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Service Quality Benchmarking Methodology for Airport Passenger Terminals Based on Level of Facility Provision

by

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Abstract

Service quality in airport terminals is considered very important to multiple stake holders including passengers, airlines, airport operator, concessionaires and local community. A critical need for the airport industry is the availability of techniques for evaluating the service quality provided to passengers. Defining overall service quality standards is important in terms of designing, managing and benchmarking the service quality of a passenger terminal. Currently there is no technique capable of defining overall service quality standards for airport terminals using objectively defined service performance criteria. Objective measurement is defined as service performance measurements determined using quantitative measurements that cannot be subjected to value criticism.

This thesis presents a comprehensive technique for determining standards of overall service quality at airport passenger terminals using objectively measured service performance criteria. Criteria for defining overall service quality standards is determined based on the value of relative importance of different service attributes at the passenger terminal. Passenger opinion was used to determine the value of attribute relative importance. A stated preference survey format was used to collect data from the passengers in order to calculate values of attribute relative importance. Advantages achieved with the technique are its versatility of recruiting respondents with a wider representation of the target population and the ability to cover a wider range of service attributes within the survey. Respondents were recruited at the main terminal of The Calgary International airport and online. Discrete choice modelling and generalised ordinal regression analysis were used as main analysis models. Finally a comprehensive evaluation scheme is developed as a tool to measure the overall service quality of a given airport terminal relative to the overall service quality standards defined by the study.

The main contribution of the research is the development of a methodology to establish overall service quality standards and the evaluation scheme for overall service quality measurement at airport terminals.

Future work is recommended to extend this methodology and develop a comprehensive industry application with industry wide consensus.

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Dedication

This thesis is dedicated to my parents and to my wife Nadeeshani for their love, endless support and encouragement

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Glossary of terms

Terms that may not be particularly familiar to the reader are found in this thesis. It is intended to define them at this stage so that the reader may have a clear understanding of this research. The definitions are appropriate to this thesis, they may have other definitions when used in other contexts. Other terms which are not frequently employed will be defined as used.

Term	Definition
Service quality	The customer's impression of the relative superiority or inferiority of a service
Terminal overall service quality	The resultant service quality impression generated by combining the service quality of all individual activities or interactions within the terminal building.
Objective service quality	The aggregate performance of all attributes determined using objective service measurements
Perceived service quality	The overall subjective judgement of quality relative to the user's expectation of quality
Objective service measurements	Service performance measurements determined using quantitative measurements that cannot be subjected to value criticism.
Subjective service measurements	Service performance measurements determined based on user's impression of service level
Service attributes	Individual factors that are considered to be the determinants of the overall service quality impression of airport users. E.g. Waiting time, walking distance, availability of washrooms, availability of restaurants

Tangible service attributes	These are attributes of which the service level can be measured using objective service measurements (e.g. waiting time, walking distance, availability of Internet services).
Intangible service attributes	These are attributes of which the service level cannot be measured using objective service measurements (e.g., ambiance, architecture, art work).
Attractive attributes	These are service attributes that are able to increase passenger satisfaction with increasing level of service
Non attractive attributes	These are service attributes that do not increase passenger satisfaction with increasing level of service
Essential service attributes	These are attributes that must be provided for the basic functions of processing, circulation and holding of passengers at the terminal.
Attribute service level	A quantitative evaluation of the service performance of each attribute.
State of attribute service availability	The level of service currently provided by an attribute
Attribute rage of service availability	The range of service level differentiation available for a given attribute.
Value of relative importance	A quantitative measurement of an attribute's contribution towards determining the quality of overall service at the passenger terminal.
The state of overall service availability	The level of overall service quality offered by combining the service quality states of all the attributes considered for evaluation

Overall service quality standards	An objectively defined criterion used to describe a specific level of overall service quality
Overall service quality grades	A scale of ordinal values that denote different standards of overall service quality (e.g. 'basic", "average", "above average")
Minimum service quality criteria	A criterion defining an overall service quality standard that will ensures a certain minimum condition of overall service availability in order to satisfy the above standard
Continuous service measures	Service level measurements that can be evaluated using ratio or interval scale measurements(e.g. time, crowd density, distance)
Categorical service measures	Service level measurements that can only be evaluated using ordinal or nominal scale of measurements(e.g. Availability of washroom facilities, availability of internet facilities, variety of seating)
Choice set	Choice set is the set of alternatives presented to the respondent in the stated preference survey
Treatment	A combinations of attributes, each with unique levels. Treatment combinations thus describe the profile of the alternatives within the choice set.
Overall passenger service environment	The entire portion of the passenger terminal system that interacts directly with the passenger. This includes both tangible and intangible service attributes

Chapter One: Introduction

Service quality of an airport terminal can be considered as the amount of satisfaction or convenience generated for the users. An airport passenger terminal is a relatively large and a complicated building. The primary purpose of an airport terminal is to facilitate the movement of passengers, luggage and other cargo from ground transportation to air transportation and vice versa. An airport terminal system provides facilities for multiple user groups such as passengers, airlines, freight forwarders, airport operator, concessionaires and visitors. Passengers can be considered as one of the primary users of the terminal system. Most of the components of an airport terminal is designed and maintained with objective of facilitating the movement of passengers. The attention of this study is on the facilities provided to serve passengers. Passengers engage in multiple activities such as processing, circulating and waiting, during their transition from ground to air and vice versa. They experience different levels of service quality at each activity. Ultimately, each separate service experience contributes to the formation of the overall impression a passenger feels about the time spent at the airport terminal. Evaluating and understanding this overall impression is equally as important as service quality at individual activities.

Overall service quality evaluation is the measurement of the resultant service quality impression generated as a result of combining the service quality of all individual activities or interactions within the terminal building. According to (TRB, 2010) overall perception of service quality is the result of a combination of factors that address productivity during wait times as well as access to a variety of services with options other than just waiting prior to aircraft boarding. Availability of multi-attribute overall service quality evaluation methods are limited. Moreover there does not exist objectively defined standards of overall service quality for airport passenger terminals. Correia and Wirasinghe (2004) have highlighted the need for overall measures and continue to state that overall measures would be useful for planning, management and benchmarking purposes. Rhoades et al. (2000) stated that a comprehensive quality index to cover a large strategic group of airports is needed in order to help guide future decision making by the travelling public and the policy makers that represent them. Francis et al. (2001) performed a survey of airport performance evaluation measures and determined that the industry lacks a standard overall service quality evaluation measure.

1.1 Motivation

The motivation for this research is the need for a methodology to define overall service quality standards for airport passenger terminals using objectively defined service performance measures. Service quality evaluation of an airport terminal can be looked at from two viewpoints. One is from the point of view of capacity evaluation. The term “level of service” is commonly used to refer service levels in the context of capacity evaluation. This term is adopted from capacity evaluation in designing and maintenance of highways. Gradations of level of service standards for a limited number of attributes within the terminal are given by TRB (2010) and Correia (2005). The other view point of service quality is evaluating level of comfort and convenience offered by various components as a measurement of user satisfaction. Terms such as “service quality”, “quality of service” are used in this context. The notion of service quality encompasses a broader scope of the terminal environment than the notion of level of service. However according industry practice and literature, both viewpoints measure level of comfort offered to passengers, but they differ in their primary purpose.

Evaluation of level of service in the context of capacity evaluation is inherently objective and deals with service factors related to the processing capacity of the terminal. It uses parameters such as processing time, waiting time, crowd density and walking distance. Techniques for defining and evaluating level of service at airport facilities has experienced lot of improvement through previous research (Correia, 2005; Correia & Wirasinghe, 2007, 2008, 2010; Correia et al., 2008b; TRB, 2010). While the above mentioned service measurements are among the most important for passenger convenience, they are not enough to represent the overall service quality. There are other important service components such as availability of washrooms, restaurants, walking aids, signage and information, etc. that are not taken into account by the current methods. Therefore a comprehensive methodology is required in order to measure overall service quality by covering a broader set of service attributes within the airport terminal.

Overall service quality measurement techniques popularly used within industry and research are most often based on passenger reviews obtained using either on-site or post experience surveys. Skytrax world airport star rating, Airport service quality survey (ASQ) by Airports Council International, North American Airport Satisfaction Study by J. D Power and Associates and Google airport reviews are some of the organizations and their programs that provide overall service quality evaluations for airports. The main limitation of the above programs is the nonexistence of a formal model to relate service level in terms of an objectively measured criteria to the given gradation or classification. Therefore it is impossible to use the results of those evaluations to predict or plan for any expected improvement in service quality through objectively established strategy of intervention. Thus someone cannot meaningfully interpret the current rating and objectively set goals for future improvements. Oppewal and Marco (2000) questioned the direct use of such ratings for benchmarking purposes based on the fact that judgements made by the respondents are not based on a well-defined range of service between a best and a worst level.

The techniques proposed by Correia et al. (2008a) and Correia et al. (2008b) are among the few methods available for objectively evaluating overall service quality. However they are limited in terms of the number and type of attributes that can be covered in the evaluation. Only time, distance and space related measures can be included with the above method.

Despite the need and repeated calls for a comprehensive methodology for defining overall service quality standards for airport passenger terminals, a sound concept that can serve operational, planning and benchmarking purposes has not yet emerged. Therefore this need to fill a critical gap in the current knowledge motivated this research.

1.2 The importance of service quality evaluation at airport passenger terminals

Passenger terminal service quality is a critical part of the overall service product delivered by an airport. Deregulation of aviation industry, airport privatization and emergence of airport competition are salient factors that drive the need for enhanced service quality in terminal facilities. It has to be noted however that different user groups demand for service quality for different reasons.

Service quality is only one of several variables (e.g. routes, scheduling, location and prices) that contribute to overall airport attractiveness for passengers. It is nevertheless an important variable because of its potential to gain competitive advantage. Even though service quality does not take prominence in airport choice, passengers in today's context are well travelled and well informed about facilities available elsewhere. Thus they tend to have a higher average expectation of service quality at any chosen airport. As airports become larger, complicated and with ever tighter security procedures, passengers are required to spend a longer duration inside this large confined service environment. Thus they become more sensitive to the service quality of the environment around them.

Service quality of the passenger terminal is an important consideration for airlines when making decisions to operate new routes (Halpern et al., 2013). Airports directly sell their service product to the airlines. Passengers are considered as secondary customers who come to the airport to consume the airline product. However the latest thinking has changed towards the direction of considering passengers as direct customers of the diversified airport product. Nevertheless, attracting airlines remains as the main method of attracting passengers to an airport even to this day. Retailers and concessionaires at the terminal use part of the product offered by the terminal as inputs to sell their own products and services and pay for it through rents and fees. Thus they too can be called consumers of the services offered by an airport terminal (Halpern et al., 2013).

Visitors and employees of the airport act as consumers too, mainly due to consumption of retail offerings at the terminal. Retailers and concessionaires are a vital source of non-aeronautical revenue for any airport. Service quality has both a direct and an indirect impact on total revenue through non-aeronautical income. The direct effect is that service quality to passengers has been found have a positive effect towards the attractiveness of the airport terminal for retailers and concessionaires. North American airport satisfaction study by J.D Power and Associates found that good customer service make passengers feel at ease and relaxed which increases repeated business and higher spending at concessions (ACRP, 2013). Findings of the above study indicate a 45% increase in retail spending with satisfied passengers. Thus enhanced service quality to passengers is a means of increasing non-aeronautical revenue. Higher non-aeronautical revenue helps airports to stay viable to operate while keeping aeronautical charges competitive. Hence airports that are capable of generating higher non-aeronautical revenue that account for a considerable portion of total revenue have a competitive advantage to attract more airlines.

Airport service quality can be an important consideration for regions where tourism is a major part of the economy. Airport infrastructure is the first and the last point of contact in a holiday destination for most travellers. Thus the perception generated at the airport can be a lasting impression that can promote repeated arrivals to the region. Rendeiro Martín-Cejas (2006) assessed airport terminal service quality with the view of providing better service quality to tourists.

An interesting fact emerging out of the above discussion is even though passenger service quality has minimal effect on forcing passenger's choice of airport, it is an influential decision factor for other key airport stakeholders such as airlines, retailers, concessionaires. A survey of 38 airport experts by Park (2003) found that airport service performance as the second most important factor for competiveness among major Asian airports. Other factors considered were demand factors, spatial factors, managerial factors and Facility (capacity) factors. Therefore airport operators give high priority for enhancing service quality to passengers. Research done by Francis et al. (2001) found that majority of airport managers are formally measuring service quality by a systematic service monitor (47 percent) or some other form (34 percent). The surveyed airport authorities have indicated a very high level of usefulness in all the service quality performance indicators they are currently using. Furthermore a survey by Airport Corporative Research programme (ACRP) found many airports list customer satisfaction as a key element of their business plan, and as such, it becomes a priority within the entire airport organization (ACRP, 2013). A survey done by Airports Council International among 120 of its members revealed that

73% of them using some form of service quality evaluation measure (subjective or objective) for monitoring their service performance (ACI, 2000).

1.3 Objectives of the research

Based on the existing knowledge gap and industry demand, this research is proposing a methodology for defining overall service quality standards for airport passenger terminals using objectively measured service performance criteria. The specific objectives this study is expecting to achieve by developing the above methodology is summarised below.

- *Planning and designing*

  Current airport planers can only plan for service quality at individual attributes. These attributes are also limited in number and type of service measures that can be used for planning. Design standards for various other important attributes are largely governed by industry rule of thumb approaches with no reference to delivered service quality. There is no methodology available to use overall service standards when planning and designing new airport terminal facilities. The methodology proposed under this research will be a useful tool for future planners in order to evaluate design parameters against overall service quality standards.

