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EVALUATION OF AIRPORT CHECK-IN LEVEL OF SERVICE

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Abstract

A methodology for determining user perceptions of the level of service (LOS) offered at airport passenger terminals is presented in this paper. The underlying concept of this methodology is a technique to derive quantitative values for passenger perceptions of service based on attitudinal surveys conducted at airports. The methodology proposed is applied in practice to existing airports. Particularly the check-in counter component is evaluated, considering factors that have a bearing on user perceptions of LOS: processing time, waiting time and space available per person. The study uses data obtained from a passenger survey conducted at Rio de Janeiro International Airport, São Paulo/Guarulhos International Airport, and São Paulo/Congonhas International Airport. The results indicate that we can get quantitative perception scales from qualitative survey data. The research described in this paper has addressed the quantitative modeling of passenger service LOS at the airport terminal. This framework represents a step forward in the process of modeling LOS perceptions for further practical applications.

Keywords: Level of service; Airport passenger terminal; Check-in counter.
Topic Area: A3 Airports and Aviation

1. Motivation

The motivation for developing landside level of service (LOS) measures is twofold. First, since one of the goals of landside planning is to improve, or at least maintain, the level of service experienced by the airport user, it is necessary to be able to measure LOS in order to know whether this goal is being achieved. Second, landside improvements are rarely without expense. To know whether a particular expenditure is justified, it is necessary to be able to measure the change in LOS resulting from it. Merely striving to meet arbitrary performance standards, without regard to the cost of doing so, is likely to lead to misallocation of resources (Gosling, 1988).

Establishing measures to evaluate operational performance of the airport landside and quality of service is one of the major problems facing the airlines and airport operators (Mumayiz, 1991). Humphreys and Francis (2000) affirm that LOS evaluation in US Airports have been undertaken at individual airports, with no standard method or reporting system for this on a national scale. Research is also needed in developing countries, mainly to generate references for planning airport infrastructure. In this regard. Fernandes and Pacheco (2002) stress that the lack of studies in Brazil to enable parameters reflecting Brazilian conditions to be estimated means that estimates made on the basis of conditions at airports in other countries are used without further evaluation. According to them, the issues of domestic traffic, in particular, deserve special attention in terms of Brazilian specifics.

Airport landside LOS and capacity have been topics of research interest over the past two decades or so. More recently, owing to the important nature of airport LOS issues, a number of studies have been initiated on the identification of the landside problem in general, and on capacity and service measures in particular. Despite all the studies developed in the last decades, LOS analysis is in a rudimentary state of development in airport design, in comparison with highway engineering. In 1986 the FAA responded to concerns of inadequate understanding of landside capacity constraints by commissioning a study (TRB, 1987) of ways to measure airport landside capacity. This study recognized that the capacity of any given landside facilities cannot be evaluated without defining acceptable LOS values, but there is currently little agreement on how to do this.

This paper presents a review of the literature on LOS evaluations. A methodology for airport LOS evaluation is presented. The technique used is based on psychometric mathematical models for analyzing categorical data. The method is then applied to the evaluation of airport check-in LOS.

2. Previous studies

Airport LOS studies date from 1975 when Heathington and Jones (1975) examined 25 characteristics relevant to the airport terminal. Some of these are availability of seating, walking distance, accessibility, orientation, waiting time and occupancy. Brink and Madison (1975) suggested that, for passengers at the airport terminal, LOS is a subjective impression of the quality of the transfer between the access mode and the aircraft. They consider this subjective perception of quality to be dependent on a series of factors, including (but not necessarily limited to):

a) Time necessary to be processed through the landside,
b) Reliability or predictability of processing time,
c) Reaction to overall landside environment,
d) Physical comfort and convenience,
e) Treatment by airline, concessionaire, security and other airport personnel,
f) Cost of air fare and airport services,
g) Type of passenger and purpose of trip,
h) Frequency of air travel, and
i) Expectation of level of service.

During the last decades, many researchers developed methods to evaluate LOS as a function of terminal characteristics and other factors. Paul (1981) followed the general idea presented by Heathington and Jones (1975). He presented a methodology for predicting passenger evaluations of airport terminal facilities through the development of relationships between measures of passenger evaluation of the facility and factors that influence their evaluation. Another initiative to evaluate passenger perception of quality of service at airport terminals was developed by Mumayiz (1985). Utilizing a method called perception-response (P-R), he tried to empirically obtain LOS ranges as function of passenger responses based on “stated” values of time spent and rating of service (Figure 1).

