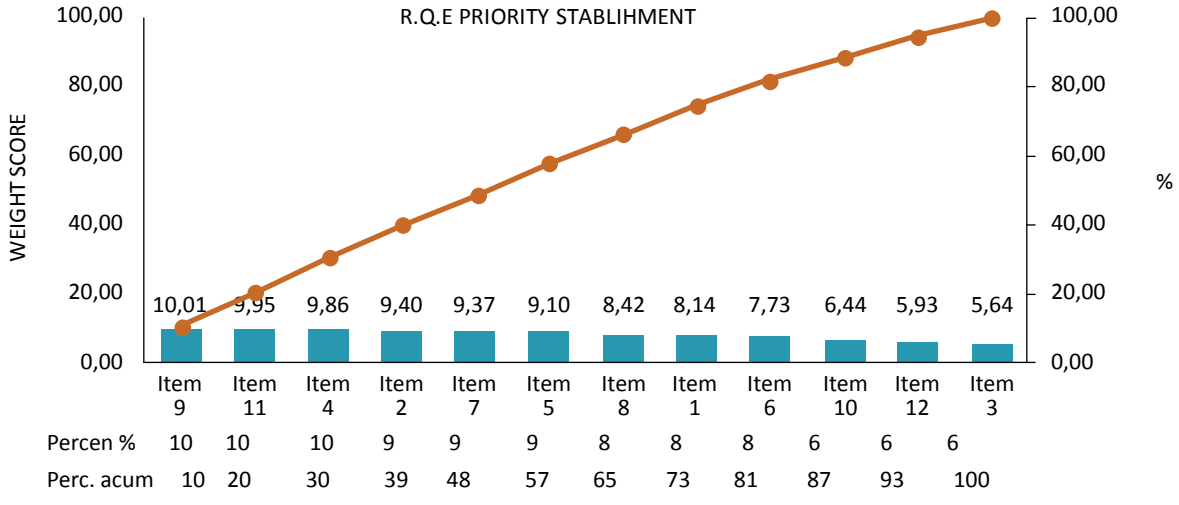

Figure 5. Pareto's chart indicating the priorities of the quality requirements demanded

Source: authors (2014).

permanence time inside the vehicles, the capacity of the vehicle and the problems with the itinerary, that is, it will reflect on the 33% of the quality requirements demanded by users. The relationship of this item with referred R.Q.E. can be seen in correlation matrix in the next chapter.

Items 10 (**Obedience to signaling**), 12 (**Itinerary**) and 3 (**bus fare**) form the group of satisfaction between fair and excellent (on the scale of satisfaction) of the client, with the weights **6.44**; **5.93**; and **5.64**, respectively. That does not mean it should not improve if possible. You can interpret the item fare price as satisfactorily positive for the client, since it is in the last position in the order of priority required by the customer. The table 4 of the requirements priority order is in the annexes of this article.

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

4.3 Correlation Matrix

On a table (Table 6 – Appendices) the quality elements extracted from the quality requirements evaluated by users (Table 1 - Appendices) were organized. The QEs, when correlated to the quality requirements in the correlation matrix, respond technically and specifically to customer requirements. Some Demanded Quality Requirements (DQR) extracted over a QE of the sources transferred by the Municipal Department of Urban Transit (DMTU).

According to Cheng and Melo Filho (2007), the correlation process aims to identify the cause-effect relationships between the deployed items from two different tables, which form a matrix, and enable the prioritization of these items according to the weights assigned.

Following the conceptual model in the literature, intensity values were assigned, according to Figure 3, in order to express when a correlation is intimately strong, medium or weak. In cases of allocation, this means that the correlation does not exist. The analysis of the interrelationships among the items was performed by team work, which thoroughly evaluated the relations and attributed the intensity weights, as shown in Figure 6.

4.4 Obtaining the Projected Quality (Conversion)

The quality projected shows the priorities regarding decisions for the quality plan, that is, the elements of quality that will certainly consider customer expectations.

The conversion process comprises converting the relative weights of R.Q.E. of the quality planned for Q.E. and it is performed considering the intensity value of the weight assigned to the correlation. The values formed for the Q.E. formed the Quality Projected, in which we noticed the quality elements of higher priority deployed of the customer requirements.