- *Management of Existing facilities*

  In order to verify that the desired service quality is delivered by the overall system, it is necessary to measure, evaluate and anticipate the delivery of services (ACI, 2000). According to ACI (2000) measurement of service quality should be regarded as part of a whole quality system which works in a continuous cycle, and should lead to a system of continuous improvement. However, current practice only allows objective measurement of service quality at individual attribute level. Airport operators do not have any technique to combine the various individual evaluations and generate an overall view of service. Such a technique would provide a systematic approach for effectively allocating resources among competing service needs. The proposed methodology will establish an overall service quality scale where the service quality evaluations at individual attributes to be systematically combined and evaluated against overall standards.

- *Evaluation and classification of overall service quality at airport terminals*

  A set of overall service quality standards can be used to evaluate and classify the level of overall service at airport terminals. This will be an effective tool for benchmarking service quality performance of airports. More importantly the objectively defined service performance measurement criteria will provide meaningful and un-biased benchmarks for comparing the service provision across a group of airports.

1.4 Scope of the research

This section describes the scope within which this research will attempt to achieve the objectives given above. Any research will have a limited amount of resources at its disposal. Therefore research scope will determine how best these resources will be allocated to achieve the goal.

The scope of the research is to develop a methodology for defining a set of overall service standards using multiple service attributes of which the level of service provision can be evaluated objectively. In an overall service context user perception of service quality depends on a variety of variables. This would include both tangible (signage, seating, waiting time, etc.) and intangible (ambiance, quality of the atmosphere, passenger attitude, interaction with staff, etc.) factors of service quality. It is difficult to objectively measure and standardize any of the intangible service quality factors. Therefore the proposed framework will be limited to evaluating service quality based on tangible attributes where the service performance can be measured or defined using an objective measurement.

Overall service quality standards are defined as a minimum service quality criteria using a set of key service attributes and objectively defined service levels of each attribute. This study identifies a comprehensive set of key service attributes in order to define the overall service standards. Identification of the set of key attributes is achieved using a detailed literature review and quantitative analysis of data found in previous work. Methodology for identifying attribute service levels as part of minimum service criteria is based on the value of relative importance of each key attribute towards overall service quality. Passenger opinion was used to determine the value of attribute relative importance. A stated preference survey was used to collect passenger opinion data in order to calculate the value of relative importance of the availability of each key service attribute.

Identification of comparable airport groups is an important consideration in the establishment of overall service quality standards. Airports within a certain geographical region can be widely varied in terms of their overall characteristics of passenger operations. Hence the establishment of overall service quality standards applicable to airports that are extremely different in terms of overall passenger characteristics can be less effective. Classification of airports based on comparable passenger characteristics is covered under the scope of this research. Available airport classification methods applicable to service quality evaluation is studied. Applicability of existing methods based on total annual passenger volume is evaluated against airport clusters formed based on multiple passenger characteristics such as domestic, international, origin-destination and transfer passenger volumes. Cluster analysis is used as the analysis technique.

1.5 Thesis layout

This thesis is organized as follows. Chapter One contains an introduction to the topic of the thesis. It elaborates the research problem, motivation, research objectives and the research scope. Chapter two contains a comprehensive literature review related to the research topic. Chapter three explains the methodology applied for the development of the overall service quality standards. Chapter four presents the study done on the classification of comparable airports. Chapter five elaborates on the application of the stated preference survey method. Chapter six presents the analysis and explanation of results. Chapter seven, the final chapter presents conclusions, research limitations and recommendations for future work.

Chapter Two: Literature review

2.1 Introduction

Service quality evaluation of airport passenger terminals fall under the general category of airport performance evaluation. Francis et al. (2001) broadly categorised airport performance evaluation as financial, service quality and environmental. Lemaitre (1998) viewed airport performance in three perspectives such as financial, marketing and operational. The definition of financial performance according to Lemaitre (1998) is the use of traditional accounting ratios which are used in most industries. Marketing measures are those which look at passenger satisfaction in terms of crowding, comfort and signage. These are based on passenger perceived evaluations. These are usually determined using passenger surveys. In contrast, operational measures are measurements of the level of delivered service. Capacity utilisation, waiting time and queue lengths are indicators used as measurements of the service delivered. Hence marketing and operational performance are related and can be considered under service quality performance. Environmental performance is another dimension of evaluation that was recently introduced to airports in view of the increasing environmental impacts of airport operations (A. Graham, 2005). Key areas considered under this category are noise, emission, waste and energy management. Based on the above discussion airport performance evaluation can be summarized as shown in Figure 2-1.

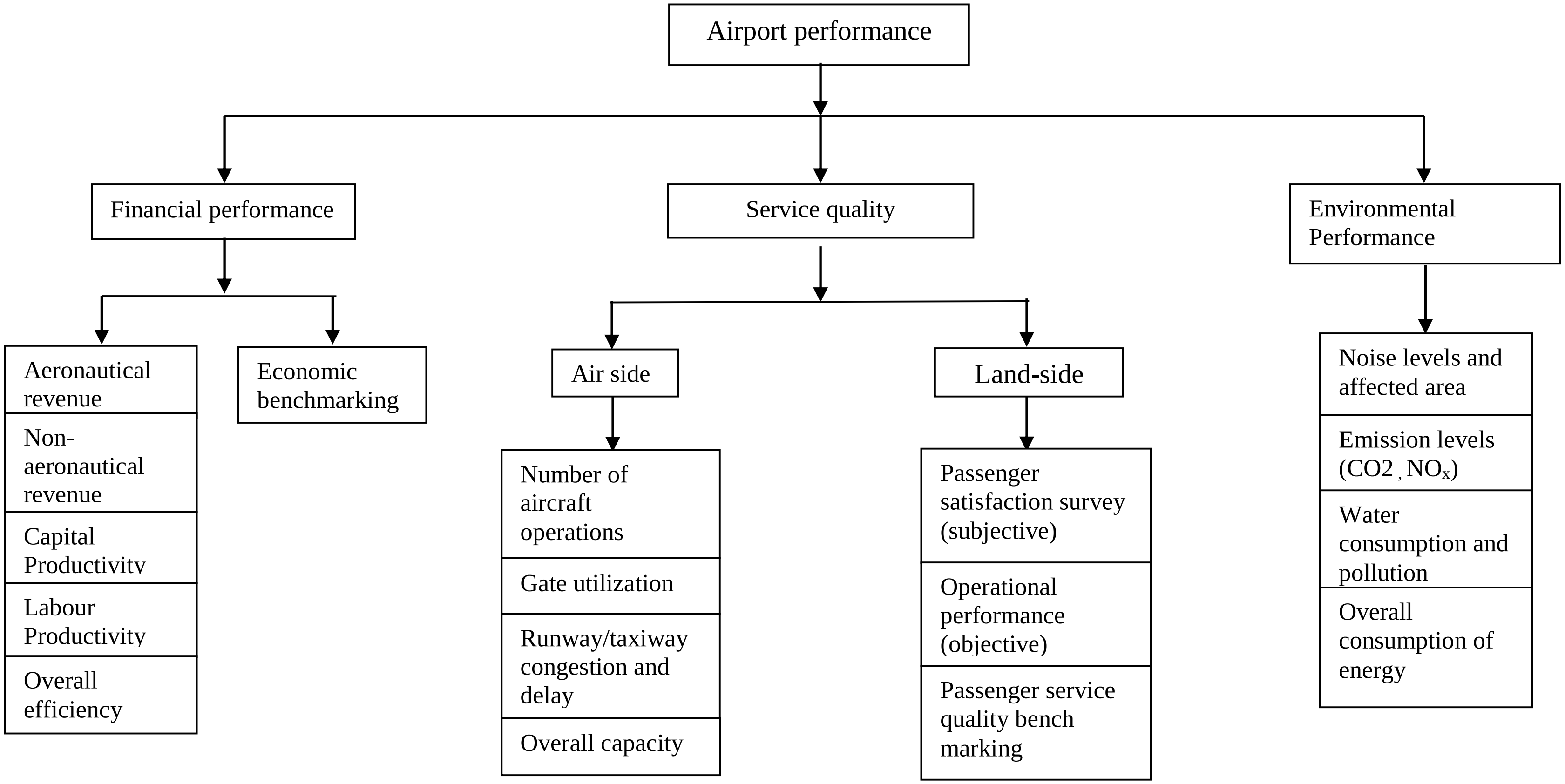


Figure 2-1: Airport performance evaluation methods

Lemer (1992) identified airport performance according to the perspective of airport stakeholders. Among them passengers, airport operator and airlines are key stakeholders. Each stakeholder has unique and sometimes conflicting performance objectives. The attention of this research is about the evaluation of performance in terms of service quality for passengers at the terminal building. This literature review will cover service quality aspects such as modelling the structure of overall service quality perception and methods of evaluating service quality at individual components as well as overall terminal. Summary of the literature review is given in Appendix Table H 1.

2.2 Service quality evaluation methods

In the literature, service quality and level of service has been used interchangeably when referring to service performance evaluation. According to TRB (2010) level of service, in the context of airport terminal planning, is a generic term that describes, either qualitatively or quantitatively, the service provided to airport travellers at various points within the airport terminal building. Zidarova and Zografos (2011) broadly categorised these approaches as methods using objective data, methods using subjective data and method using both objective and subjective data.

2.2.1 Evaluation methodologies using objective measures

Objective measures evaluate service performance using objective measurement criteria such as time, space, distance, etc. The results of objective measurements cannot be subjected to value criticism (ACI, 2000). Processing time, waiting time, queue lengths and space provided are the most common measures used in processing functions. Availability of seats and space/density are measures used in waiting areas. Walking distance, space/density and walking time are measures used to evaluate circulating elements.

Senevirathne and Martel (1994) proposed measures to objectively evaluate seat availability in waiting areas, accessibility for amenities, walking distance in circulation, way finding and occupancy (density). Measure of seat availability was obtained as the ratio of seats provided and the optimally required number of seats. Measure of accessibility was obtained based on the percentage of additional distance a passenger has to walk to access concessions and amenities, while proceeding from one activity to another. Way finding (orientation) measure is based on the ratio of total available sight lines to the required number of sight lines. A sight line is defined as a direct link between two points obtained either by directional signs or visibility. Improved measures for orientation were developed later by incorporating more factors related to passenger way finding (Churchill et al., 2008). However no effort was taken to define thresholds corresponding to performance standards in each measure.

Level of service standards (LOS) evaluate the passenger terminal based on objectively measured indicators. A set of level of service standards as used in current practice was first introduced in 1970s by Transport Canada (TC). The measure used by Transport Canada to define standards is the area per passenger. This is also called occupancy rate when defined as passengers per unite area. The motivation behind defining such a system of service standards was the need to accurately define airport land side capacity for planning and operational purposes. This scheme has a six level scale ranging from A: excellent to F: system breakdown. Each level has a corresponding area per passenger value denoting the threshold for each LOS category. It provides LOS standards for five key areas in the terminal building such as check-in, waiting/circulate, hold room, baggage claim and preprimary inspection line. IATA adopted the Transport Canada Standards and published a slightly updated version as part of AACC/IATA's Guidelines for

Airport Capacity/Demand Management, second edition, in 1990. Table 2-1 shows the IATA level of service standards.

Table 2-1: IATA Level of service standards

TERMINAL AREA	A	B	C	D	E
Check-in Queue Area	1.8M^2	1.6 M^2	1.4 M^2	1.2 M^2	1.0 M^2
Wait/Circulate	2.7 M^2	2.3 M^2	1.9 M^2	1.5 M^2	1.0 M^2
Hold Room	1.4 M^2	1.2 M^2	1.0 M^2	0.8 M^2	0.6 M^2
Baggage Claim	2.0 M^2	1.8 M^2	1.6 M^2	1.4 M^2	1.2 M^2
Government Inspection	1.4 M^2	1.2 M^2	1.0 M^2	0.8 M^2	0.6 M^2

Source: (TRB, 2010)

Seneviratne and Martel (1995) criticized the above standards for over estimating space requirements. The current version of the standard is limited to few types of facilities and also unable to evaluate overall level of service. Another criticism directed at this model is its linearity between space and service standard that may not correspond to the service standard perceived by passengers (Ashford, 1988; Fernandes & Pacheco, 2002). However it's identification of different values of space provision with respect to changes in service levels is an advantage compared to static standards provided elsewhere.

Way-finding or orientation is one of the most important attributes that affect passenger convenience in an airport terminal. Objective measures are developed to evaluate the ease of way-finding for passengers. The initial work on terminal way-finding was done by Braaksma and Cook in 1980 (Churchill et al., 2008; Dada & Wirasinghe, 1999). A measure of human orientation called visibility index (VI) was proposed. VI is the ratio between aggregation of places to which sight lines are available and the total number of place that should be seen. Later this work was extended to include relevancy of activity center-pairs and also distinguished primary activities from secondary activities (Tosic & Babic, 1984). A complete review of these techniques are found in Dada and Wirasinghe (1999) and Churchill et al. (2008). Dada and Wirasinghe (1999) proposed a new visibility index after overcoming several limitations of previous versions of orientation measures. They investigated the effects of distance, number of decision points, number of directional signs and number of level changes on orientation level of service. This is an improvement to the binary treatment given to connectivity by previous models. They developed visibility index VI for the entire terminal as well as for individual points VI_i. Lam et al. (2003) and Tam and Lam (2004) used the new visibility index to evaluate the orientation level of service at an airport in Hong Kong. Their findings suggested that usage of a facility is related to the ease of its location.

Visibility index (VI) for the entire terminal is given by:

$$VI = \sum_{ij} r_{ij} k_{ij} \, w_j \Big/ \sum_{ij} r_{ij} \, w_j \qquad (1)$$

Visibility index for an individual activity center is given by:

$$VI = \left(\sum_{i=1}^{N} r_{ij} k_{ij} w_j \; + \sum_{j=1}^{N} r_{ij} k_{ij} w_j \right) \Big/ 2N \qquad (2)$$

Where:

k_{ij} = Value of visual access between points *i* and *j* considering physical variables,

r_{ij} = element of the relevancy matrix,

w_j = weight of activity centre *j* and,

N = number of activity centers.