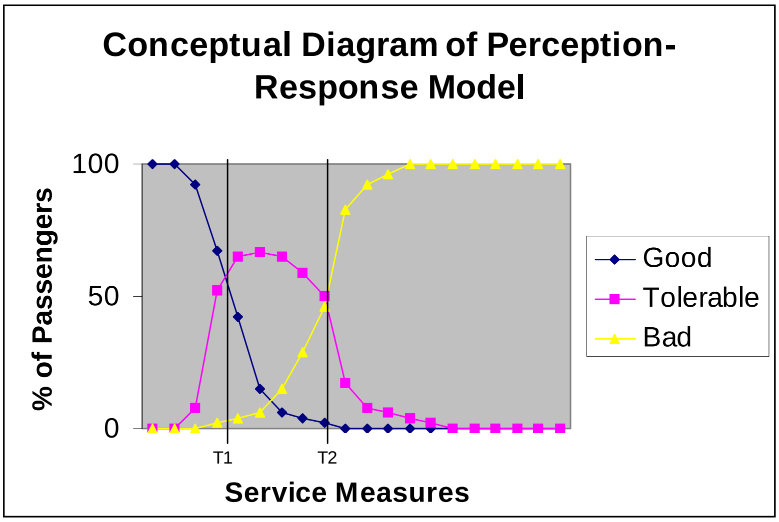

Figure 1: Conceptual diagram of perception-response model (Mumayiz, 1985)

The methodology is detailed by Mumayiz and Ashford (1986). The main drawback of the mentioned methodology is that it allows the evaluation of only one attribute per time. Nevertheless, Ashford (1988) suggested that a strong interaction exists between space provision and time; that interaction cannot be obtained by the P-R concept as it has been presented. Mumayiz (1991) stated that a three-dimensional P-R concept could be developed accounting for the variations of delay and crowding, but, according to the author, no work has been done to support this hypothesis because of problems associated with adequately interpreting and collecting passenger perceptions of crowding and space provided. In addition to that deficiency, recent LOS studies of airport passenger terminal processing components have shown that perceived and actual time revealed enormous discrepancies (Park, 1994; Park, 1999; Yen et. al., 2001). Those discrepancies indicate that obtaining data by stated-preference technique must be used with caution.

Müller (1987) proposed a framework for evaluating quality of service at airport passenger terminals according to passengers' perceptions, using a psychological scaling technique. The main advantage of the technique employed was the transformation of qualitative data (categorical passengers' responses about quality of service) into quantitative data through a quantitative quality continuum.

Omer and Khan (1988) developed a method for applying the utility and cost-effectiveness theories for measuring user-perceived LOS and for establishing economical design criteria on airport landside. The methodology proposes the application of attitudinal survey techniques to ask the users to indicate the relative importance of LOS factors (e.g. waiting time, processing time, space availability) and to rate each LOS attribute/factor through a semantic scaling method. After that, the weight rates would be transformed to a relative value scale and then combined into a utility measure. That methodology was applied at some Canadian airports by Omer (1990) for the check-in, baggage claim, boarding lounge and preliminary inspection line (PIL) area subsystems. He provides composite utility equations for each of the subsystems mentioned. Figure 2 illustrates the relationship between physical measures, utility and level of service for the case of check-in and baggage claim facilities. Muller and Gosling (1991) criticize their methodology. According to them, rank numbers are ordinal not cardinal, and cannot therefore be summed together, and most service measures do not have upper bounds and cannot be converted to a scale of 0 to 1. These problems could be circumvented by rating rather than by ranking. Ndoh and Ashford (1993) also criticize the approach, saying that the direct use of survey rating scales in the model suggested is inappropriate.

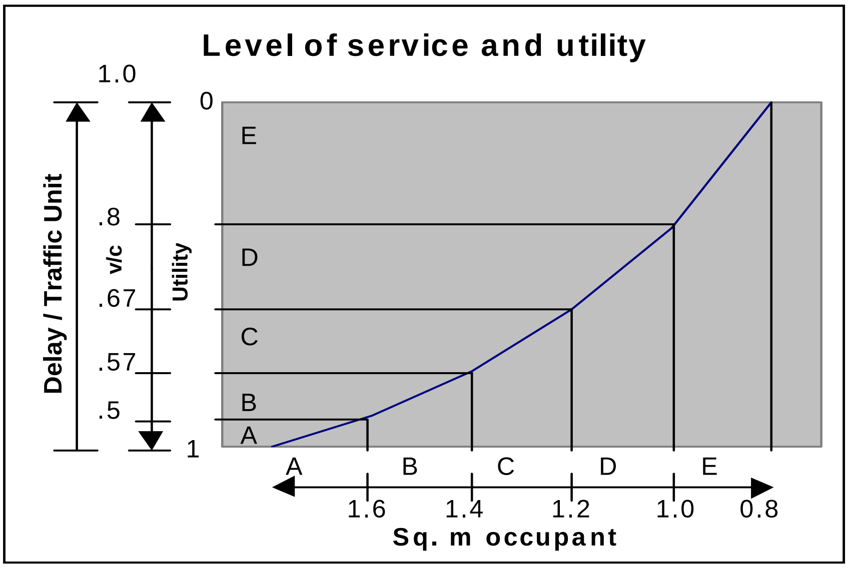

Figure 2: Level of service and utility: check-in and baggage claim
(Omer and Khan, 1988)

