

# Quality Function Deployment in Airport Terminals: The Airport of Porto Alegre Case

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**Abstract**—Since years 90, the Brazilian air market suffered major changes, starting with the opening of the market and culminating with increasing competition in the airline market. These factors, coupled with the country's economic stability, and the ease to credit, generated a significant increase in demand in the last decade. Current infrastructure of airports could not keep up with the growing market, which led to the situation faced daily in Brazilian airports: crowded waiting rooms and constant delays in flights. Within this context, this work aims to evaluate the quality of services within Porto Alegre Airport/Salgado Filho. Quality function Deployment tool (QFD) is used as the main tool for evaluating the levels of quality. The requirements have been identified and prioritized with the application of market research, and subsequently analyzed by the statistical tool Principal Component Analysis (PCA). The result was the construction of a survey instrument to assess airports, statistically valid, and a methodology to weave strategic guidelines for implementation of improvements.

**Index Terms**—Quality Function deployment (QFD), quality service, airport's customers prioritization

## I. INTRODUCTION

In a country of continental dimensions such as Brazil, air transports play an important role, both in economic and cultural development. Flexible policy of Brazilian commercial aviation, which occurred in the years 90, allowed the gradual removal of control over economic variables. The new management model, together with the economic stability of the country and the insecurity of other transport modes eventually boost strongly the air market. On the other hand, technological advances in aircraft, becoming larger and heavier, brought problems in airport infrastructure [1].

The demand for air travel has increased significantly in the first decade of the 21st century, but the airport infrastructure was unable to keep up with this growing market. In this way, what if there are crowded terminals and delays in flights. This reality has given rise to studies that optimize operational procedures, as well as the areas

available at airports. Therefore, the development of service levels for passenger terminals at airports has been a constant search for airport operators around the world [2], [3].

To know and analyze user's preferences regarding airports passenger terminals makes it possible to identify its priorities. This process assists decision-making throughout processes of analysis of portfolio of investments in the sector. This can result in cost reduction, redirection of investment and increased level of users' satisfaction. In this way, the relevance of this research is attributed to the growing number of passengers and, consequently, the largest moving within the airport terminals, not only people, but also of more aircraft and increased wear of the operation infrastructure.

In this context, the objective of this paper is to present a methodology that brings together market research techniques, statistical techniques of principal component analysis - PCA and quality function deployment - QFD, to assess the quality of services in passenger terminals. Also part of the scope of the study is to identify some key components of quality infrastructure and airport services, in order to contribute to the identification of the services that need improvement. This practice enables the maximization of future investments.

## II. QUALITY IN TRANSPORT

Today, the perception of quality has become essential for the evaluation of level of service of any industry, wherever the market. According to the Airports Council International [4], the shuttle can be understood as something that is produced and consumed simultaneously, and may not be stored, and where customers have direct contact with the operation. Underground airport customers are airlines, passengers, concessionaires and all others that use the physical space of the airport, but are not necessarily interested in the modal. However, these users have different perceptions regarding the performance of the operations. A way to manage the infrastructure and quality of the airport services is the user satisfaction survey, aimed at identifying, from the expectations, priorities in the actions of service improvements. In this work, the users were the passengers.

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### A. Airports Services: Quality and Level of Service

Several studies about level of service in passenger terminal were developed for many international agencies [4]-[6]. However, most of these studies were strongly criticized, mainly for not prioritizing the users' survey on the development of the patterns and methods proposed [7]-[9]. On the other hand, many works show methods to evaluate level of services in airports passenger's terminals under the users' view [7], [10]-[17]. Table I shows some methods that had evaluate the quality in several transport modes.

TABLE I. METHODS THAT EVALUATED THE QUALITY IN TRANSPORT.

Sector	Methods
Road Concession	Quality Function Deployment (QFD) [18]
Cabotage Transport	Quality Function Deployment (QFD) + Stated Preference (SP) [19]
Cargo Transport	Analytic Hierarchy Process (AHP) [14]
	Quality Function Deployment (QFD) [20]
	Quality Function Deployment (QFD) [21]
Public Transport	Quality Function Deployment (QFD) + Principal Component Analysis (PCA) [22]
	Quality Function Deployment (QFD) [23]
	Quality Function Deployment (QFD) + Principal Component Analysis (PCA) [24]
	Quality Function Deployment (QFD) [25]
	Psychometric Scaling Technique [7]
Air Transport	Opinion Survey [13]
	Opinion Survey [26]
	Satisfaction Survey [27]
	Analytic Hierarchy Process (AHP) [28]
	Perception – Response Method (P-R) [10]
	Analytic Hierarchy Process (AHP) [17]
	Utility Function [11]
	Fuzzy Logical [15]
	Opinion Survey [12]
	Analytic Hierarchy Process (AHP) [3]
Analytic Hierarchy Process (AHP) [29]	
Linear Regression [30]	