An important component of this study is the introduction of k_{ij}. This was calculated using an indicator of reduction in visual access called the Tardity differential. Tardity differential is the walking time difference between an expert and a novice, divided by route length along a particular route. This study found the Tardity differential to be a function of number of level changes and the number of decision points along a route. This an important revelation when determining the level of orientation found inside passenger terminals in general.

Airports council International performed a survey of their member airports in an effort to assess approaches taken by airports for managing service quality. The information gathered by the survey revealed facts about how the industry is measuring service quality. ACI separated the service quality evaluation methods as subjective and objective (ACI, 2000). The survey found all together 58 different objective criteria being used. Areas evaluated using objective criteria included passenger terminal service components, ground access components and airside service components. Table 2-2 below shows the list of objective criteria pertaining to service quality assessment in the terminal. It can be seen that most airports have a keen interest on time related measurements. Availability of trolleys, level changing means, cleanliness and response to complaints are also important for airport operators. However none of the airports surveyed used any objective indicator of overall service performance.

Table 2-2: Objective criteria used by ACI airports

Objective criteria	Number of airports
Response to/analysis of complaints/mail/comments	13
Response to phone calls	8
Flight information display system (FIDS)	4
Monitoring of information to passengers	3
Availability of automated services	2
Ticketing waiting time	2
Availability of telecommunications	1
Availability of lifts/escalators/moving walkways/conveyors/stairs	12
Repair/maintenance monitoring	3
Availability of trolleys	20
Cleanliness	12
Availability of assistance for disabled	4
Seat congestion	2
Check-in Wait time	29
Check-in process time	4
security heck wait time	18
Immigration/Police check wait time	21
Baggage delivery time	28
Baggage wait time	4
Custom wait time	8
Overall process time	7

Source: ACI (2000)

2.2.2 Evaluation methodologies using subjective measures

Evaluating the passenger terminal performance using various indicators of passenger perception falls under this category. ACI (2000) defines subjective measurement, which depends on the subjective value attributed to quality of service by passengers. These values can be obtained using survey, comment cards, or complaints. Passenger perception is very important to the airport operator in order to gauge the effectiveness of the facilities provided at the terminal. However airports have only recently started to recognize customer perception as an important determinant of service delivery. Following subsections provide further details on analysis techniques used with subjective data.

2.2.2.1 Methods using fuzzy set theory

Park (1994) used fuzzy set theory to evaluate level of service at airport landside components on the basis of passenger perception. Passenger perception was obtained using linguistic expressions such as "bearable", "long", "accepted", "complicated", "tolerable" and "bad". Young criticized the available service quality evaluation methods for being limited to temporal and spatial factors of service. The service quality factors considered in Young's study were temporal, spatial (quantitative), comfort and reasonable service (qualitative). A set of six landside facility components were identified (processing, holding, circulation, concessions, parking and ground access). Service quality factors were identified under each component in order to represent the temporal, special, comfort and reasonable service aspects. Data was collected from a survey of a panel of airport experts and a subsequent survey of airport passengers. Data was analyzed using a fuzzy-multi decision model to obtain the quality rating of service components. Correia and Wirasinghe (2004) criticized the above approach for not being able to associate actual physical measures to the subjective ratings. Furthermore this research does not suggest any objective measure appropriate for most factors. There are other similar studies that applied fuzzy set theory for evaluating service quality at airport terminals, but they too does not identify any service standards based on objective service measures (Chien-Chang, 2012; Lupo, 2015). They have used the fuzzy set approach mainly to deal with the vagueness and imprecise nature of passenger responses given for service quality evaluations.

2.2.2.2 Methods using linear regression analysis

de Barros et al. (2007) modelled the overall service quality perception of transfer passengers using ratings given for individual service attributes. A set of facilities were identified as key service quality drivers. A regression model was estimated using ratings for five key service attributes as independent variables and the overall service quality rating as the dependant variable. Using the regression equation they were able to establish relative importance weights for key service quality drivers. However, the drawback of this approach is using passenger responses in the regression analysis without any utility transformation. Correia et al. (2008a) introduced a global index for evaluating overall level of service. They divided the terminal layout according to passenger type such as departing, arriving and transferring. Each passenger type interacts with a different set of facilities encompassing their global airport experience. The analysis methodology is similar to the study by de Barros et al. (2007).

2.2.2.3 Methods using psychometric scaling

Ndoh and Ashford (1993) used psychometric scaling technique to evaluate access level of service at an airport in London, United Kingdom. Psychometrics and psychological scaling theory have given extensive consideration to the behavior of subjects, sampled from a specific population, in choosing among alternatives (Correia et al., 2008b). It transforms the categorical user perception ratings on to a continuous utility scale. This is performed based on an assumption of the variability of an individual's judgment on thresholds of successive categories and the rating given. They used this technique to analyze the categorical satisfaction ratings obtained from passengers on 12 airport access related attributes. They found passengers were most satisfied with luggage handing and access to terminal. Furthermore they revealed that passengers were unsatisfactory with parking costs and information on access. They further analyzed the effect of access level of service on access model choice. This technique has also been used for the establishment of service quality standards by integrating objective and subjective data which will be explained later.

2.2.2.4 Other methods

Skytrax is a passenger satisfaction survey that ranks airport service quality using a five star rating scale. Skytrax performs a web based customer satisfaction survey and obtains post experience passenger reviews. They present awards to airports under different service categories based on the overall service performance. In 2014 their website claims to have collected about 12.85million entries from air passengers on 410 airports. Skytrax survey takes customer feedback related to around 40 service attributes of the airport. Skytrax also gives a service quality ranking to airports based on a qualitative audit of the terminal facilities. The service quality classification used by Skytrax is shown in Table 2-3.

Airports Council International (ACI) performs the Airport Service Quality Survey (ASQ). Over 200 airports participate in this survey. A sample of departing passengers is surveyed monthly and results generated quarterly for each airport. This was initiated by IATA in 1993, with its Global Airport Monitor program. This survey covers close to 35 key service areas of the airport terminal. Through the ASQ program ACI delivers a range of other services to its member airports. This includes benchmarking, identifying service bottlenecks and performance certification.

Table 2-3: Skytrax service quality classification

Classification	Definition
5 STAR AIRPORT SKYTRAX	The ultimate Approval, awarded to Airports achieving the highest Quality standards. A 5 Star ranking recognises highest standards of Product and Service delivery across the many different assessment categories in the Airport environments. 5-Star Status recognizes airports which are at the forefront of product / service innovation.
4 STAR AIRPORT SKYTRAX	A mark of quality Approval, awarded to Airports achieving a good overall Quality performance. A 4-Star ranking signifies Airports providing a good standard of Product and Service delivery across many different assessment categories in the Airport environment.
3 STAR AIRPORT SKYTRAX	3-Star Ranking is awarded to Airports supplying a fair Quality performance that conforms to an industry "average" - when assessing the standards of Product and Service delivery across the different assessment categories in the Airport environment. 3 Star ranking signifies a satisfactory standard of core Product facilities, but reflects some Product weaknesses or a lower / less
2 STAR AIRPORT SKYTRAX	2-Star Ranking is awarded to Airports supplying for a poor Quality performance - falling below the industry average in the measured competitive product and service sectors. 2 Star Ranking represents a poor standard of Product across different ranking categories - and poor standards of Staff Service delivery across the Airport environment.
1 STAR AIRPORT SKYTRAX	1-Star Ranking is awarded to Airports achieving a very poor Quality performance. 1 Star ranking represents very poor standards of Product across most of the featured categories - with poor and inconsistent standards of Staff Service around the Airport environment.
RANKING IN PROGRESS SKYTRAX	The Unclassified Airport category covers airports that are either subject to a Star Ranking review - or those airports which have been dropped from the Star Ranking programme.

Source: Skytrax (2014)

Airport operators themselves use a range of service quality evaluation methods using subjective data. They use this data to identify some of the qualitative performance factors that cannot be covered by objective measures alone. ACI survey on airport service quality performance measures also identified a list of subjective measures used by airport operators. They identified about 210 different areas where airport operators collect passenger evaluations. This number is significantly higher than the number of objective measures (58) used. The attractiveness of subjective measures can be attributed to the lack of standardised techniques for evaluating objective measures and the convenience of collecting subjective data. Table 2-4 shows some selected areas of service measurement from the ACI study.

A critical limitation of evaluating service quality based on user ratings is the inability to relate them with objective measurements of service performance. Thus it is difficult to use this information for planning future improvements. Furthermore some passengers tend to complain more than other passenger types. For example, in the United Kingdom, business travellers, frequent travellers, and male passengers tend to be far more critical than foreign leisure travellers, first time users, and female passengers (A. Graham, 2008). Hence comparisons made between airports from different regions and markets based on customer feedback should be interpreted with caution. User rating of service quality had been used within other service sectors such as hotels long before airports adopted this concept. Five star rating method is a very popular service rating scale that first started in the hotel industry and subsequently been used in a multitude of other areas including airports.

Table 2-4: Evaluation criteria used by ACI airports

Evaluation criteria	Number of airports
Overall customer satisfaction at the airport/overall attractiveness/convenience of airport/overall quality of service	24
Signage/access and user-friendliness of terminal/finding your way/signs for pedestrian	36
Disabled accessibility/assistance	6
Quality of public announcements	10
Walking distance/walking time	9
Terminal atmosphere/comfort	13
Terminal temperature/air conditioning	13
Terminal decor/aesthetics/style	7
Usefulness of electronic ticketing systems	1
Modernity of facilities	2
Overall cleanliness/cleanliness of terminal	37
Toilets/restrooms-overall standard	10
Cleanliness of restrooms	18
Availability/number of restrooms	6
Ease of finding restrooms	2
Waiting times in general	2
Escalators/elevators/moving walkways	3
Seating areas	13
Number of telephone booths/telecommunication facilities	18
Entertainment in terminals/children's play areas	5
Nurseries	2
Advertisement of the airport	1
Smoking lounge/areas	3
Airlines/tour operators/choice and frequency of destination	5
Punctuality	4
Service in case of flight delay	1
Security/airport safety	12
Overall attitude of staff	8
Staff appearance	2
Competence/responsiveness of staff	5
Courtesy and friendliness/empathy of staff	6

Objective criteria	**Number of airports**
FID overall satisfaction	15
Information overall satisfaction	13
Check-in overall satisfaction	14
security check overall satisfaction	7
Staff friendliness	8
Waiting time	5
Police control overall satisfaction	9
Variety of concessions	2
Restaurant overall satisfaction	19
Quality of goods	12
Choice	11
Value for money	13
Shopping overall satisfaction	24
Concessions staff courtesy	19
Airline lounge overall satisfaction	4
Gate lounge overall satisfaction	6
Baggage delivery overall satisfaction	10
Waiting time at baggage delivery	10
Availability of baggage carts and trolleys	18

Source: ACI (2000)

2.2.3 Evaluation methodologies using subjective and objective measures

Previous sections discussed on several limitations when objective or subjective measures are used in isolation. Researchers determined that the integration of these two forms of data can solve most of the issues previously noted. When objective measures are combined with subjective measures the outcome contains the robustness of objective evaluation and improves it's conformance to user perceived service levels. Most of these methods seek to define threshold values of objective measurements corresponding to thresholds of passenger perceived quality. Zidarova and Zografos (2011) divided them into three types based on the technique applied. They are psychometric scaling, fuzzy set theory and P-R curves. However the industry seems to be lagging in adopting these measures for operational and planning purposes. This could mainly be due to the lack of specialized staff, higher data needs of new techniques and lack of industry wide consensus on implementing them.

2.2.3.1 Utility theoretic approach

Omer and Khan (1988) proposed a methodology of evaluating level of service based on user perceived quality. They criticized arbitrary standards used for terminal level of service evaluation at that time. A frame work was proposed for the study of level of service, based on principle of utility and cost effectiveness theories. The proposed methodology applied attitudinal survey techniques to question users on the relative importance of service factors of a given sub system such as check-in and to rate each factor using a semantic scaling method. Subsequently, weighted ratings were transformed to a relative value scale and then combined to form a utility measure. Research results were presented in Omer (1990). Müller and Gosling (1991) pointed out several flaws in this approach. A critical flaw they have highlighted is the use of rank values to obtain relative weights. Rank values are ordinal, not cardinal and therefore cannot be summed to obtain weights. However the underlying idea of Omer and Khan about reducing the different measures to a common "utility" scale has considerable appeal.

Siddiqui (1994) used method similar method as above to determine level of service standards for the airport curb-side. Performance measures they used were, time to find a loading or unloading position and distance to terminal entrance door. Results indicated that time to find a loading-unloading position is more important than distance to terminal entrance. Utility equations for time-delay, walking distance and equation for composite utility was developed for departing and arrival curbs. Because the methodology used the same approach as the previous research, same flaws and deficiencies associated with linear transformation of rating and ranking of service measures can be found in this research as well.

2.2.3.2 Methods using psychometric scaling

The psychometric technique enables the transformation of qualitative perception on quality into quantitative values of quality (Müller & Gosling, 1991). Therefore the quality perception can be modeled as a quantitative variable. These models can be used to determine changes in quality perception with respect to changes in quantitative explanatory variables such as waiting time, walking distance etc. Development of the technique and it's background is extensively discussed in Muller (1987) and Correia (2005).