Martel and Seneviratne (1990) analyzed the factors influencing quality of service (QOS) in passenger terminal buildings. Through a personal interview survey of departing passengers, they found that availability of space is the most significant factor influencing quality of service from the passenger's point of view. Within the circulation elements, 53 percent of the respondents believed that information is the most important factor. Similarly, for the waiting areas, the most important factor was the availability of seats and for the processing elements it was the waiting time. The study concludes that QOS is a complex concept that is inappropriate to evaluate with one indicator and the factors influencing QOS differ depending on the element of the passenger terminal building. Seneviratne and Martel (1991) applied the results of this survey to the measurement of performance variables for passenger terminal buildings. The measures were developed through the suggestion of global indices for the most important variables that have a bearing on the evaluation of LOS, according to the passenger views found in the survey. Most of these global indexes proposed were applied in Seneviratne and Martel (1994); here they used six indexes to describe terminal subsystem characteristics:

a) availability of seats;
b) walking distance;
c) accessibility;
d) orientation (i.e., availability of information);
e) waiting time; and
f) occupancy (i.e. density).

Ndoh and Ashford (1993) employed the theories of perception scaling and categorical judgment to evaluate airport access LOS. The categories were graded “very satisfactory”, “satisfactory”, “indifferent”, “unsatisfactory”, and “very unsatisfactory”. Data was collected by stated preference technique. The analysis considered 12 attributes (e.g. mode economy, mode comfort, access information, etc). They presented the scale values for each access mode (private car, taxi, metro, etc) for each attribute considered.

Ndoh and Ashford (1994) explored the use of fuzzy set theory, particularly linguistic fuzzy set models, as a technique for evaluating transportation LOS through the incorporation of qualitative components such as convenience and comfort. They indicated that previous approaches used to estimate LOS provided crisp scale values of LOS that cannot be given linguistic values that are precise in comparison with the manner in which passengers originally expressed their perception of services. The authors apply the methodology proposed to evaluate processing services at an airport (check-in, security inspection and passport control subsystems) using hypothetical values. Although the methodology seems reasonable, it was not properly validated. Further, the method does not offer any goodness-of-fit test to assess the quality of the measurement.

Park (1994) employs fuzzy set theory for the LOS evaluation based on passenger perceptions, considering three types of factors: temporal or spatial as quantitative measures; and comfort factors and reasonable service factors as qualitative measures. The methodology utilizes an expert panel to obtain the degree of importance of several terminal components and a passengers’ survey at Seoul Kimpo Airport to obtain quality ratings of facilities on five different areas of the airport terminal: service processing, holding, circulation, ground access and concessions. The surveys explored the used of linguistic expressions as bearable, long, accepted, complicated, tolerable, bad, etc. The outputs of the expert panel and the passenger survey were further applied to a fuzzy multi-decision model to obtain the quantitative quality ratings of the facilities surveyed. In addition to that, the author provided a comparison between real service performance indicators (temporal measures) and perceived values obtained by the perception-response (P-R) research that was developed by Mumayiz (1985). The comparison of results of the two methods shows a totally different perception of service standards, in particular for the security screening service and for the passport control. The differences indicate that the P-R model as originally developed has many failures, mainly because of the lag-time between the service experience and filling out of the questionnaire by the airport user.

Yen (1995) conducted a survey at the municipal airport of Austin, Texas. He applied logit models to estimate a “long” model and a “short” model to predict the probabilities that a passenger will rate a service on the basis of perceived time measures. The long and short models were then used to build a mechanism to define different service levels. Yen et al. (2001) presents two advantages of that model:

- it measures the level of service at airport passenger terminals on the basis of a well-defined behavioral model;
- the model has the capacity of forecasting.

The Airports Council International (ACI, 2000) undertook to develop a quality survey with its ACI members. According to the survey, 61.7% of respondents make use of subjective criteria and 43.3% make use of objective criteria; 31.7% make use of both objective and subjective criteria. Although there is no worldwide procedure for assessing quality of service at airports, the trends for processing components of airport passenger terminals is focused on measuring basically the waiting/processing time associated with individual facilities.

Yen et. al. (2001) present a quantitative model to define the level of service at airport passenger terminals. The model uses the fuzzy concept to relate subjective service ratings to time measurements of associated waiting or service processes. Respondents were asked to rate each service from five possible items: very satisfied, satisfied, neutral, unsatisfied and very unsatisfied; following the calculation of five consecutive membership functions of service ratings, the thresholds can be estimated mathematically to set up the interval of each service level. By the analysis of empirical data, they conclude that in each process the mean of perceived time is always greater than the one actually measured and perceptive measurements have more deviation from their means than objective measurements.

3. Methodology proposed

The methodology adopted for LOS evaluation is based on the psychometric scaling technique developed by Bock and Jones (1968) and further applied by Muller (1987) and Ndoh and Ashford (1993).