An airport terminal can be defined as a set of interacting subsystems, allowing the realization of modal transfer: from land to air and vice-versa. Around these movements, ie, the embarkation and disembarkation of passengers, a number of different components are installed and services are produced, in order to ensure customer expectations in relation to the terminal [27]. In other words, in addition to meeting the satisfaction with the result of the service (meet the scheduled times of departure and arrival, for example), there is still satisfaction during the generation process itself, with which the client has direct contact (comfort, security, etc.).

Currently, the Brazilian airline industry is in transition, with the modernization of airports and airlines. The Brazilian government initiated a program of privatization of airports, whose goal is to accelerate modernization. Just seven months after announcing the privatization

program, the Brazilian Federal Government held the first auction with lots including concessions of airports of Guarulhos (SP), Campinas (SP) and Brasilia (DF). The entry of private capital in airport management should generate an increase in the number of studies addressing the identification of service quality in passenger terminals, in order to reduce costs, redirect investment and increase the level of customer satisfaction.

### III. IMPROVING THE QUALITY OF SERVICES THROUGH QFD

The assumption that customer satisfaction is a key issue to the success of a company is already consolidated in the market. To achieve this goal, the company must provide a product or service with higher added value to ensure its quality. In this sense, the higher the approximation client company, the greater the suitability of services to the needs demanded. QFD, a widespread tool, seeks to incorporate the process of developing the perfect product or service meeting the needs explicit, implicit, current and future customers, quickly and effectively.

It is in the planning stages that are the most likely to ensure the fulfillment of customer needs with quality [31]. Investments made at this stage reverberate in substantial savings of resources spent in later stages of problem solving. Part of this initial stage is listening to customers. However, it is not always easy to translate the desires and expectations of consumers into products or services. Often, the staff of companies coming up with language used does not fit directly to the technical specifications, such as: good picture, nice place, easy to use, good to ride, easy to understand, and so on.

What makes QFD a different tool, the feasibility is that it has to explain the relationship between customer needs, the characteristics of the product / service and the parameters of the production process, thus allowing the harmonization and prioritization of the various decisions taken during the process of designing the product/service. Other important issue to be emphasized is the collective commitment of the members involved in the process, they now have a common understanding regarding the decisions, their reasons and their implications.

A systematic QFD involves the construction of a series of integrated arrays, where the first one is deployed demands of quality according to the customers (in this study defined as passengers at Porto Alegre International Airport), and its quality, items that are measurable qualities of these defendants. Following are deployed arrays of parts of the product, the processes that involve the resources needed for their realization (human and infrastructure) and costs.

### IV. METHODOLOGICAL PROCEDURE

The methodology follows the conceptual model of Ribeiro [32], shown in Figure 1, a simplified method adapted from matrices Akao [33]. This methodology was applied in different cases in teaching workshops, being

flexible to different knowledge areas such as manufacturing, education and transport [22], [34]-[39].

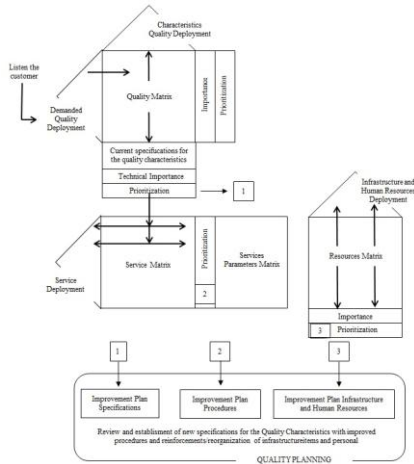


Figure 1. Conceptual model for services (Ribeiro *et al.*, 2001).

The focus of this study was the terminals of the airport complex of Porto Alegre. Salgado Filho Airport is located in the capital city of Porto Alegre, which suffers from urbanization nearby. This characteristic complicates the feasibility of expansion of its facilities. The biggest losers are the passengers who suffer flight delays, lack of parking spaces (paid or not), with the cost associated with parking, and the lack of more modern instruments that allow the aircraft landing in low visibility (instruments called "anti-fog"). The latter, a characteristic common in autumn and winter in the state capital. For these factors, it was decided that the target population of this study are passengers.