Initial work on modeling service quality at passenger terminal components using psychometric scaling technique is found in Muller (1987). An application of the model is demonstrated using data collected at the passenger check-in lobby of San Francisco International Airport. This technique allowed to develop a causal relationship between passenger perception and objective measures of attribute service levels (occupancy at lobby areas, waiting time etc.). A logarithmic function was used to transform objective measurements of attributes (waiting time, occupancy, etc.) into quality perception values. Quality perception was modeled for individual attributes as well as overall check-in lobby. Overall service quality perception was modeled using crowding and waiting time attributes. However this research failed to establish a statistically significant model for the overall service quality perception using psychometric scaling technique. Authors found insufficient sample size as the possible cause for this. They established trade off rates between waiting time and crowding to maintain the same level of quality. Thus they were able to calculate money value of service quality increments and compared costs and benefits of alternative designs. However they did not develop level of service standards with respect to different attributes of check-in lobby service level. This technique is data intensive for modeling overall service quality standards. This can be attributed to the need to create homogeneous passenger categories in terms of exposure to similar attribute service levels.

Correia (2005) made advancements to psychometric scaling technique in order to determine level of service standards. Separate models of quality perception were developed for attributes (e.g. waiting time, space provided and processing time) of different components (e.g. check-in, baggage claim, etc.). Their approach enabled to determine level of service standards corresponding to multiple service levels. Correia (2005) used a weighted addition technique to obtain overall service quality evaluation. The approach used by Müller and Gosling (1991) needed a large amount of data in order to establish a statistically significant overall service quality model. However Correia (2005) has overcome this limitation by modeling overall perception using a method of weighted addition. Correia (2005) used the psychometric scaling method on a set of overall service measures as well. They used walking distance, total service time and two orientation measures as indicators of overall terminal service quality. The two orientation measures were actual walking distance over minimum walking distance and tardity differential. Tradity differential was proposed by Dada and Wirasinghe (1999) as a measure of reduction in visual access.

2.2.3.3 Methods using fuzzy set theory

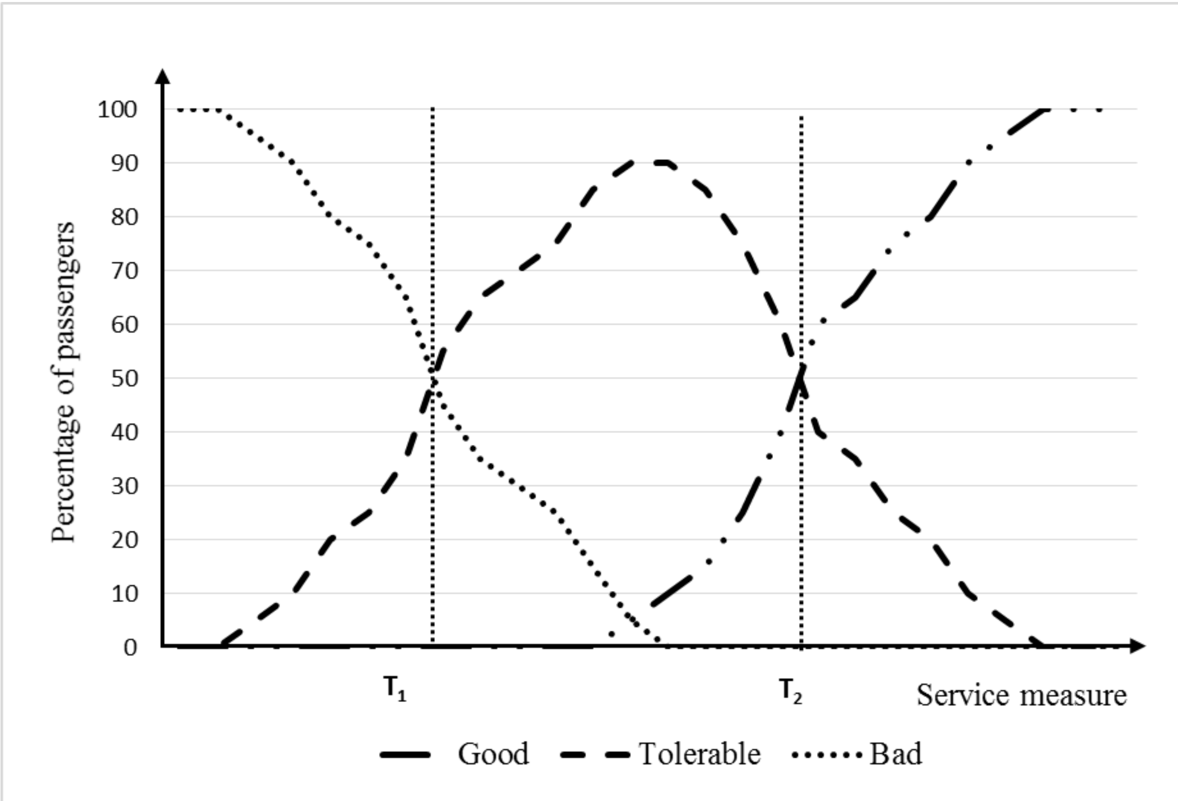
Yen et al. (2001) presented a quantitative model to evaluate level of service at airport passenger terminals. Their model used fuzzy set analysis to relate subjective service ratings to observed measurements of waiting time and processing time. Passengers were asked to state their perceived processing time and waiting time and to rate the performance of these facilities. Respondents were given a five point linguistic scale to rate the perceived performance. Using fuzzy set theory five consecutive membership functions were developed. Thereafter the service level thresholds were mathematically determined in order to establish service level standards. They also measured actual waiting time by video recording the activities at the terminal. This data was also analyzed using similar procedure and concluded that standards based on subjective perception is greater than the standards based on objective measures. The use of fuzzy set theory enabled them to account for the imprecise nature of perception ratings. The difference between perceived and measured service parameters is an important revelation made in this study. Furthermore the above study found that passengers perceived measurements tend to deviate further from the measured values for less tolerable activities such as waiting at security.

Yen and Teng (2003) developed level of service standards for passenger crowding using a similar approach to Yen et al. (2001). Data was collected at the Taipei Sung-Shan Airport (TSA) and Chiang Kai-Shek International Airport (TPE). They collected perceived quality rating on the level of crowding using a questioner given to passengers. At the same time corresponding crowding density measurements was obtained by video recording the area. Respondents rated each waiting area using five possible notions: “very satisfied”, “satisfied”, “neutral”, “unsatisfied”, and “very unsatisfied”. Using the membership function of each notion set, thresholds were obtained for five consecutive service levels of crowding. Statistical analysis of perception data and density data showed that crowding is a key factor affecting passenger’s subjective rating of service quality at relevant facilities. It was also found that passengers traveling at peak periods tend to tolerate crowding more than the passengers traveling during off-peak periods. They also found that passengers were less tolerant of crowding at baggage claim than the check-in area. This indicates passenger perception of service quality varies depending on their expectation of prevailing conditions as well as whether they are starting or concluding the journey.

2.2.3.4 Methods using perception response (P-R) method

Perception response (P-R) model of service quality evaluation was proposed by Mumayiz (1985). It is a graphical presentation of collective attitudes of a group of passengers towards a range of operational service levels offered at a facility. This work attempted to relate passenger's perception to time spent in various processing components. A level of service scale with three ordered categories was proposed (A, good; B, tolerable; and C, bad). The response percentage for each service level was plotted against time spent in each facility. The time spent in a facility and the corresponding perception was obtained from passengers after they have been at the airport. A mail back survey was used to collect data.

Figure 2-2 shows a conceptual depiction of the P-R model. Threshold T_2 for level of service "good" was defined as the point in which the "good" curve exceeds the "tolerable" curve. Similarly threshold T_1 for "bad" was defined as the point in which the number of "bad" responses exceeds the number of "tolerable" ones. Level of service for "tolerable" was defined as the interval between these two limits. This approach is criticized for being limited to one attribute at a time (Correia & Wirasinghe, 2004, 2007). Application of this method is limited to evaluating time spent at processing elements. No attempt has been made so far to test this approach with other service measures such as space availability and walking distance. Müller and Gosling (1991) criticized this approach being data hungry and its limitation to be use for facility planning, since there is no objective basis for estimating a reasonable target.



Source: Park (1994)

Figure 2-2: Depiction of the perception response model

Further limitation of this approach was highlighted by Park (1994). They pointed out the questionnaire and survey method does not precisely reflect passenger’s perception with their responses. This was attributed to the time lag that existed between perceived service and the passenger’s response. Passenger's perception was generated at the airport terminal, but the response was given at home or another place after completing the journey. Moreover Park (1999) showed perceived and actual time had enormous discrepancies in the P-R model. This approach could have been improved if objectively measured time was used instead of stated time by passengers.

2.2.3.5 Methods using benchmarking techniques

Benchmarking is a positive, proactive process to change operations in a structured fashion to achieve superior performance. A benefit of using benchmarking is that organizations are forced to investigate external industry best practices and incorporate those practices into their own operations. A review on application of benchmarking in airport sector in general can be found in A. Graham (2005) and Francis et al. (2002). However specific attention to work regarding benchmarking service quality provision at airport terminals is limited.

Fernandes and Pacheco (2002) used data envelopment analysis (DEA) to evaluate passenger terminal capacity of 35 Brazilian domestic airports in terms of efficiency. They used factors such as area provided at various facilities (curb front, departure lounge, baggage claim area and apron area), number of check-in counters and number of vehicle parking spots as inputs against number of passengers processed as the output. Using DEA they identified airports that functioned with maximum utilization of capacity and those that had surplus capacity. Using forecasting methods they were able to determine which airports were at imminent need of capacity expansion. This analysis ignores the operational factors such as processing speed of passengers and relationship between level of service and capacity. Nevertheless, this analysis gives a good insight about when and where additional capacity need to be invested with comparison to standards compatible with local conditions.

Yeh and Kuo (2003) compared 14 major Asia-Pacific international airports based on qualitative inputs given by 15 international travel agents. They used a fuzzy multi attribute decision making model to comparatively rank airports based on subjective inputs for six service attributes (comfort, processing time, convenience, courtesy of staff, information visibility and security). A questionnaire survey asked respondents to indicate the relative importance and perceived performance of each attribute for different airports using a set of fuzzy linguistic variables. The results were used to order the attributes based on the value of relative importance. The order of attribute importance they obtained was: courtesy of staff, security, convenience, comfort, processing time and information visibility. This method produced a ranking of attributes based on importance, but did not allow to relatively rate the service standard that could have given a better representation of the current state of service level.

2.2.3.6 Methods using linear regression analysis

Paul (1981) attempted to model passenger perception for airport service quality using regression and correlation analysis. He demonstrated model development for originating and terminating functions of the terminal. He considered six types of factors influencing passenger evaluation of service quality. They are: passenger characteristics, trip characteristics, airline system characteristics, airline local characteristics, terminal building characteristics and general environmental characteristics. Each of these factors consisted of subcomponents that can be objectively measured. All together around 30 service factors were considered for the analysis.

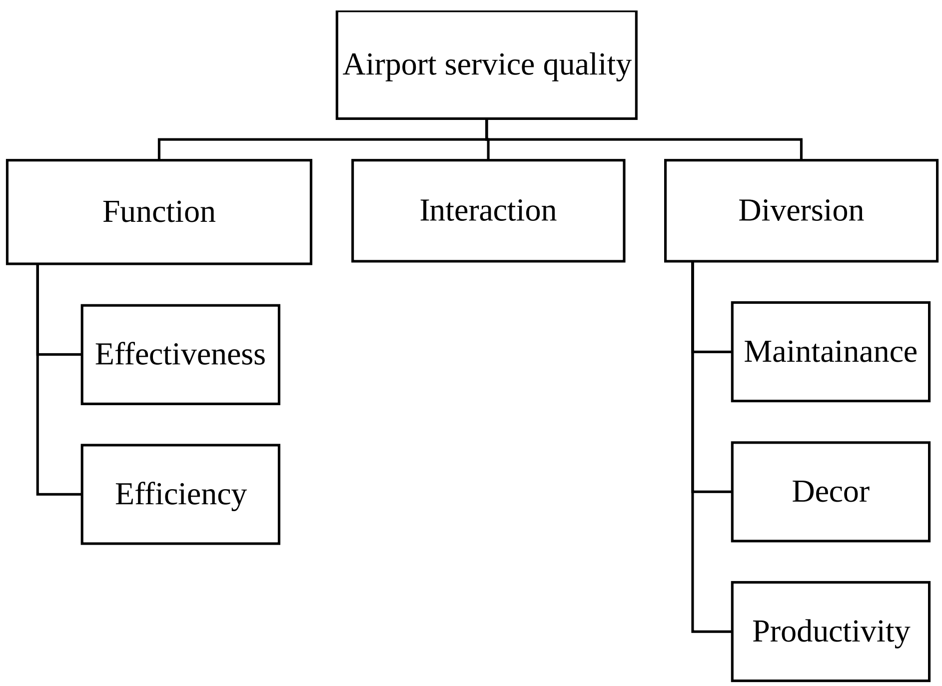
The methodology involved measuring each service quality factor and obtaining a service quality rating (1 to 7 scale) for overall functions (originating and terminating) and components (ticketing counters, baggage claim, deplaning/enplaning means, etc.). A series of correlation analysis steps were used to determine which factors had significant influence over passenger evaluation of functions and components. Factors that showed significant correlation with perceived quality rating were selected to be used in a multiple linear regression model with overall quality rating as the dependant variable. This is a comprehensive approach that covered a wide range of potential factors affecting perception of service quality. This research was able to establish a linear additive relationship between perceived service quality and performance of service factors. Most of the factors defined at the beginning of the study failed to appear in the final model due to weak or no significant relationship with overall ratings. As pointed out earlier under section 2.2.3.1 and 2.2.3.2 direct use of categorical perception ratings with linear regression analysis method is a flaw in terms of methodology.