This phase of QFD application is of utmost importance because it is in this phase that one can see the quality elements that best meet the quality criteria required by the customer.

To calculate the index of projected quality priorities, we calculated the weighted arithmetic average of the correlation values of each Q.E. and the relative weights of R.Q.E. Thus, there was obtained the absolute weight, which was converted into relative weight.

Next, the conversion matrix for the priority index analysis of the quality elements shown in Figure 7.

Pareto's chart (Figure 8) was designed to assist in the analysis of results. It may be noted that the element (d) - **Implementation of a public transport network that enables the integration of all its lines in the city, with the payment of a single tariff (basic project)** - has obtained the highest Priority Index (PI), 13.5%. It is noteworthy that this criterion is in the basic project of the new public transport network in the city and that, if met, it will optimize 33% of the quality requirements demanded by users, as seen in section 4.2.

The element (e) - **Construction at the expense of the winning bid, a connecting station (Integration terminal) (basic project)** - has presented the second largest P.I. and further strengthens the element (d), which pays attention to the importance of the nature of these criteria.

The third largest P.I. was the element (h) - Broadening of the fleet in initially 15% (basic project). This item is closely linked to the issue of the capacity of the vehicles, the waiting time at the bus stops and the number of buses per fleet, and it can be observed in the correlation matrix (see Figure 6).

In fourth place is the element (q) - **Possibility of future expansions, with the construction of more connecting stations and the implementation of new lines (basic project)** - in which there is a priority for the creation of more strategic lines that reach the entire population satisfactorily. Therefore, it is observed in the graph that the attention aimed to these first 4 items will meet user requirements by 44%. The Priority Table of Q.E. is in the Annexes of this article (Table 8).

In the priority order regarding the third well evaluated quality requirement demanded (item 4) – **Bus stops adapted for people with special needs - PNE's** – with **9,86**, previously discussed in the graph of Figure 6 and Table 4 (attached). The quality elements that are more closely related were (b) – **implementation of new shelters for a total of 200 units throughout the RTCM (Base Project)** – and (a) – "**Planning, Project and implementing terminals, bus stops, shelters, signage [...]** "(Law 17,344) - weights **6** and **5.64**, and 7th and 8th positions in the prioritization order respectively. It is worth mentioning that the team received only part of the basic project information, preventing the development of this requirement in more quality elements. However, the classification of those items was considerably relevant due to the weight assigned to item 4 during the compilation of

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

QUALITY HOME (CORRELATION)			"Planning, project, and implementing terminals, bus stops, shelters, signaling..." (Law 17,344)	Bus stops - implementation of new shelters for a total of 200 units throughout the RTCM.	"Promoting the physical, operational, and tariff integration among the means of public, collective, individual, and special transport." (Law 17.344).	Implementation of a public transport network that enables the integration of all its lines, with the payment of a single tariff in the municipality. (Basic project)	Construction at the expense of the winning bid, of a connecting station (integration terminal). (Basic project)	Conducting credentialing or contracting, by means of authorization, permition or concession of companies with proven capabilities and technologies to meet the requirements and specialties required by law. (basic project)	Renewal of permanent fleet, so that the average age remains around 3.5 years. (Basic project)	Fleet expansion initially at 15%. (Basic project)	Quality of service provided to the population according to criteria established by the government, in particular: convenience and comfort. (Law 17,344)	"[...] Regular manufacturing models must include in their technical characteristics, among others: internal corridor for circulation, emergency window, door opening system controlled by the driver, enough height for safe circulation and proper ventilation, permanently at citizen's disposal [...] (law 17,344)	Quality of service provided to the population according to criteria established by the government, in particular: speed, frequency, and timeliness of service (Law 17.344)	Improve at least twice the number of trips currently offered to users, that is, a bus of each line should depart every 10 minutes. (basic project)	Increased daily trip average, from 325.93 to 1092 (Basic design).	Reduction of the current extension average of the lines by using the new system. (Basic project)	"Service to all the population living in urban and rural areas of the municipality " (Law 17.344).	Possibility of future expansion, with the construction of connecting stations and the implementation of new lines (Basic design).	Information system that allows users to identify the itinerary (Basic project).
QUALITY REQUIREMENTS DEMENDED	OUTSIDE THE OPERATING SYSTEM	1.Bus Stops.	2	4							1								
		2.Integration Terminal.	2			4	4								1	4	2	1	
		3.Fare price.			1	4													
		4.Bus stops adapted for people with special needs.	2	4													1		
		5.Bus quantity per fleet.						2	1	4				2	2		1	2	
		6.Structural condition of the vehicles.							4		4	2							
	INSIDE THE OPERATING SYSTEM	7.Waiting time at stops.				2	2			4			4	4	1				
		8.Training and friendliness of the staff.									2								
		9.Vehicle Capacity.				2	4			4				4	2			4	
		10.Obedience to signaling.	2																
		11.Permanence time inside the vehicles.				4	4						2			4		2	
		12.Itinerary.				4							1			4	4	4	4