**A. Market Research**

The first step is to "listen to customers", which aims to translate the attributes that influence customer perception to product quality. In this study, we identified the qualities demanded by passengers on the infrastructure and services of the passenger terminal of the airport. This process was accomplished in 02 steps: (i) Exploratory and (ii) quantitative phase [40], [41].

In the exploratory phase passengers were heard when awaiting their flights in the departure lounge. Also, some industry experts were interviewed. In addition, a literature review was conducted aiming at identifying additional attributes. The results were divided into the quality demands, grouped by affinity, forming a logical tree, which is shown in Table II.

In the second phase, a framework was conceived from the logical tree resulting from the first phase, with specific and objective questions where respondents' weights assigned to items. The sample was defined for convenience and 240 responses were obtained. This number was considered sufficient for academic purposes. The questionnaire was pre-tested and validated according to Cronbach's alpha coefficient, which measures the internal consistency and reliability of the responses. Values above 0,70 are considered satisfactory measures, this study showed a value of 0,90. In Table II can be seen coefficient values for each construct.

TABLE II. TREE QUALITY.

Constructs	Quality Demanded
Airport Access $\alpha = 0,784$	Availability of public transport and taxi service
	Conservation status of vehicles of public transport and taxi service
	Ease of integration with the airport station Trensurb Availability of a bus line pre-defined, linking the road to the airport
Comfort in Airport Dependencies $\alpha = 0,751$	Availability of equipment of facilitate the offset, such as elevators, escalators and baggage carts Distribution of seats inside the terminals
	Distribution of the bathrooms inside the terminals
Airport Parking $\alpha = 0,696$	Availability of parking spaces Ease in transport between the parking and the dependencies of the terminals
	Rates for parking
Equipment operation (fingers, baggage conveyor belt, etc.) $\alpha = 0,711$	Speedy recovery of luggage (waiting time)
	Avoid flight delays due to weather (modernization of equipment)
	Ease of access to the embarkation and disembarkation of passengers
	Ease of integration between terminals (two physic terminals)
Food and Convenience Stores $\alpha = 0,865$	Availability of food shops on both terminals
	Availability of convenience services on both terminals
	Rates in services and convenience products Rates in services and products supply
Information Service $\alpha = 0,722$	Availability of information counters at the airport
	Availability of electronic information panels at terminals Signaling for guidance of passengers in the and out of the terminals

**B. Quality Matrix**

The quality matrix is a kind of conceptual map that provides the means for inter-functional planning and communications [25]. It is the first of three matrices that make up the conceptual model applied to services, and the matrix is also considered more important.

The prioritization of demands qualities was performed using the statistical technique of Principal Component Analysis (PCA). This technique is often used to identify a small number of factors that account for most of the observed variance in the data, and also to show the relationship between the variables [42]. The implementation of the PCA in this study was confirmatory in nature, which allows checking how well the measured variables represent the constructs. The main advantage is that it is able to test a theory analytically, explaining how different items measured describe important behavioral measures [43]. Therefore, evaluating the quality of the medium used in a behavioral model is important because one cannot obtain valid conclusions without valid measures.

For the results obtained by applying the PCA was calculated Cronbach's alpha, with the objective of validating the internal consistency of the constructs. That is, checking whether the constructs are well grouped. The Cronbach's alpha for all constructs were superior measure considered satisfactory. Therefore, the results of PCA



transportation, whether public (bus, metro, etc.), or individual (taxi). Another issue that deserves further consideration for future improvements is a complex operation, such as the modernization of instrument approach and improving the integration of the terminals, the first being a major reason for late flights in the months from May to September.

For the quality prioritized in the Matrix Quality, after considering the competition and the difficulty of action for improvement, given the necessary caveats, the results also pointed to investments aimed at improving access to the terminal by means of public transport and operation thereof. Public transport fleet modernization, improved transportation network that meets the complex and the integration between the two terminals, and system upgrade approximation of aircraft instruments by 61% would meet the expectations demanded by passengers who use the airport in Porto Alegre.

The unfolding of Matrix Services showed that improvements made in maintenance of the terminals are the priority. These services, along with those operating in the parking lane and account for 51% of the needs of passengers. That is, investments in these sectors, improve the perceived quality of the complex according to these customers.

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