2.3 Methods revealing the structure of the overall service quality perception

Previous section reviewed research work and techniques that attempt to evaluate the prevailing service quality at passenger terminals. This section will review methods that were developed to reveal the structure of the overall airport service quality perception of passengers. Service quality is a perception generated within the user about the service environment. Hence any evaluation of service quality should give enough consideration to the structure of service quality perception within the user. Apparent lack of it would make the evaluation less meaningful for users. This includes identification of attributes as key drivers of service quality perception and the identification of the value of relative importance of the above key attributes.

2.3.1 Methods to determine salient factors of service quality perception

Fodness and Murray (2005) developed a hierarchical dimensional structure to explain how passengers perceive service quality at an airport terminal. They used methods from marketing and services research to identify and test the dimensionality of passenger's expectations about airport service quality. The research consists of a qualitative exploration of the airport experience from the passenger perspective. A review of relevant literature was used to identify variables, clarify basic concepts and generate a conceptual model of airport service quality expectations. A quantitative analysis was used to test the dimensionality of the conceptual model. According to the study findings passenger perception of airport service quality consists of three primary dimensions such as function, interaction and diversion. Figure 2-3 shows the hierarchical structure of the service quality perception dimensions.



Source: Fodness and Murray (2005)
Figure 2-3: Hierarchical structure for airport service quality expectations

Effectiveness refers to efficient movement of passengers through the terminal and that includes elements of circulation, signage and functional layout of the terminal. Efficiency sub-dimension refers to the passenger's concern on time lines of their movement through the terminal. Interaction dimension refers to the passenger's concern of finding information. It includes access to information, staff behaviour in problem solving and advice. Diversion refers to factors that divert passengers from feeling confined in the premises. Productivity and maintenance are sub dimensions of diversion. These are primary activities that people as allocate their time while waiting. Productivity refers to spending time for activities such as job-related work or education-related work. Maintenance refers to activities directed at both people's bodies (e.g. eating, resting, grooming) and their possessions (e.g. housework, shopping). In an airport terminal productivity refers to the ability to read, do business or work. Similarly maintenance refers to eating, shopping or resting. Decor is the appreciation of the surrounding architectural features of the service environment. These dimensions provide important reference to determine critical service quality attributes for evaluation.

Two separate studies by Lubbe et al. (2011) and Farahani and Törmä (2010) confirm the compatibility of the above model under different airport settings in South African and Sweden respectively. Farahani and Törmä (2010) tested the original construct in two Swedish airports and concluded that the original model was valid with few modifications suggested at the sub-dimension level to account for the change in interaction due to technological advances.

Other research have used factor analysis in order to determine salient factors affecting terminal service performance. Rhoades et al. (2000) Used factor analysis on the relative importance weights given to a set of 12 service attributes by a group of airport experts. Their analysis found four factors. The first factor address passenger service issues such as food and beverage, rest-room facilities, retail and duty free and special services. The second factor includes issues of airport access such as parking, rental car services, and ground transportation. The third factor involves areas of airline-airport interface that include gate boarding areas, baggage claim facilities, and information display. The final factor includes inter-terminal transportation. Liou et al. (2011) used factor analysis on the subjective service quality ratings given by airport passengers on a set of 24 service attributes. This study found the presence of eight salient factors of service quality. They are such as convenience, comfort, immigration and customs, transportation, courtesy of staff, information visibility, security and price of retail goods. They went on to perform a decision rule base analysis to determine prominent decision rules used by airport users to arrive at overall service quality evaluations. Their findings showed that frequent flyers are highly concerned about the airport staff courtesy and immigration. Whereas essential considerations for non-frequent flyers were security, convenience, and transportation.

Jeon and Kim (2012) used a combination of explanatory factor analysis, confirmatory factor analysis and structural equation modeling to determine the relationship between factors of service, passenger emotional state and behavioral intensions. Similar to Fodness and Murray (2005) they considered the terminal environment as a "servicescape". The term 'servicescape' refers to the physical surrounding in which services are provided. They surveyed air passengers with regard to 45 attributes. Two emotional states such as positive (Happy, excited, active etc.) and negative (angry, anxious, unpleasant etc.) were used. The behavioural intensions that were considered are revisit and word of mouth. The study findings indicated that factors such as functional, aesthetic, safety, and social affected positive emotions. Whereas factors such as ambient conditions and social significantly influenced negative emotions. Furthermore it was found that only positive emotions have a significant effect on behavioural intentions.

Bogicevic et al. (2013) used a content analysis technique to analyze 1,095 traveller comments related to 33 airports. They used a computer application ("Web spider") to randomly extract user comments and ratings related to a group of airports from a travel rating website. Furthermore they used the two factor model of customer perception on products and services. The two factor model defines satisfaction and dissatisfaction of a customer (passenger) as separate continuums. Thus the intension of the study was to identify key drivers of passenger satisfaction and dissatisfaction. According to the analysis none of the factors considered were determined as exclusively satisfiers or dis-satisfiers. However they found poor performance in dinning, signage and security check was mentioned more frequently with negative comments. Hence they were identified as dis-satisfiers. Good performance in cleanliness and pleasant surrounding was mentioned more frequently in positive recommendations. Hence they were identified as satisfiers. They found that most factors generated both satisfaction and dissatisfaction, thus the perception depended on factor performance. Staff courtesy, baggage handling and shopping were the most frequently mentioned attributes with both positive and negative comments. Graphical data mining techniques such as word trees revealed a branching view of how reviewers used the key words and phrases. These findings were useful to identify important managerial implications related to key service components.

Martel and Senevirathne (1990) performed a survey of airport passengers and found waiting time, seating availability and information as the most important criteria in processing elements, waiting areas and circulation respectively. In this study, they performed a series of passenger surveys that asked passengers to rank the most influential service attributes of the passenger terminal. They primarily used a comparison of means approach in order to determine the most influential attributes. In that study they found the rankings given by business and leisure travelers did not significantly differ when compared to each other. Seneviratne and Martel (1991) used the same survey data form the previous study and identified the most important set of variables for overall terminal performance. They found Information for circulation, waiting time and convenience at processing elements and seating availability, access to concessions and internal environment for waiting areas as the most influential factors for service quality performance. A methodology combining techniques such as comparison of means and skim trees were used for the analysis.

2.3.2 Methods determining relative importance of service factors

The value of relative importance of service attributes is an important aspect of service quality assessment. The value of relative importance in terms of service quality evaluation refers to the effect or importance attached to individual service attributes for determining the overall quality perception by the users. Researchers and industry practitioner are using the value of relative importance in order to prioritise management intervention and modelling overall service quality perception.

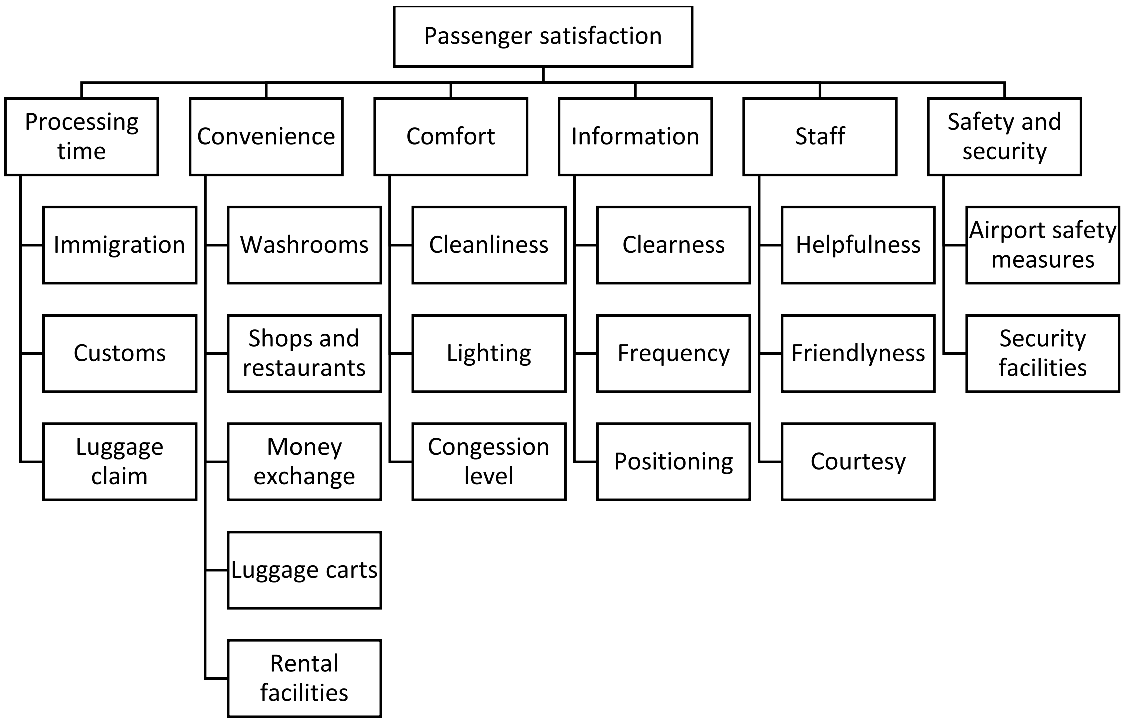
2.3.2.1 Regression methods

Regression analysis is a popular technique for determining the value of relative importance of service attributes for overall airport service quality. Most studies have used the overall service perception rating of passengers as the dependent variable and the service quality ratings at individual attributes as explanatory variables when using this method (Correia, 2005; Correia et al., 2008a; de Barros et al., 2007; Mikulić & Prebežac, 2008; Paul, 1981). Multiple linear regression technique has been used in most of the studies. This approach is based on the linear model of information integration for inferential judgement (Fishbein & Ajzen, 1975). According to this model, the attitude of a person towards an objects can be viewed as a linear function of that person's evaluation of the attributes of that object. None of the studies however used actual performance of the service attributes for analysis, rather they used passenger rating of satisfaction. Correia and Wirasinghe (2007) and Correia and Wirasinghe (2010) used the liner multi attribute function to model overall evaluation at service components such as check-in counters and baggage claim area. Direct use of passenger perception rating in regression analysis has been criticised by Müller and Gosling (1991). However given simplicity and cost efficiency of survey design, administration and data collection this approach can be used to generate reasonably good results.

2.3.2.2 AHP methods

Analytical hierarchy process is a multi-criteria decision making method used in many fields of science particularly for handing both objective and subjective decision criteria. This method enables to structure the decision problem by way of a sequence of hierarchical steps. At each level of the hierarchy a series of pairwise comparisons are made using a standardised quantitative scale. Final decision is obtained by integrating the pairwise comparisons at each stage of the hierarchy and using a standardised process of analysis. Several airport related research have used this technique to determine the relative importance among a chosen set of critical service attributes

Correia et al. (2007) used analytical hierarchy process (AHP) to determine the importance users assign to various components of an airport passenger terminal. They used parking, departure hall, check-in, departure lounge and concessions as sub-components for the study. Each component has several attributes (e.g. departure lounge: Courtesy and comfort). They surveyed 103 air passengers at São Paulo/ Guarulhos International Airport in Brazil for the analysis. Their survey asked the respondents to make 22 pair-wise comparisons. Tsai et al. (2011) used AHP approach to determine values of relative importance among 12 service attributes. They surveyed 226 airport passengers at Taoyuan International Airport in Taiwan. Respondents were asked to make 15 pair-wise comparisons in the survey. Lupo (2015) used AHP method to evaluate the relative importance among 20 service attributes of the passenger terminal environment. They established a three level hierarchy to represent the service quality structure of the terminal. AHP related other research also use a similar hierarchical structure of the service quality environment. Figure 2-4 shows the structure used by Lupo (2015).



Source: Lupo (2015)
Figure 2-4: Hierarchical service quality structure

2.3.2.3 Other methods (direct rating and usage rate)

Direct rating methods also have been used to determine the relative importance of airport service attributes. Chang and Chen (2012) studied the service need of elderly passengers at airports. They surveyed passengers age 65 years and above at an airport in Taiwan. The survey obtained ratings of importance and perception of service level for 21 service attributes related to air travel. Their results indicate that attributes such as information on direction, transport information to and from the airport, announcement of cancelled flights, check-in staff courtesy and delay are the most important attributes for passengers in this age group.

Rhoades et al. (2000) surveyed a group of airport consultants and operators to determine the relative importance of passenger terminal components. They have asked the respondents to give two separate ratings from an expert point of view and a passenger point of view. A rating scale of 1-100 was used and the mean rating was taken as the relative importance value. Study results showed that parking, restrooms, and baggage handling facilities were among the most important for respondents. The authors did not find a statistically significant difference between the expert's view of quality factors and their reported perception of passenger quality issues. However authors could have expected the later result due to strong correlation in the two separate ratings given by the same respondent to the same question. Chien-Chang (2012) used direct importance rating to determine the values of relative importance of a set of airport service attributes. Simplicity for administering surveys and less burden to respondents are the advantages of this method. Respondent's biasness of anchoring the rating is a significant limitation found in this approach. Furthermore respondents tend to overestimate the importance when attributes are evaluated individually than evaluating attributes as a bundle. These limitations tend to overpower the benefits offered by this approach.

Research on passenger terminal orientation has also used relative importance values in order to differentiate the tendency to access different nodes within the terminal building. Tosic and Babic (1984) and Lam et al. (2003) have used observed proportion of passenger usage as the value of relative importance. Tam and Lam (2004) and Dada and Wirasinghe (1999) have used passenger rating as the relative importance. Figure 2-5 shows a comparison of terminal component rankings obtained using the importance values calculated based on passenger usage and passenger rating.