Figure 6 - Correlation between the quality elements *versus* quality requirements demanded

Source: authors (2014)

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

QUALITY HOME (CORRELATION)			QUALITY ELEMENTS																PLANNED QUALITY			
			a	b	c	d	e	f	g	h	i	j	l	m	n	o	p	q	r				
			Bus stops - implementation of new shelters for a total of 200 units throughout the RTCM.	"Promoting the physical, operational, and tariff integration among the means of public, collective, individual, and special transport." (Law 17.344).	Implementation of a public transport network that enables the integration of all its lines, with the payment of a single tariff in the municipality. (Basic project)	Construction at the expense of the winning bid, of a connecting station (integration terminal). (Basic project)	Conducting credentialing or contracting, by means of authorization, permition or concession of companies with proven capabilities and technologies to meet the requirements and specialties required by law. (basic project)	Renewal of permanent fleet, so that the average age remains around 3.5 years. (Basic project)	Fleet expansion initially at 15%. (Basic project)	Quality of service provided to the population according to criteria established by the government, in particular: c onvenience and comfort. (Law 17.344)	"[...] Regular manufacturing models must include in their technical characteristics, among others: internal corridor for circulation, emergency window, door opening system controlled by the driver, enough height for safe circulation and proper ventilation, permanently at citizen's disposal [...] (law 17.344)	Quality of service provided to the population according to criteria established by the government, in particular: speed, frequency, and timeliness of service (Law 17.344)	Improve at least twice the number of trips currently offered to users, that is, a bus of each line should depart every 10 minutes. (basic project)	Increased daily trip average, from 325.93 to 1092 (Basic design).	Reduction of the current extension average of the lines by using the new system. (Basic project)	"Service to all the population living in urban and rural areas of the municipality " (Law 17.344).	Possibility of future expansion, with the construction of connecting stations and the implementation of new lines (Basic design).	Information system that allows users to identify the itinerary (Basic project).	IMPORTANCE DEGREE	SATISFACTION LEVEL	ABSOLUT WEIGHT	RELATIVE WEIGHT %	PESO RELATIVO %
QUALITY REQUIREMENTS DEMENDED	OUTSIDE THE OPERATING SYSTEM	1.Bus Stops.	2	4							1									7,40	6,73	49,80	8,14
		2.Integration Terminal.	2			4	4								1	4	2	1		7,07	8,13	57,48	9,40
		3.Fare price.			1	4														7,00	4,93	34,51	5,64
		4.Bus stops adapted for people with special needs.	2	4													1			7,80	7,73	60,29	9,86
		5.Bus quantity per fleet.						2	1	4				2	2		1	2		7,87	7,07	55,64	9,10
		6.Structural condition of the vehicles.							4		4	2								7,47	6,33	47,29	7,73
	INSIDE THE OPERATING SYSTEM	7.Waiting time at stops.				2	2			4			4	4	1					7,67	7,47	57,29	9,37
		8.Training and friendliness of the staff.									2									7,80	6,60	51,48	8,42
		9.Vehicle Capacity.				2	4			4				4	2			4		8,27	7,4	61,20	10,01
		10.Obedience to signaling.	2																	6,87	5,73	39,37	6,44
		11.Permanence time inside the vehicles.				4	4						2			4		2		8,53	7,13	60,82	9,95
		12.Itinerary.				4							1			4	4	4	4	6,40	5,67	36,29	5,93
																						611,46	100,00
PROJECTED QUALITY	ABSOLUT WEIGHT		0,676872404	0,720217185	0,056438688	1,624586727	1,361616132	0,181993589	0,40032267	1,13913453	0,559157426	0,154670526	0,633083767	0,957140941	0,569868511	1,0112583	0,614995421	1,112652831	0,237385929	12,01139558			
	PESO RELATIVE WEIGHT % RELATIVO %		5,64	6,00	0,47	13,53	11,34	1,52	3,33	9,48	4,66	1,29	5,27	7,97	4,74	8,42	5,12	9,26	1,98	100,0004599			