Psychometrics and psychological scaling theory has given extensive consideration to the behavior of subjects, sampled from a specific population, in choosing among alternatives (Bock and Jones, 1968). These ideas can be applied to passenger level of service evaluation of an airport terminal by considering passengers as subject to the experience of being processed at the terminal during the transition between their access and egress mode (whether by ground or air), and then being asked to choose a rating for the quality of that experience (Muller and Gosling, 1991). Most of the studies on this subject are developed from the work of Thurstone (1959). He introduced the fundamental concept of a sensory continuum, which remains an essential part of current psychological theory.

There are many methods available on psychometric scaling theory. We could divide them into two categories. There are the methods where judges assess a stimulus directly in terms of other objects, in which category are included the constant, paired comparisons and rank order methods. On the other category, successive-categories judgments, however, depend upon passenger evaluations of the stimulus as a function of rating categories. For the purpose of measuring terminal LOS, it is supposed that the passenger will experience a stimulus only once during his/her trip experience, which is being measured; in this case constant, paired comparisons and rank order methods are not useful for measuring performance variables LOS of different terminal components. For this research, the successive categories method will be employed, since it is the most suitable for measuring airport passenger terminal LOS. The method has been mathematically developed by Bock and Jones (1968), as presented below.

4. The method of successive categories

Consider one terminal component such as check-in. In developing this theory for evaluating LOS for check-in, we will consider three component characteristics: waiting time, processing time and availability of space denoted by X_1, X_2 and X_3 respectively. In general, Xj will denote the value of the characteristic (stimulus), where j is the characteristic.

Consider N air passengers that have been serviced at the check-in counter. All of them have experienced identical waiting time in the queue, processing time at the counter and a level of crowding while waiting in line. They are asked to rate those three characteristics into five ordered level of service categories. In general these categories will be defined by

k, which is described as follows: unacceptable (k = 1), poor (k = 2), fair (k = 3), good (k = 4) or excellent (k = 5).

Hypothetically, consider that 30 passengers have rated the waiting time characteristic into five categories. The results of this survey are presented at Table 1.

Table 1 Passenger answers of a hypothetical survey

1 - Unacceptable	2 - Poor	3 - Fair	4 - Good	5 - Excellent	Total
0	5	20	5	0	30

From this data, it is possible to obtain the proportion of responses where the waiting time is assigned at or below category k. Let us denote these proportion of responses as p_{jk}, where j represents the characteristic and k represent the category. Table 2 illustrates the calculation of the proportions for the hypothetical example previously provided.

Table 2 Cumulative responses and proportions.

k - category	1 - Unaccep.	2 - Poor	3 - Fair	4 - Good	5 - Excellent
Responses at or below k	0	5	25	30	30
Proportions (p_{jk})	0.00	0.17	0.83	1.00	1.00

In this example, for instance, 83% (p_{13} = 0.83) of passengers judge stimulus 1 at or below category 3 (fair).

Suppose it is possible to obtain a quantitative LOS rating from N surveyed passengers. Consider that this rating v_j, for a given characteristic j can be defined as follows, for a given passenger:

$$v_{ji} = \mu_j^{LOS} + \varepsilon_{ji} \qquad (1)$$

where μ_j^{LOS} is a fixed component, specific to X_j, but common to all passengers, and ε_{ji} is a random component characteristic of stimulus X_j and a randomly selected passenger i.

The position of a given category boundary is also assumed to be perceived at different points on the continuum by different passengers. Its location is also defined by a probability distribution with its own mean and dispersion. Thus the perceived location of the upper boundary of category k is given by:

$$v_{ki} = \mu_k^{UB} + \varepsilon_{ki} \qquad (2)$$

where μ_k^{UB} is a fixed component associated with point k on the continuum. The component ε_{ki} is random, based on passenger i.

Figure 3 illustrates the position of a stimulus X_j, for characteristic j, and category boundaries, as defined by a given passenger i. In this illustration, the passenger i has rated characteristic j as fair (category 3) by choosing a value between v_{2i} and v_{3i}. He/she has also interpreted the category boundaries at v_{1i}, v_{2i}, v_{3i} and v_{4i}, as shown. It is worth noting that the upper boundary of category 5 is $+\infty$.

Each passenger might position the stimulus in a different point and interpret the category boundaries in a different way. We assume the joint distribution of ε_j and ε_k to be bivariate normal, with means of zero, variances δ_j^2 and γ_k^2, and intercorrelation zero. In the absence of information to the contrary, it is usual to consider the variance γ_k^2 to be constant across all categories *k*; so we will assume that $\gamma_k^2 = \gamma^2$ for all *k*. Figure 4 illustrates the assumptions of normality for the distributions of v_j and v_k's.