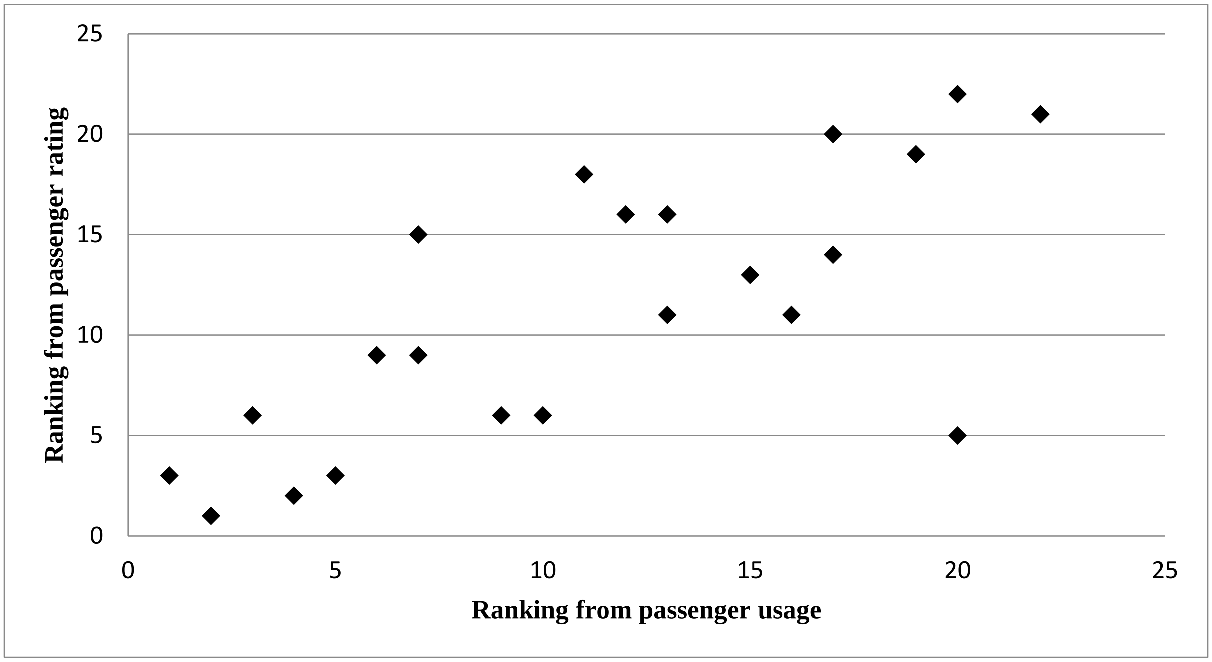


Figure 2-5: Comparison of facility ranking obtained using passenger usage vs rating

Data used for the comparison is from Lam et al. (2003) and Tam and Lam (2004). The two studies selected for the comparison has collected data at the same airport using identical passenger groups (departing and transferring passengers). Spearman rank correlation (r_s) was used to check the degree of agreement between the rankings given by the two different methods. Rank correlation coefficient of 0.73 indicated a strong agreement between the two methods. Given the data is collected under similar conditions, it is reasonable to conclude that passenger usage proportion and passenger rating assigns similar relative importance to passenger terminal components.

2.4 Service quality evaluation used in other service sectors

A literature review of service quality evaluations in other service industries such as banking (Abdullah et al., 2011; Pushpalatha & Jagathi, 2013; Sangeetha & Mahalingam, 2011), hospitals (Handayani et al., 2015; Pai & Chary, 2013) and hotels (Akbaba, 2006; Wu & Ko, 2013; Yilmaz,

2009) revealed that most of them are not using any standard approach to evaluate service quality using objectively measured service criteria. Popular models used for evaluation are SERVQUAL (Parasuraman et al., 1988) and SERVPERF (Cronin & Taylor, 1992). Overall service quality evaluation in the hotel industry is an exception to most other sectors mentioned above. Hotel industry has been successful in implementing objectively defined overall service quality standards for evaluating and classification of hotel establishments. Therefore approaches to standardise service provision in the hotels sector can provide useful implications for the development of a new framework of objective overall service standards for airport passenger terminals.

2.4.1 Hotel classification schemes

Hotels and travel industry is an area where service quality is considered as the foremost performance indicator. According to German Hotel and Restaurant Association, hotel classification is meant to be meaningful both for the customer and for the hotel industry. It must contribute to transparency and safety of hotel offers in a way that would help customers to determine what sort of conditions they can expect for the price they are paying. It also helps the hotelier in terms of positioning in the market. Hotel service quality classifications come from mainly two groups of sources. One is government or semi-government organizations, hotel trade organizations and independent rating agencies and hotel operators themselves. The other group consists of mainly internet based hotel booking companies and travel information providers. The main difference between these two sources is that the former source is using more standard practice to determine service quality classification and focus more on objective service criteria. There is very little or no subjective criteria included in this method in order to maintain standardisation.

Examples of such classification systems are Hotelstars by HOTREC, Forbes Travel Guide's Ratings, AAA Diamond ratings by Automobile Association (AMA).

Different schemes have different level of complexity based on number of service attributes considered and how they are grouped. The gradation used in most instances is a five point categorical scale. The gradation (1 to 5) in the classification is intended to be an indication of the amount of facilities and services provided. For example the least rating of "one" does not interpret poor quality but minimum facilities necessary to ensuring basic conditions. Most of these classification schemes define the standards using either a minimum service criteria with respect to a set of key service components or minimum service criteria and a points system. Hotelstars programme used in European hotels is an example of the latter type.

2.5 Conclusion

This literature review gives a comprehensive understanding about the state of the art of service quality evaluation in airport passenger terminals. Based on the literature review following conclusions can be made.

- Passenger terminal service quality is a multifaceted notion shared by multiple stakeholders. Each different stake holder view service quality using multiple qualitative and quantitative dimensions. However most of the research and industry practice focus on the service quality offered to air passengers. This is justifiable as air passengers consume the vast majority of services offered at the terminal.
- Service quality perception of passengers at the terminal is a function of qualitative and quantitative factors. According to the literature these factors can be broadly categorised as factors pertaining to airport and airline characteristics and factors pertaining to passenger

characteristics. Airport and airline characteristics have the most influence for determining the service quality offered at the terminal.

- Service quality evaluation of attributes objective service performance measures such as processing time, waiting time, walking distance, space availability and orientation (way finding) is covered in previous research. Advance techniques have been developed in order to determine service quality standards that correlate with passenger perception. However airports industry seems to be still relying on conventional space standards for capacity evaluation. Thus the conventional standards need to be updated using the newer techniques.
- However measurement of service performance using objective measures are lacking for most of the other important amenities that serve comfort and convenience such as availability of washrooms, concessions, information etc. Currently subjective passenger evaluation is used by both industry practitioners and researchers for assessing their level of service provision. Furthermore no research effort has been made to define objective means of evaluating these service factors.
- Methods capable of assessing overall service quality is lacking. Current industry practice for evaluating overall service quality is based on passenger reviews and ratings. The available methods for evaluating overall service quality have the following limitations. (1) Number of attributes that can be considered for overall evaluation is highly limited. (2) Level of service at most of the service factors are evaluated using passenger ratings. (3) They are not capable of defining objectively defined service performance standards for overall service quality.
- Service quality benchmarking using objectively defined service standards does not exist.

Based on the literature review it was understood that service quality evaluation at airport passenger terminals is very important in order to evaluate, manage and improve current standards. The focus of this research is to improve the state of the art of overall service quality evaluation. This research will attempt to fill the existing knowledge gap in determining overall service quality standards using objectively defined service performance criteria.

Chapter Three: Methodology and theoretical framework

3.1 Introduction

According to the literature review it was apparent that there does not exist a standard approach to define overall service quality of an airport passenger terminal. Service quality standards have been defined for attributes such as time, distance, orientation and space. An overall service quality model that evaluates multiple number of service attributes does not exist. Service quality evaluations can be performed by defining a certain scale to quantitatively represent the level of service delivered. Such a scale can be either continuous or ordinal. In order to establish standards, the methodology must be able to define specific criteria that differentiate between distinct levels of service provision on the evaluation scale. Any such standardisation to classify overall service quality using objectively measured service performance criteria does not exist in state of the art. Therefore the overall objective of this research is to develop a framework that is capable of defining a set of overall service quality standards using objectively measured service performance.

In this chapter the key steps of the methodology to achieve the above objective will be presented. The key steps of the methodology are listed as follows.

- Defining the passenger terminal overall service environment: This step will identify components of the overall service experience and their inter relationships within the physical layout of the terminal building. This step will also identify the key service quality attributes of the passenger terminal that influence the service perception most.
- Classification of airport terminal systems based on the provision of comparable facilities: This step will establish criteria to define comparable airports in terms of the characteristics overall passenger operations. Overall service quality standards would only be effective within a comparable group of airports.

- Design and implementation of a stated preference experiment: The stated preference survey is used to determine the values of relative importance of service attributes. Assignment of service levels of attributes for the criteria of defining overall service quality standards is performed based on the value of attribute relative importance.
- Analysis and classification of attributes: Data from the stated preference survey will be analysed and the results will be used to classify attribute service levels as minimum service criteria for overall service grades.

3.2 Conceptualization of overall service quality

Before evaluating service quality, it is necessary to conceptualize overall service quality in a way that enables objective evaluation. This section will utilize existing literature in order to define the concept of service quality and determine the relationship between objectively evaluated service quality and customer satisfaction.

Service quality is defined as the customer's impression of the relative superiority or inferiority of a service provider and its services (Prakash & Mohanty, 2012). In other words it is the impression of a customer based on the difference between the expectation of service provider and the service delivered. According to Parasuraman et al. (1988) service quality is an abstract and elusive construct because of three features unique to services such as intangibility, heterogeneity and inseparability of production and consumption. Mitra and Golder (2006) define two basic types of service quality such as objective and perceived. Objective quality is defined as the aggregate performance of all vector product attributes (those attributes customers prefer either at a higher or a lower magnitude). Objective quality does not include intangible attributes such as aesthetics or extrinsic attributes such as brand image and service personal behaviour. Perceived quality is defined as the overall subjective judgement of quality relative to the expectation of quality. These expectations are based on one's own and other's experiences plus various other sources including brand reputation, price and advertising. The focus of this research is on the evaluation of objective quality.

Mitra and Golder (2006) empirically established the relationship between objective quality and perceived quality. Their findings showed how the effect of objective quality on perceived quality is distributed in terms of time lag. It was shown that 10% of the change in objective quality affects perceived quality immediately or in the short term and up to 35% in the long term. This finding indicates that there is a time lag for the changes in objective quality to be reflected in perceived quality and over time perceive quality will move towards objective quality. Furthermore their research findings have suggested that there is an asymmetric effect caused by increase and decrease of objective service quality on perceived quality. A decrease in objective quality has a larger short-terms and long-term effect on perceived quality than an equivalent increase.

It is the perceived quality that affects customer satisfaction and patronage intention. There is a lot of discussion in service and marketing literature regarding the relationship between perceived service quality and it's causal relationship with customer satisfaction (Cronin & Taylor, 1992; Parasuraman et al., 1988; Prakash & Mohanty, 2012). According to them, service quality and customer satisfaction are related. They are two distinct constructs. Service quality is a total or inclusive attitude relating to the excellence of the service. Whereas satisfaction is an emotion related to a specific transaction. Empirical research by Cronin and Taylor (1992) and Parasuraman et al. (1988) showed that service quality leads to customer satisfaction and not the other way around. Prakash and Mohanty (2012) presents more findings to support the above relationship. Furthermore the empirical studies by Cronin and Taylor (1992) found that customer satisfaction affects patronage intention significantly, but there was no support for service quality affecting patronage intentions directly.

Based on the above discussion we can establish the order of the causal relationship between service quality, customer satisfaction and patronage intentions. Figure 3-1 depicts the structure of the above relationship.

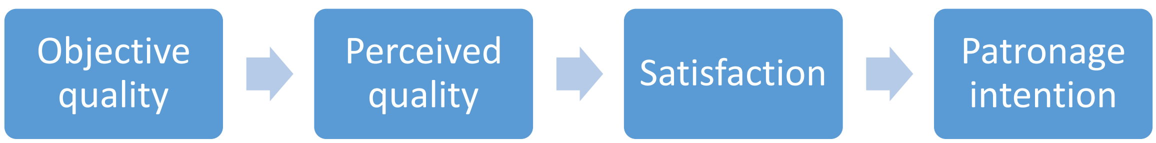


Figure 3-1: Causal relationship of service quality with satisfaction and patronage intention

According to the above relationship, objective service quality has an indirect effect on the ultimate customer satisfaction and customer patronage. An airport service environment has a higher amount of objective service attributes compared to most other service facilities. Hence the influence of objective service quality on the perceived service quality can be significant in an airport context. It is important to accept that objective service quality alone cannot give a complete picture of overall service quality. Nevertheless as it was emphasized above, an airport terminal is an exception to other service encounters such that its objective service component accounts for a significant portion of the overall service outcome. The airport operators cannot directly intervene with perceived quality in order to influence passenger satisfaction. However the operator can strongly influence passenger satisfaction and patronage intention through improving objective service quality. Evaluating objective service quality gives a tangible basis to manage or regulate the service provision to users. Unfortunately there is a lack of tools developed to evaluate objective service quality at airports. It can be seen from the literature review that objective evaluation of service quality is limited to few attributes (level of service evaluation). Most of the techniques related to airport service quality is focusing on evaluating perceived service quality. Following section will give an introduction to the main components of an airport terminal system specifically related to objective service.

3.3 Airport passenger terminal system

Airports are among the largest infrastructure designed to serve transportation needs of people. An airport can be divided into two major components, such as the airside and the land side (Horonjeff et al., 2010). The passenger terminal takes up a major portion of the airport landside system. It involves a large number of service attributes (e.g., ticketing, check-in, boarding pass control, passport control, security screening, customs control, baggage claim, ancillary services, etc.). An airport serves the needs of multiple stakeholders simultaneously. Table 3-1 lists the different users and the facilities provided to them at an airport terminal building. Figure 3-2 shows the overview of a typical passenger terminal system from a passenger's perspective.