Figure 7 - Priority Index Matrix of quality elements

Source: authors (2014).

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

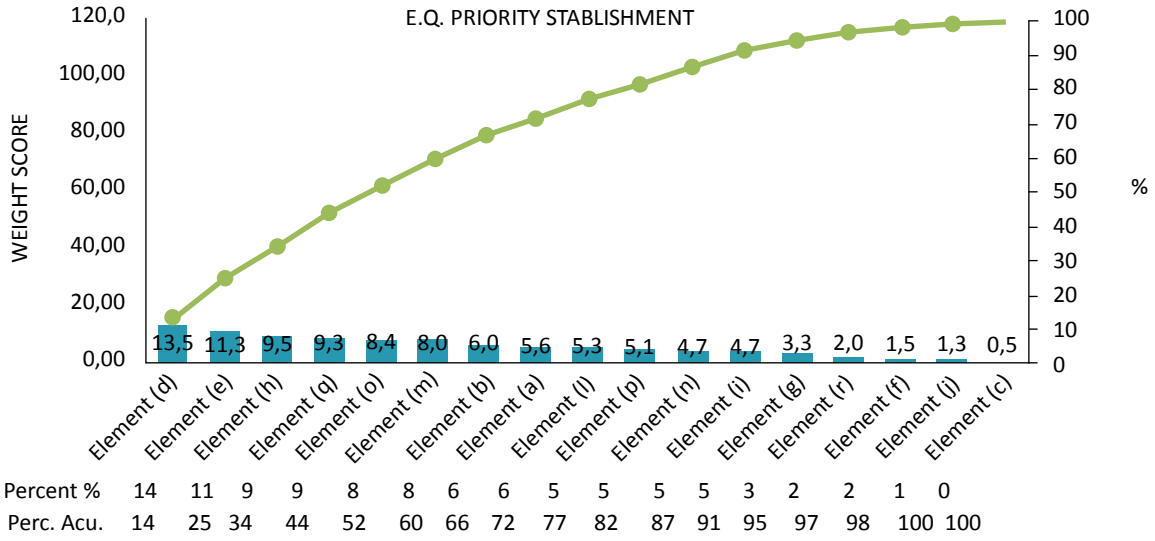

Figure 8 - Pareto's chart indicating the priorities of the Quality Elements

Source: authors (2014).

R.Q.E., which reveals the prioritization according to such criteria in terms of the quality plan before the high degree of user dissatisfaction with the current situation.

5. FINAL CONSIDERATIONS

It is clear that the improvement systems of quality control techniques prove to be increasingly effective, particularly in the areas of public interest, since the development challenges of the globalized societies are constantly facing the quality control problems, along with the requirements of its consumers, so that they can serve as the foundation for information on how companies and government must act to improve the basic conditions for life.

Thus, with the development of the case study we came to the conclusion that it is possible to use tools such as QDF (Quality Function Deployment), a quality control system aimed to identify the main requirements of the users of public collective transport in the city of Marabá, in order to implement improvements in the system, thus mitigating the inconvenience suffered by their clients.