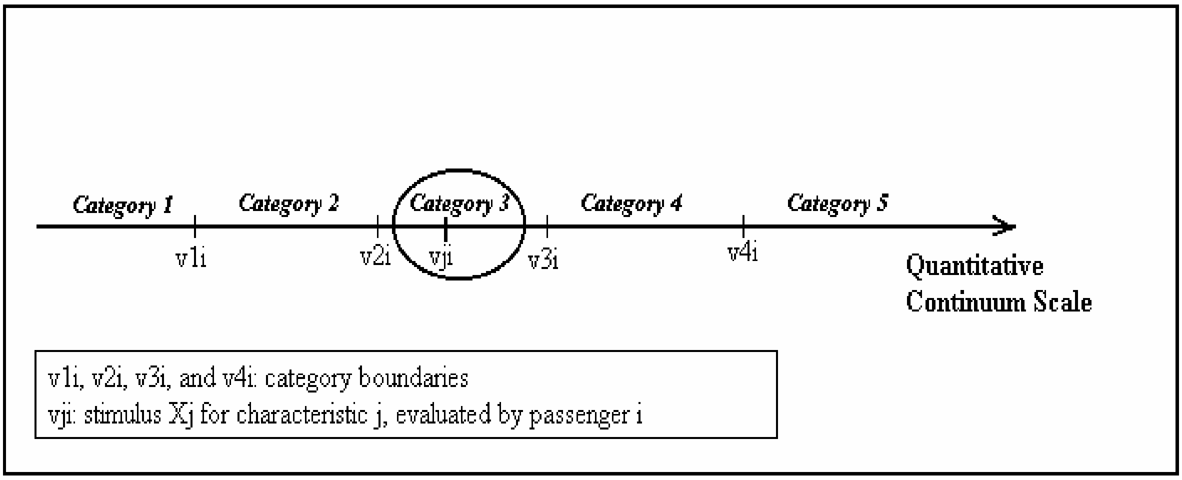

Figure 3: Illustration of quantitative continuum scale for one passenger

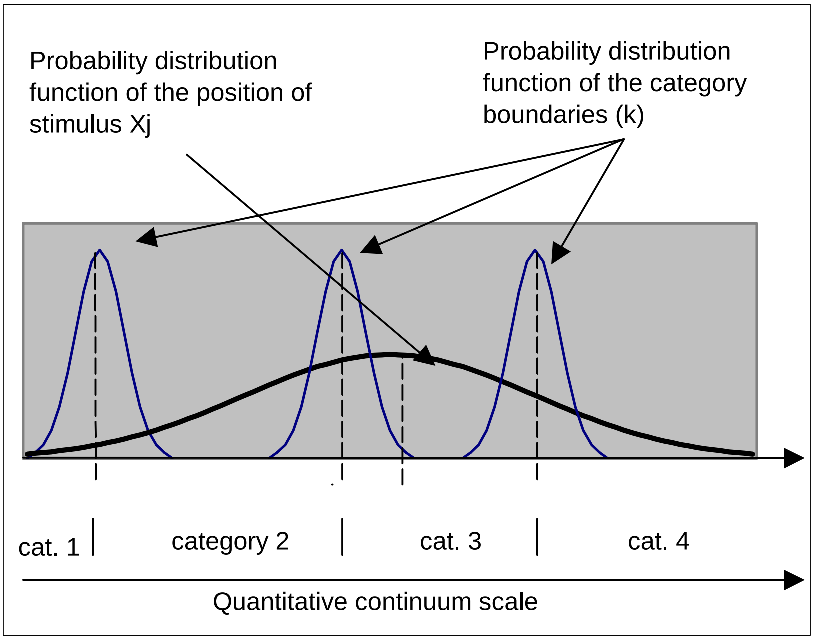

Figure 4: Illustration of the successive categories method for all passengers

The response of passenger *i* is assumed to be determined as follows. Stimulus *Xj* will be rated at or below point *k* for passenger *i* if

$$v_{jki} = v_{ji} - v_{ki} = \mu_j^{LOS} - \mu_k^{UB} + \varepsilon_{ji} - \varepsilon_{ki} \leq 0 \qquad (3)$$

Clearly, v_{jk} is normally distributed, with mean

$$\mu(v_{jk}) = \mu_j^{LOS} - \mu_k^{UB}, \qquad (4)$$

and variance

$$\nu(v_{jk}) = \delta_j^2 + \gamma^2 = \sigma_j^2 \qquad (5)$$

Equation (3) can be illustrated using figure 3. We note that v_j is smaller than v_3. In this case $v_{jk} = v_j - v_3 < 0$. So, stimulus j is rated at or below point $k = 3$, that means category 3. Although it is very obvious, this equation will be very useful to the development of the model. The application of this equation to an integral of probability distribution, considering the mentioned assumptions, and after some algebraic developments can provide the following relation:

$$P_{jk} = \Phi\left[(\mu_k^{UB} - \mu_j^{LOS}) / \sigma_j\right] \qquad (6)$$

Equation (6) represents the probability that a passenger will judge stimulus X_j at or below category k.