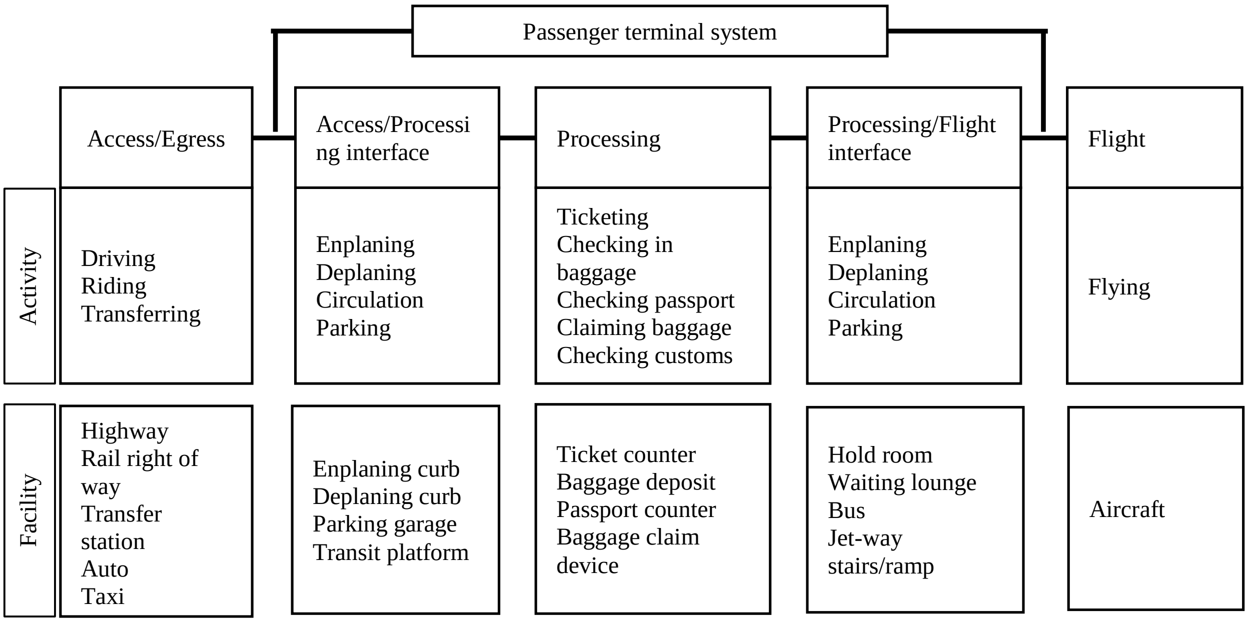
The definition of the overall service environment needs to be dealt in two parts. First the wide variation among airports needs to be considered. Classification of airports can be used to identify more homogeneous airports in terms of overall facility provision. Secondly the overall service environment can be defined for all airport types in general.

Table 3-1: Airport terminal users

Local community	Airport Operator	Airlines	Passengers	Meeters & greeters	Federal Agencies	Commercial tenants
Shopping malls Conference facilities Recreational facilities Hotels	Office space Employee parking and access	Check-in area Out bound and inbound Baggage handling devices Administration office space Flight operations and crew ready rooms Flight operations and crew ready rooms Cabin services Employee parking and access Ramp vehicle and cart parking and maintenance	Parking and terminal access Curb-side facilities (Trolleys, baggage drop, etc.) Check-in counters, automated kiosks Entertainment systems, recreational facilities and concessions Information display systems Baggage handling devises Security screening facilities Immigration and emigration counters Gates and related facilities	Arrival and departure Curb-side area Waiting lounges before security Concessions Entertainments systems	Immigration and emigration counters Security screening stations (Passengers and baggage) Special holding areas for additional screening and interrogation Sterile areas for international passenger screening Food and health inspection facilities Video surveillance facilities Emergency response equipment and staff areas Administration and staff rest rooms	Concession space Employee parking and access

Common facilities

Circulation facilities (travellators, elevators, shuttles), waiting areas, lobby, Information display systems, parking and access, communication and IT facilities, way-finding, wash rooms, toilets



Source: (Horonjeff et al., 2010)

Figure 3-2: Components of the passenger terminal system

3.4 Classification of comparable airports for overall service quality standards

Airports are widely varying in terms of overall magnitude of operations, type of passengers handled, geographical location, type of airline market handled etc. Overall service environment of the airport tend to differentiate a lot depending on the magnitude and type of operations. Therefore it is practically impossible to define a set of standards that is applicable to all types of airports. Overall service standards would only be valid within a comparable group of facilities. In this context classification of airports based on the provision of passenger facilities is an important first consideration.

Currently airports are being classified based on a variety of variables depending on a variety of specific needs. Most classifications use variables such as region/location or total annual passenger volume handled by the airport. Total passenger volume may relate to the overall magnitude of the airport, but it lacks relevance to the facilities and configuration of the overall passenger terminal system. Classification of airports based on multiple variables such as volumes of different passenger types can be used develop more comparable groups of airports in terms of overall configurations of the terminal system. Classification of airports based on multiple variables can be achieved using available techniques such as cluster analysis. Chapter Four of this thesis presents a detail discussion on classification methods of airports. Furthermore a methodology is presented using cluster analysis for determining comparable groups of airports. The variables used for the analysis includes annual volumes of international, domestic, origin-destination and transfer passengers. Data for the analysis was obtained from the T-100 and airport origin/destination-survey databases of the U.S. Bureau of Transportation Statistics. Results of the analysis was used to identify airport groups with different passenger characteristics. Results of the analysis were compared with existing broad classification criteria using total passenger volume.

3.5 Defining the passenger terminal overall service environment

Correia et al. (2008a) defined the global service quality environment within an airport terminal according to the flow path of different passenger types such as departing, arriving and transferring. Each passenger type interacts with a different set of facilities encompassing their global airport experience. Thus it is possible to conceptualize the overall environment as a set of exclusive corridors (concourses) dedicated to each type of passenger flow.

3.5.1 Departing passenger flow path

Departing passengers can be either international or domestic. General procedure to process departing passenger at most airports are similar. Exceptions can be found depending on special security procedures required by immigration and air transportation security authorities in certain countries. Passengers access the departure hall by car, shuttle or transit bus using the access road system or by foot from the car park facility. The departure hall may also be directly accessible from light rail at some airports. At the departure hall passengers proceed to check-in area operated by respective airlines. Passengers either check-in at automated kiosks or at the conventional check-in counters. Then passengers with check luggage can proceed to baggage drop. Passengers who have checked-in remotely can proceed directly to baggage drop location. Afterwards all the passengers will proceed to security inspection area. At security check, all passengers and their carry-on luggage are screened. Total time for screening (waiting time and processing time) can depend on the specific security procedures implemented and number of screening channels in operation. After security check passengers enter the airside concourse where passengers can choose to visit concessions, wait at various common waiting areas or proceed to gate holding areas before boarding the aircraft. Figure 3-3 shows the flow of departing passengers through the departure concourse.

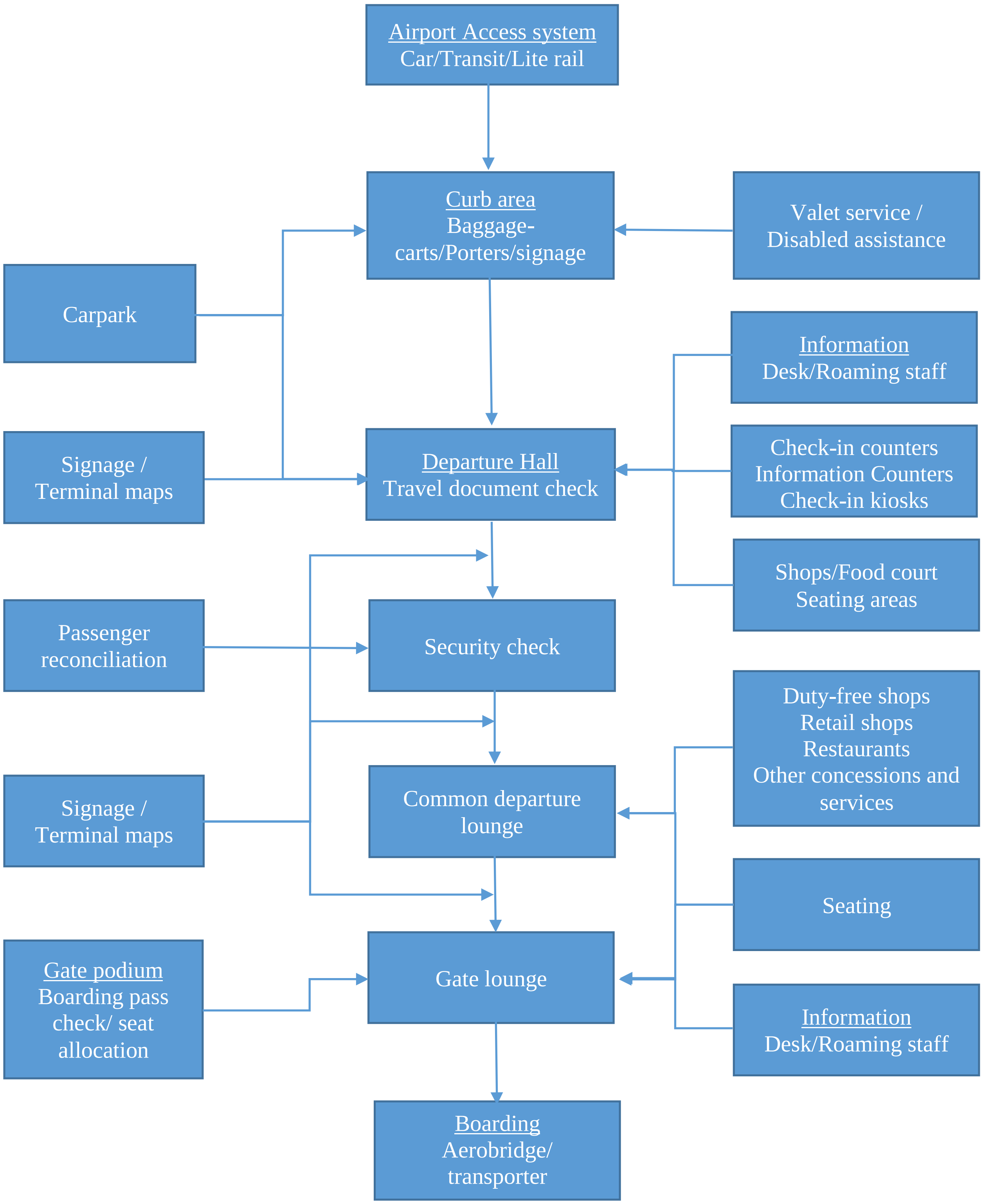


Figure 3-3: Departing passenger flow path

3.5.2 Connecting passengers

Connecting passengers are those who change their aircraft between the origin and destination. Connecting passengers can be either domestic to domestic, domestic to international, international to domestic or international to international. Depending on specific procedures in place by air transportation security agencies and immigration authorities, flow of these passengers can be different from country to country. In Canadian airports, connecting international passengers within Canada or to another international destination need to clear customs and immigration. Thus upon deplaning they will be escorted through a series of sterile corridors until they clear immigration and customs. These passengers have to claim their checked luggage and re-check them before continuing to a connecting flight. Once they clear customs they will either change terminal or remain in the same terminal depending on the next flight. Before proceeding to the connecting gate these passenger have to go through a security screening at the terminal where they are taking the onward flight. Once they clear security, their sequence of flow will be the same as a departing passenger. Procedures can be different in other countries, for example in countries where there is no visa requirement for transiting, immigration and customs procedures are not needed for international to international connections. Domestic to domestic connections does not require immigration, customs and security screening at the transfer airport. They will directly go to the connecting gate lounge without exiting the secure side of the airport. In other situations where passengers have to change terminal, they may have to go through security screening again before entering to the secure side of the nest terminal. Some airports provide air-side connectors between terminals that allows passengers to change terminals without leaving the secured area. Figure 3-4 shows the connecting passenger flow path.