Analyzing the goals of the article in parallel with the results and the theoretical framework raised, it can be seen that the survey assessed the level of quality of public transport services, concluding that the QFD tool was able to map the improvement needs according to the perceptions of users, and the three main priorities are: the establishment of a collective transport network that enables the integration of all its lines, with the payment of a single tariff; the construction of a connection station (integration terminal); and the expansion of the fleet by 15%.

From these results, it was possible to identify the shortcomings of the public transportation system of the city and guide decision making for its improvement, so that it becomes the mostly satisfactory system to its users.

As a proposal for future research, it is suggested further study with a larger sample, aiming at a more detailed and more accurate consumer needs. It is also recommended the development of the methodology proposed in this work in other areas such as health and education, in order to optimize the use of human resources, and implement improvements in the population's lifestyle. It would also be relevant to apply the methodology in other regions of the country.

REFERENCES

Akao, Y. (1996), Introdução ao desdobramento da qualidade, Fundação Christiano Ottoni, Belo Horizonte, MG.

Almeida, L.G. (1987), Qualidade: Introdução a um processo de melhoria, José Olympio, Rio de Janeiro, RJ.

ANTP - Associação Nacional de Transportes Públicos. (2008), O transporte público e o trânsito para uma cidade melhor, ANTP, São Paulo, SP.

Brasileiro, A., Orrico Filho, R. D. e Fortes, J. A. A. S. (1996), "Produtividade e competitividade na regulamentação do transporte urbano: nove casos brasileiros", em Orrico Filho, R. D. *et al.*, Ônibus urbano: regulamentação e mercados, LGE, Brasília, DF, pp. 155-169.

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

Carnevalli, J. (2010), "Axiomatic design application for minimising the difficulties of QFD usage", *International Journal of Production Economics,* Vol. 125, No. 1, pp. 1-12.

Carvalho, M. M. (1997), QFD - Uma ferramenta de tomada de decisão em projeto, Tese de Doutorado em Engenharia de Produção, Universidade Federal de Santa Catarina, Florianópolis, SC.

Cheg, L.C. et al. (1995), Planejamento da qualidade, Fundação Christiano Ottoni, Belo Horizonte, MG.

Chen, Y-T. (2011), "Applying GRA and QFD to Improve Library Service Quality", Journal of Academic Librarianship, Vol. 37, No.3, pp. 237-245.

Drumond, F. B. (1995), Ouvindo o cliente para o planejamento do produto, em Cheng, L. C. *et al*. QFD – Planejamento da Qualidade, Fundação Christiano Ottoni, . Belo Horizonte, MG, pp. 78-88.

Estorilio, C. (2007), QFD – Desdobramento da Função Qualidade, Universidade Tecnológica Federal do Paraná, Curitiba, PR.

Eureka, W. E. *et* Ryan, N. E. (1992), QFD: perspectivas gerenciais do desdobramento da função qualidade, Qualitymark, Rio de Janeiro, RJ.

Gil, A. (2008), Como elaborar projetos de pesquisa, 4 ed., Atlas, São Paulo, SP.

Kamvys, K, Gotzamani, K, Andreas Andronikidis, A e Georgiou, A. C. (2014), "Capturing and prioritizing students' requirements for course design by embedding Fuzzy-AHP and linear programming in QFD", *European Journal of Operational Research*, Vol. 237, No. 3, pp. 1083-1094.

Fernandes, F. S. *et* Bodmer, M. (1995), "Gestão empresarial da qualidade nos transportes: aproximação entre teoria e prática", *Revista dos Transportes Públicos - ANTP*, Ano 18, pp. 33-43.

Lourenço Filho, R. C. D. (1984), Controle estatístico de qualidade. Livros Técnicos e Científicos, Rio de Janeiro, RJ.

Miguel, P. A. C. (2001), Qualidade: enfoques e ferramentas, Artliber, São Paulo, SP.

Mizuno, S. (1993), Gerência para Melhoria da qualidade: as sete novas ferramentas de controle da qualidade, LTC, Rio de Janeiro, RJ.

Pêgo, F. F. (2006), Aplicação da metodologia QFD no transporte coletivo urbano de passageiros, Dissertação de Pós-Graduação em Engenharia Civil, Universidade Federal do Espírito Santo, Vitória, ES.