The inverse of this function is

$$(\mu_k^{UB} - \mu_j^{LOS}) / \sigma_j = \Phi^{-1}\left(P_{jk}\right) \qquad (7)$$

Data from experimental design may be cast in the form of observed proportions p_{jk}, the proportions of judgments of X_j at or below category k. Then according to the model,

$$(\mu_k^{UB} - \mu_j^{LOS}) / \sigma_j \cong \left[\Phi^{-1}(p_{jk})\right]$$
$$\cong \left(y_{jk}\right) \qquad (8)$$

y_{jk} is the normal deviate corresponding to the proportion p_{jk} in the lower tail of the unit normal distribution.

Bock and Jones showed that the estimate of μ_k^{UB}, $\underline{\mu}_k^{UB}$, can be determined as the average of the k[th] value of the standard normal deviates over all passenger groups j, that is:

$$\underline{\mu}_k^{UB} = \frac{1}{n}\sum_{j=1}^{n} y_{jk} \qquad (10)$$

According to the normal distribution, y will vary linearly with $\underline{\mu}_k^{UB}$, and so the estimate of μ_j^{LOS} and σ_j can be obtained by the regression line defined using these values of $\underline{\mu}_k^{UB}$ as the independent variables, and the y_{jk}, $k = 1, 2, \ldots, (m\text{-}1)$, for each j as the dependent variables. The slope will be $(1/\underline{\sigma}_j)$ and the intercept on the $\underline{\mu}_k^{UB}$ axis will be the value of μ_j^{LOS}.

The results obtained by application of the successive categories method are quantitative values, which represent the passenger perception of facility characteristics.

5. The Chi-Square test for normality

The conformity of the observed proportions of response in each category, designated

p_{jk} - $p_{j,k-1}$ with those derived from the model designated P_{jk} - $P_{j,k-1}$, may be tested by computing a total χ^2 for the discrepancies between them:

$$\chi^2 = \sum_{j=1}^{n} \sum_{k=1}^{m-1} \frac{\{[(p_{jk} - p_{j,k-1}) - (P_{jk} - P_{j,k-1})]N_j\}^2}{(P_{jk} - P_{j,k-1})N_j} \qquad (11)$$

To determine the degrees of freedom for the total χ^2, we note that there are $n(m-1)$ independent observed proportions (according to the assumptions stated before). From this total $2(n-1)$ degrees of freedom are consumed by the estimates of μ_j^{LOS} and σ_j not determined by the estimates of μ_k^{UB}, and $m - 1$ are consumed by the estimates of μ_k^{UB}. Thus, the residual variation is on $(n-1)(m-3)$ degrees of freedom, and it is necessary to use not less than four categories and two objects if the model is to be tested.

6. Facility characteristics surveyed in the analysis

Check-in counter LOS evaluations have been previously undertaken by many researchers and perhaps it is the airport passenger terminal component most studied. The check-in counter is the first processing component in the terminal which passengers pass through during the enplaning trip. In this facility, passengers get their seats finally assigned, drop the baggage, and obtain a boarding pass with the gate and flight numbers.

The level of service provided at the check-in counter reflects both the airport and airline images. In addition to that, because it is one of the first components in the passengers pathway, it can cause delay to other activities and finally to the departing flight. Not only can a poor level of service can cause operational problems to passengers, airlines and airport administration, but it can add to passenger stress.

Despite the reasonable number of studies dealing with check-in counter LOS, we have found many opportunities to improve the LOS evaluation.

As it has been shown, the research on LOS for check-in facilities has concentrated itself mainly on service times and space available for passengers. The ACI survey (ACI, 2000) shows that these practice have been widely used within the airport industry. Between the airports surveyed, the only objective criteria used for check-in facilities are the check-in waiting time/queue and check-in transaction time. Nonetheless, Martel and Seneviratne (1990) provide some factors that have a bear on the LOS passenger perception of check-in facilities:

(i) shorter waiting time
(ii) convenience (counter space, ease of baggage handling)
(iii) space for circulation
(iv) aesthetics

Objective measurement of the aesthetics variable is impossible to be undertaken, since it is a very subjective variable. Obviously any passenger could provide his/her perception about the terminal aesthetics, expressing it by a linguistic variable as good or excellent; however, it is difficult to propose any performance variable relative to aesthetics, which could be correlated to the aesthetics LOS passengers ratings. Anyway, aesthetics is not regarded to be as important as the other factors (waiting time and space for circulation). On the other hand, counter space and ease of baggage handling are clearly correlated to space for circulation. It is easy to see that counter space increases proportionally to space for circulation; the same can be said about baggage handling, since more space for circulation certainly provides a convenient baggage handling process.

In addition to waiting time, the processing time variable is always crucial in any check-in LOS evaluations.

In summary, this research will survey the following three check-in characteristics:

- WT: waiting time.
- PT: processing time.
- AS: availability of space.

7. Survey application

This section describes the survey application in order to evaluate the level of service at an airport passenger terminal.

During June, 11th-29th, 2003, 115 passengers have been interviewed. 10 questionnaires were discarded for lacking important information. In this case, 105 surveys have been considered to be good for analyses. For the purpose of obtaining real stimulus for each passenger interviewed, they have been observed prior to the interviewing process. In summary, the survey process provided the following information:

- Nominal data: gender, purpose of trip (business/tourism), type of flight (international/domestic), number of checked-in bags, and party size.
- Passengers' responses of LOS (divided into five categories: 1-poor, 2-regular, 3- fair, 4-good, 5-excellent).
- Stimulus data: waiting time, processing time, and availability of space.

8. Data analysis

The following three figures represent the survey distribution of responses for each airport: Rio de Janeiro International Airport, São Paulo/Guarulhos International Airport, and São Paulo/Congonhas International Airport. The responses are distributed within the 5 rating categories: 1 - unacceptable, 2 - poor, 3 - fair, 4 - good, 5 - excellent. Although these charts are useful for providing a qualitative idea of how an airport facility is evaluated by passengers, they do not provide any precise information to assist airport planners and managers. We can see for instance that the majority of responses in Rio de Janeiro International Airport are concentrated within the 5th category (excellent), as opposed to Sao Paulo airports, where the majority of responses are concentrated within the 4th category (good). Nevertheless, we do not have a scale to represent the LOS evaluations for each facility / airport. Because of these shortcomings, we will present in this paper the results of quantitative values corresponding to passenger perceptions of the level of service offered at check-in facilities.