Pereira Neto, W. A. (2001), Modelo multicritério de avaliação de desempenho operacional do transporte coletivo por ônibus no município de Fortaleza, Dissertação de Mestrado em Ciências em Engenharia de Transporte, Universidade Federal do Ceará, Fortaleza, CE.

Sperandio, C. C. S. (2005). Aplicação da metodologia QFD para a priorização dos itens de fiscalização do transporte ferroviário de cargas sob a percepção do cliente, Dissertação de Mestrado em Engenharia Civil, Universidade Federal do Espírito Santo, Vitória, ES.

Vera, L. A. N. *et* Fischmann, A. A. (1999), "Aspectos organizacionais e institucionais relevantes na gestão e operação do sistema de transporte urbano da cidade de Curitiba – Brasil", apresentado no X CLATPU: Congresso Latino-Americano de Transporte Público y Urbano, Caracas, Venezuela, 1999.

Yin, R. K. (2005), Estudo de caso: planejamento e métodos, Bookman, Porto Alegre, RS.

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

APPENDICES

Table 5 - Priority in terms of the quality requirements demanded by public transport service users

PRIORITIZATION	QUALITY REQUIREMENTS DEMANDED	PRIORITY INDICATOR
1º	Vehicle Capacity	10,01
2º	Permanence time inside the vehicles	9,95
3º	Bus stops adapted for people with special needs - PNEs.	9,86
4º	Integration Terminal	9,40
5º	Waiting time at stops	9,37
6º	Bus quantity per fleet	9,10
7º	Training and friendliness of the staff	8,42
8º	Bus stops	8,14
9º	Structural condition of the vehicles	7,73
10º	Obedience to signaling	6,44
11º	Itinerary	5,93
12º	Fare price	5,64

Source: authors (2014).

Table 6 - Extraction of quality elements

Relation of the Quality Elements to the items of the table of quality requirements demanded (affinity theorem usage)	
Vehicle Capacity	Increased daily trip average, from 325.93 to 1092 (New system).
Permanence time inside the vehicles	Reduction of the current line extension average with the new system.
Bus stops adapted for people with special needs	
Integration Terminal	Promoting the physical, operational, and tariff integration among the means of public, collective, individual, and special transport.
	Implementation of a public transport network that enables the integration of all its lines, with the payment of a single tariff in the municipality.
	Construction at the expense of the winning bid, of a connecting station (integration terminal).
Waiting time at stops	Quality of service provided to the population according to criteria established by the government, in particular: speed, frequency, and timeliness of service.
	Improve at least twice the number of trips currently offered to users, that is, a bus of each line should depart every 10 minutes.
	Increased daily trip average, from 325.93 to 1092 (New system).
Bus quantity per fleet	Conducting credentialing or contracting, by means of authorization, permition or concession of companies with proven capabilities and technologies to meet the requirements and specialties required by law.
	Renewal of permanent fleet, so that the average age remains around 3.5 years.
	Fleet expansion initially at 15%.
Training and friendliness of the staff	
Bus stops	"Plan the design and implement terminals, bus stops, shelters, signage, and other services and/or public transportation system equipment."
	Bus stops - implementation of new shelters for a total of 200 units throughout the RTCM.
Structural condition of the bus	Quality of service provided to the population according to criteria established by the government, in particular: convenience and comfort.
	... Regular manufacturing models must include in their technical characteristics, among others: internal corridor for circulation, emergency window, door opening system controlled by the driver, enough height for safe circulation and proper ventilation, permanently at citizen's disposal...
Obedience to signaling	Quality of the service provided to population according to the criteria established by the government, in particular: security.

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

Itinerary	Service provided to all the population living in urban and rural areas of the municipality.
	The new system also includes the possibility of future expansion, with the construction of more connecting stations and the implementation of new lines.
	Information system that allows users to identify the itinerary.
Fare price	

Source: authors (2014).