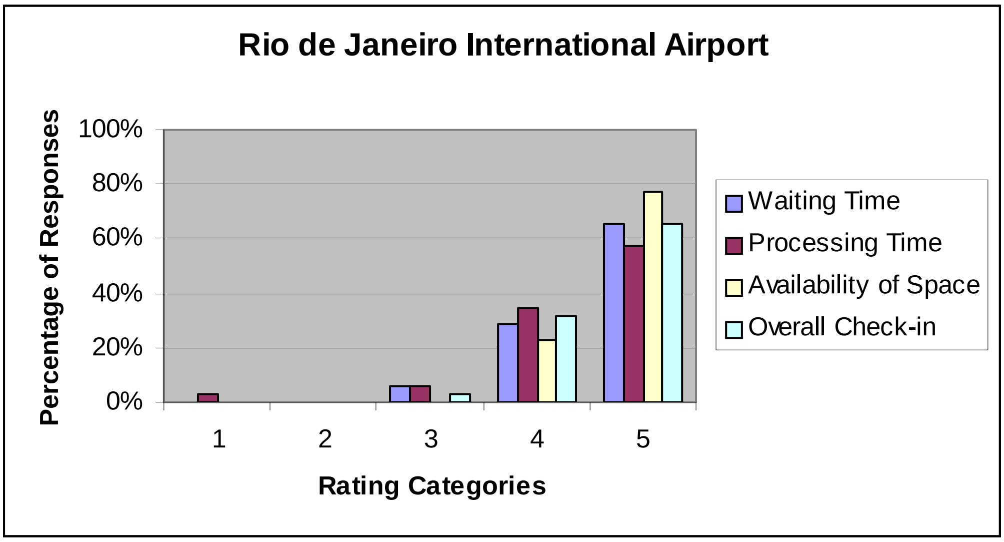

Figure 5: Distribution of Responses - Rio de Janeiro International Airport

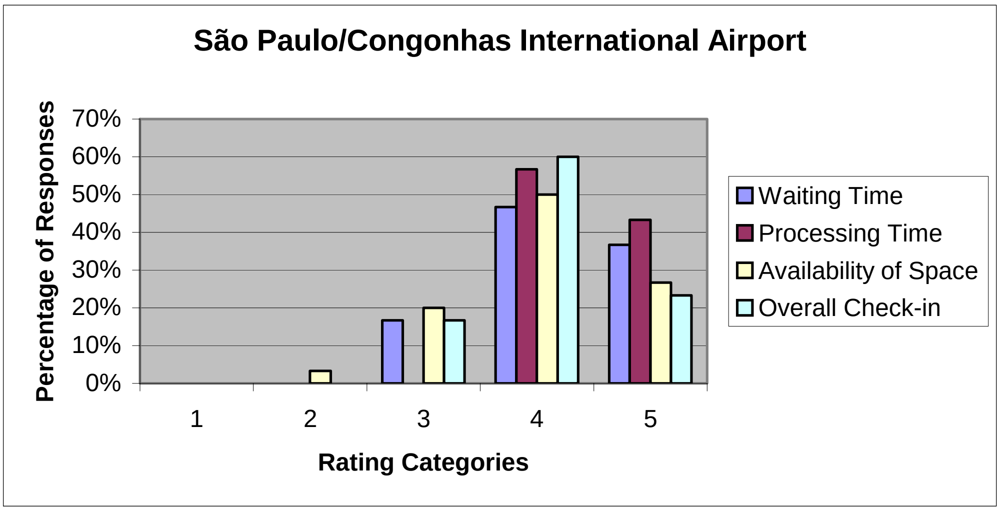

Figure 6: Distribution of responses - São Paulo/Congonhas Intl. Airport

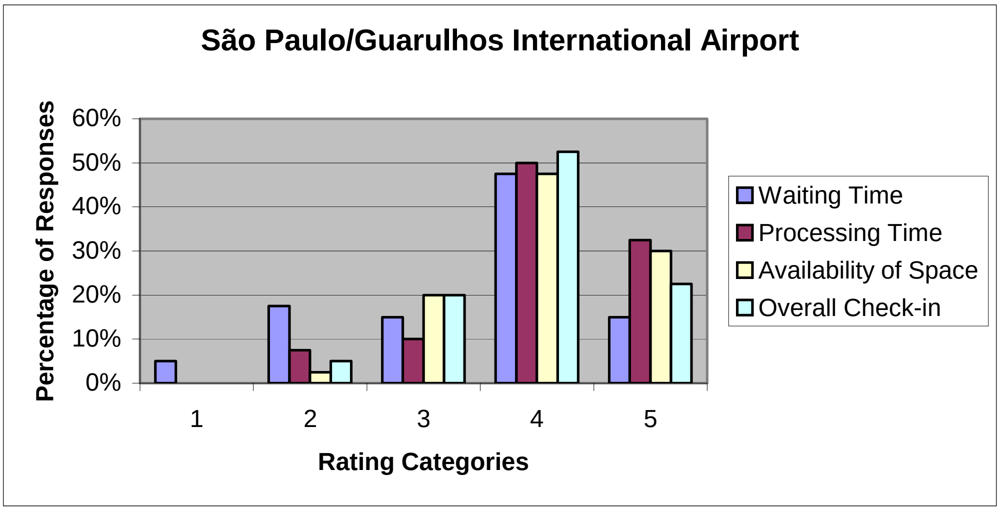

Figure 7: Distribution of responses - Sao Paulo/Guarulhos International Airport

By using the method of successive categories, LOS scales were obtained and the results are presented in Table 3. Chi-square values with 6 degrees of freedom were calculated for each of the three airports. The values are 3.43 compared with a test-statistic of 3.455 at 75 percent significance level (Rio de Janeiro); 11.785 compared with a test-statistic of 12.592 at 5 percent significance level (São Paulo/Guarulhos); and 6.243 compared with a test-statistic of 6.626 at 25% significance level (São Paulo/Congonhas). The model parameters can therefore be used to predict the observed proportions.

Table 3 LOS ratings

Airport	**LOS Attributes**	**Quantitative LOS Rating (μ_j^{LOS})**	**Rating Category**
Rio de Janeiro International Airport	Waiting Time	1.854	Excellent
	Processing Time	1.642	Excellent
	Availability of Space	2.297	Excellent
	Overall Check-in	**2.155**	**Excellent**
São Paulo/Guarulhos International Airport	Waiting Time	0.523	Fair
	Processing Time	1.169	Good
	Availability of Space	1.395	Good
	Overall Check-in	**1.154**	**Good**
São Paulo/Congonhas International Airport	Waiting Time	1.553	Good
	Processing Time	1.836	Good
	Availability of Space	1.304	Good
	Overall Check-in	**1.465**	**Good**

Table 4 Category boundaries

	Category Boundaries (μ_k^{UB})								
	Rio de Janeiro			**São Paulo/Guarulhos**			**São Paulo/Congonhas**		
Unacceptable	- ∞	to	-0.267	- ∞	to	-1.279	- ∞	to	-1.659
Poor				- 1.279	to	-0.390	-1.659	to	-0.553
Fair	-0.267	to	0.267	-0.390	to	0.390	-0.553	to	0.553
Good	0.267	to	1.554	0.390	to	1.753	0.553	to	2.004
Excellent	1.554	to	+ ∞	1.753	to	+ ∞	2.004	to	+ ∞

Ratings of the three airports according to overall check-in evaluation can be summarized as follows: Rio de Janeiro International - Excellent / μ_j^{LOS} = 2.155; São Paulo/Congonhas - Good / μ_j^{LOS} = 1.465; and São Paulo Guarulhos - Good / μ_j^{LOS} = 1.154. Although no airport have a consolidated poor or unacceptable evaluation, the consolidated evaluation of waiting time at São Paulo Guarulhos Airport is μ_j^{LOS} = 0.523 (fair); this is very close to the border between categories poor and fair (μ_k^{UB} = 0.390).

The category boundaries (Table 4) are different for each of the three airports because their evaluation has been conducted separately. It represents how passengers evaluate the borders between categories.

9. Conclusions

Although check-in LOS evaluations have been performed in many airports located in North America, Europe and Asia, the South American continent has been rather neglected. With this study, we hope to contribute to the airport research in Brazil and in all South America. A second step in our research effort is to develop a correlation between LOS quantitative ratings and actual stimulus values (waiting time, processing time and space available). These values have been collected for each individual passenger through observation. From these correlations, it will be possible to set LOS standards, which will be an important tool for airport planners and managers.

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