Table 7 - Quality Elements - DMTU

1st LEVEL	ITEM No.	2nd LEVEL
OUTSIDE THE OPERATING SYSTEM	1	"Planning, project, and implementing terminals, bus stops, shelters, signaling..." (Law 17,344)
	2	Bus stops - implementation of new shelters for a total of 200 units throughout the RTCM.
	3	"Promoting the physical, operational, and tariff integration among the means of public, collective, individual, and special transport." (Law 17.344).
	4	Implementation of a public transport network that enables the integration of all its lines, with the payment of a single tariff in the municipality. (Basic project)
	5	Construction at the expense of the winning bid, of a connecting station (integration terminal). (Basic project)
	6	Conducting credentialing or contracting, by means of authorization, permition or concession of companies with proven capabilities and technologies to meet the requirements and specialties required by law. (basic project)
	7	Renewal of permanent fleet, so that the average age remains around 3.5 years. (Basic project)
	8	Fleet expansion initially at 15%. (Basic project)
	9	Quality of service provided to the population according to criteria established by the government, in particular: convenience and comfort. (Law 17,344)
	10	"[...] Regular manufacturing models must include in their technical characteristics, among others: internal corridor for circulation, emergency window, door opening system controlled by the driver, enough height for safe circulation and proper ventilation, permanently at citizen's disposal [...] (law 17,344)
INSIDE THE OPERATING SYSTEM	11	Quality of service provided to the population according to criteria established by the government, in particular: speed, frequency, and timeliness of service (Law 17.344)
	12	Increased daily trip average, from 325.93 to 1092 (Basic design).
	13	Improve at least twice the number of trips currently offered to users, that is, a bus of each line should depart every 10 minutes. (basic project)
	14	Reduction of the current extension average of the lines by using the new system. (Basic project)
	15	"Service to all the population living in urban and rural areas of the municipality " (Law 17.344).
	16	Possibility of future expansion, with the construction of connecting stations and the implementation of new lines (Basic design).
	17	Information system that allows users to identify the itinerary (Basic project).

Source: authors (2014).

Table 8 - Priority of the quality elements

1º	Implementation of a public transport network that enables the integration of all its lines, with the payment of a single tariff in the municipality. (Basic project)	13,53
2º	Construction at the expense of the winning bid, of a connecting station (integration terminal). (Basic project)	11,34
3º	Fleet expansion initially at 15%. (Basic project)	9,48
4º	Possibility of future expansion, with the construction of connecting stations and the implementation of new lines (Basic design).	9,26
5º	Reduction of the current extension average of the lines by using the new system. (Basic project)	8,42
6º	Double at least twice the number of trips currently offered to users, that is, a bus of each line should depart every 10 minutes. (basic project)	7,97

Electronic Journal of Management & System
Volume 11, Number 1, 2016, pp. 31-48
DOI: 10.20985/1980-5160.2016.v11n1.783

7º	Bus stops - implementation of new shelters for a total of 200 units throughout the RTCM.	6
8º	"Planning, project, and implementing terminals, bus stops, shelters, signaling..." (Law 17,344)	5,64
9º	Quality of service provided to the population according to criteria established by the government, in particular: speed, frequency, and timeliness of service (Law 17.344)	5,27
10º	"Service to all the population living in urban and rural areas of the municipality " (Law 17.344).	5,12
11º	Increased daily trip average, from 325.93 to 1092 (Basic design).	4,74
12º	Quality of service provided to the population according to criteria established by the government, in particular: convenience and comfort. (Law 17,344)	4,66
13º	Renewal of permanent fleet, so that the average age remains around 3.5 years. (Basic project)	3,33
14º	Information system that allows users to identify the itinerary (Basic project).	1,98
15º	Conducting credentialing or contracting, by means of authorization, permition or concession of companies with proven capabilities and technologies to meet the requirements and specialties required by law. (basic project)	1,52
16º	"[...] Regular manufacturing models must include in their technical characteristics, among others: internal corridor for circulation, emergency window, door opening system controlled by the driver, enough height for safe circulation and proper ventilation, permanently at citizen's disposal [...] (law 17,344)	1,29
17º	"Promoting the physical, operational, and tariff integration among the means of public, collective, individual, and special transport." (Law 17.344).	0,47

Source: authors (2014).