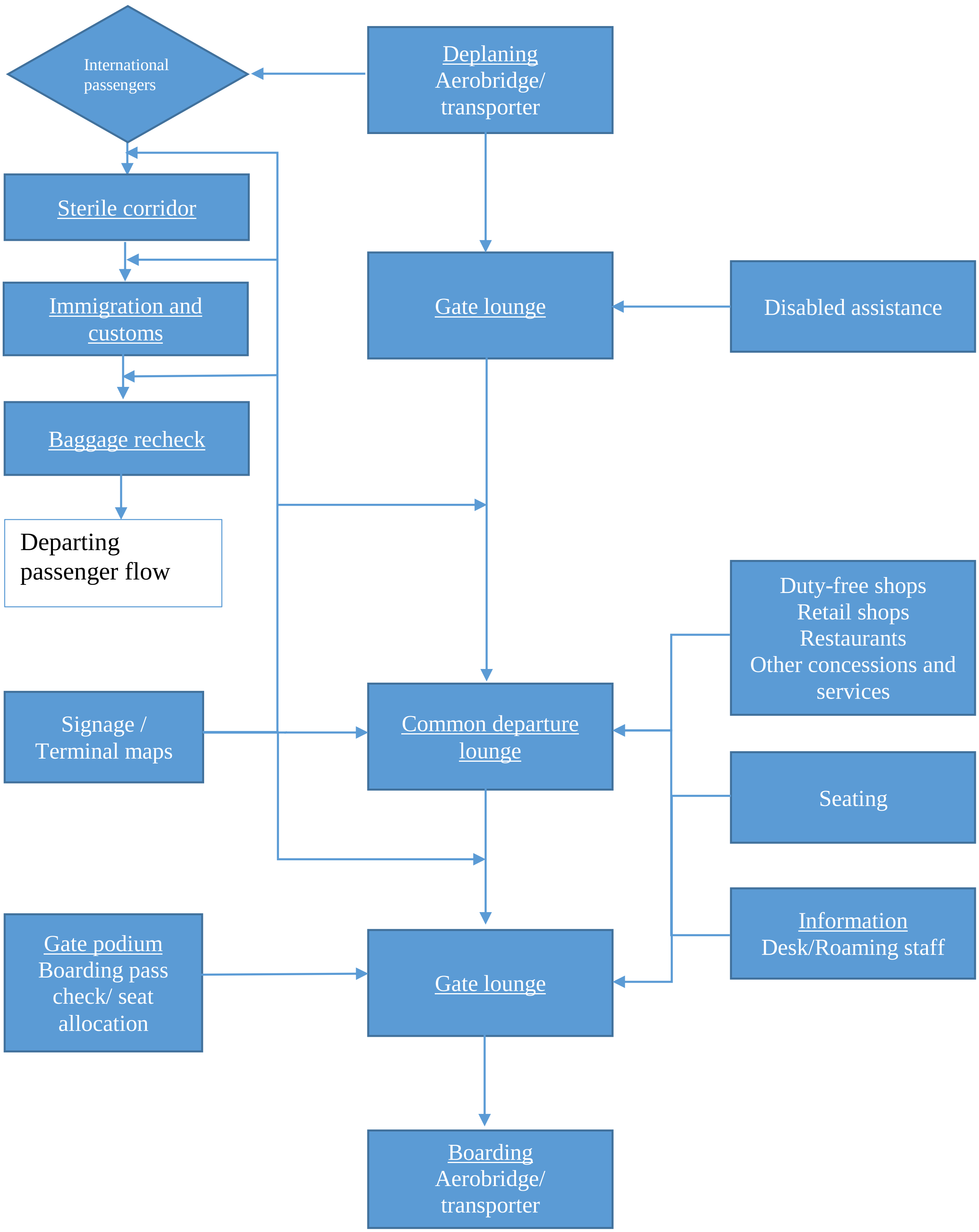


Figure 3-4: Connecting passenger flow path

3.5.3 Arriving passengers

Arriving passengers are either domestic or international. Flow path and procedures for arriving passengers are similar for most airports. Arriving domestic passengers enter the terminal building either at departure level or ground level depending on the type of aircraft they have used. Then they are directed to the domestic baggage claim area using a series of signage and corridors. The corridors are designed such a way that once the passengers exit the secured side of the terminal they are not allowed to turn back. Most often baggage claim devices are located at ground level close to the arrival curb. This area is called the arrival hall. From the arrival hall, passengers can proceed toward the arrival curb front or other services such as transportation, hotel/accommodation, tourist information centres, rail connections, parking facilities and food court/shops. Depending on the airport, rental car and transit terminal may be located at a remote location on the airport property that is accessed via shuttles. International arrivals follow the same flow path as connecting passengers for International – domestic connections. Arriving international passengers proceed to arrival hall after customs check. Depending on the airport arriving international and domestic passengers may share the same arrival hall or there may be a separate arrival hall for international passengers. Figure 3-5 Shows the arriving passenger flow path.

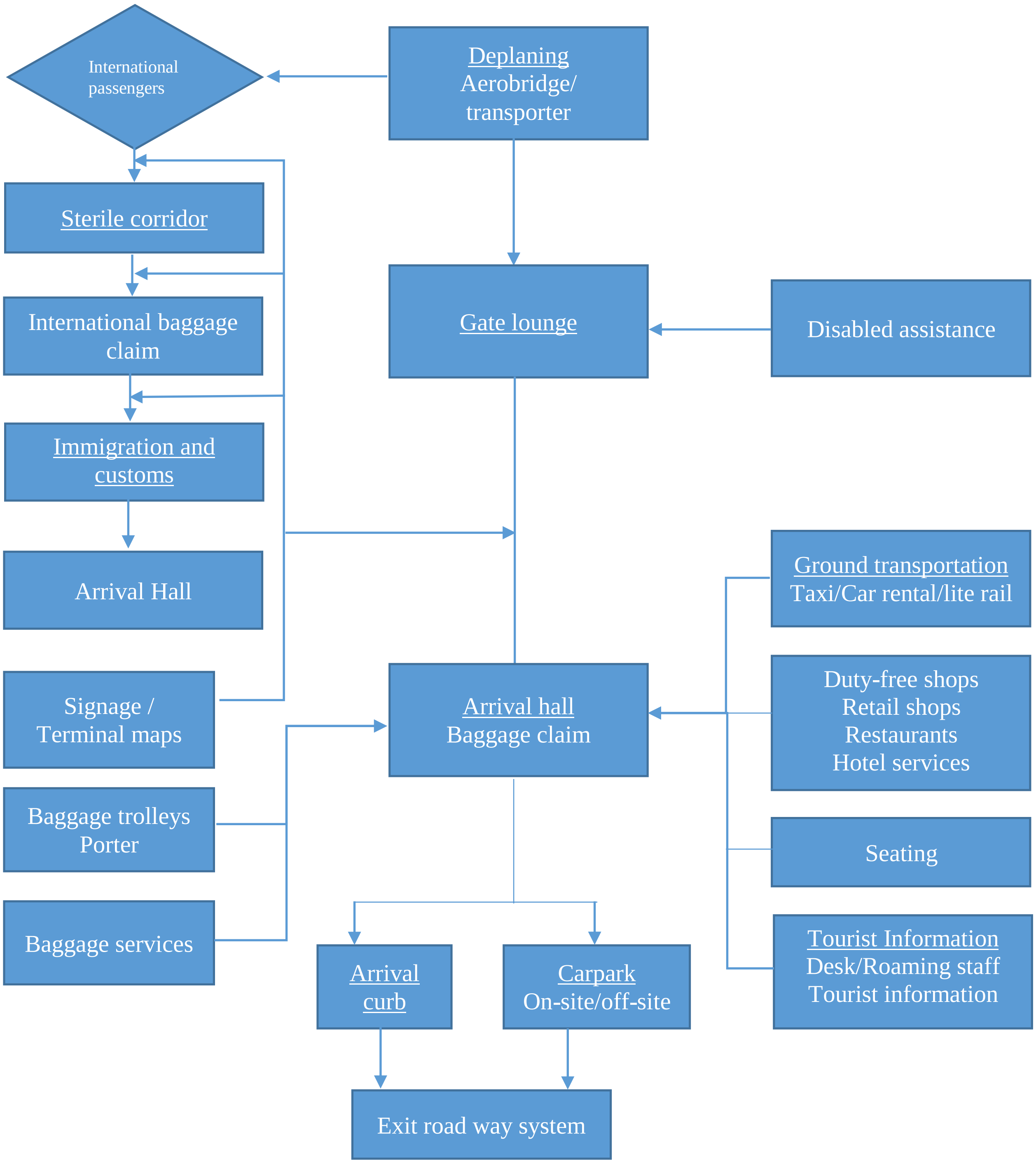


Figure 3-5: Arriving passenger flow path

3.5.4 Identification of attribute functional categories

Within each flow path passengers make use of various service components (attributes) during their transition from ground to air or vice versa. They can be classified according the layout and functionality. Unlike other service environments, passengers in an airport experience the physical layout in a specific sequence of events according to the direction of their flow. Thus the layout of facilities represent different stages of passenger being transferred from ground to air. For example, departing passenger flow path can be classified as Departure curb, Check-in hall (departure hall), circulation departure lounge, gate lounge and concessions. Airport passenger terminal is a facility where nearly continuous inflow of passengers being processed and batched according to flight departures or the other way around. To accommodate this process it is necessary to have processing and holding functions. Circulation function provides connectivity between other functions. Martel and Senevirathne (1990) used a similar criteria to categorize airport facilities when determining factors influencing service quality. However this categorization is made by considering the airport terminal mainly as a processing facility. In order to evaluate the overall service quality, it is necessary to look at the terminal building from a broader perspective. In order to make the passengers feel satisfied, the terminal building is required to facilitate their various other needs while being processed to board an aircraft. Thus this study broaden the categorization by adding two new groups such as concessions and common amenities.

Concessions are an important group of facilities in a modern airport. Concessions include various commercial offerings such as food and beverages, shopping, spa, entertainment etc. Concessions such as restaurants, shopping, entertainment facilities, newsstands etc. provide a good source of diversion for the air traveller during the waiting time at the airport. Airport operators also see them as a lucrative source of alternative income. Facilities such as washrooms, information services (flight-information display, signs, staff) and water fountains also serve a very important role in the overall terminal system. They are commonly available throughout all passenger flow paths. They mainly serve basic human needs while spending time in the confined environment of the terminal. This research identifies them as common amenities. Figure 3-6 shows a two dimensional classification of the overall service environment of the airport terminal.

The overall service environment outlined above consists of attributes of which the service level can be defined using objective measures. They can also be called tangible attributes. The intangible attributes are also important in terms of overall service experience. It includes attributes such as architectural features of the building, building décor, staff courtesy, security environment etc. Features such as décor and building architecture play a prominent role for representing the identity of the airport and the country or region where the airport is located. In the literature review it was mentioned that Fodness and Murray (2005) found building décor and interaction with staff as main dimensions of overall service quality perception of passengers within an airport terminal. However the service level of these attributes cannot be evaluated using objective measurements. Therefore intangible attributes are not considered within the scope of the study.

The overall service environment of a passenger terminal building can be defined using the flow paths of different passenger types. The service environment along each flow path is defined as the overall service environment available for a particular passenger type. Each overall service environment is different in terms of the set of service attributes provided and the expectation of service depending on the type of passenger. Therefore in order to recognise this difference, definition of overall service quality standards needs to be done separately for each different overall service environment. This will provide more flexibility when evaluating the overall service quality using the proposed set of overall standards.

Figure 3-6: Overall service environment

This process will give three separate overall service quality evaluations for a given terminal building. Later these separate evaluations can be combined to derive a single value of overall service quality for the entire terminal building. A methodology of combining the separate overall service quality evaluations is not covered under the scope of this research.

The methodology of this research will identify overall service quality standards for the overall service environments of departing flow path and arriving flow path. Transfer flow path is not considered due to resource limitations of the study. However the methodology proposed for each flow path is identical.

3.6 Available methods to measure overall service quality at passenger terminals

It is important to look at how various service attributes contribute to determine the overall service quality. This process will reveal available methods of integrating service quality at individual attributes to form an overall service quality measure.

3.6.1 Linear additive function

In this approach overall service quality evaluation is assumed to be as a linear function of service quality at individual attributes. The functional form is shown in Equation-3. This way of structuring overall service quality evaluation is based on the linear model of information integration for inferential judgement (Fishbein & Ajzen, 1975). According to this model, attitude of a person towards an objects can be viewed as a linear function of that person's evaluation of attributes of that object.

$$Overall\ service\ quality = W_1(SQA_1) + W_2(SQA_2) + \cdots + W_k(SQA_k) \quad (3)$$

Where:

W_k is the value of relative importance for k^{th} attribute, SQA_k is the service quality at k^{th} attribute.

Correia et al. (2008a), de Barros et al. (2007) and Paul (1981) used linear regression models to estimate the overall service quality using the linear additive approach. Researches have used linear regression due to the simplicity of modelling and less data requirement compared to categorical data analysis techniques. The linear additive approach for determining the overall evaluation has been successfully used in other fields such as phycology and marketing (Fishbein & Ajzen, 1975). However using linear regression method to determine the parameter of the model can restrict the number of attributes that can be considered due to loss of statistical efficiency. This is caused by the inherent limitation in the mind of the ordinary passenger to process all the information regarding too many attributes at the passenger terminal. Hence the overall impression in the mind of the passenger is more likely to be based on a few interactions he or she got affected most. This loss of information can be significant in an airport environment due to its complexity. Furthermore all of these models were developed using data collected with on-site survey. Thus the researcher is limited to the service attributes available at the particular site chosen for data collection. Furthermore regression analysis can be less effective with attributes where service level does not vary significantly over a short period. Attributes such as signage, availability of washrooms, orientation, internet services, and variety of restaurants are few examples. Therefore it is difficult to estimate values of relative importance regression analysis. Stated preference survey technique can be used to overcome such limitations.

3.6.2 Hierarchical structure of service factors

In the literature review several methods were presented that identified a hierarchical structure of service factors (Correia et al., 2007; Fodness & Murray, 2005; Jeon & Kim, 2012; Lupo, 2015). Factor analysis is used to determine primary factors based on survey data. AHP is used to determine relative importance weights among the primary factors and sub factors on a given hierarchical structure of attributes. Most often data is sought using either survey of passengers or panel of experts. The hierarchical structure can be used to overcome some limitations found in linear regressions methods discussed previously. Thus the linear integration can be performed step wise using the hierarchical structure. The hierarchical structure of service components can be defined either functionally (Lupo, 2015) or spatially (Correia et al., 2007; Paul, 1981).

Approaches to integrate service quality of multiple service attributes in order to obtain an overall evaluation are limited. The main limitation with current methods of overall service quality evaluation is that they do not provide a discriminant process to determine an objectively defined criteria for identifying a set of standards. Nevertheless the findings of above methods have important implications to this research. They are (1) Identification of key service attribute, (2) identification of the linear integration technique as a method of combining the service quality of multiple service attributes to form an overall measure of service quality (3) Hierarchical structure of service attributes allows to simplify the evaluation of the overall service environment. It allows to assume the overall environment as a combination of smaller sub-environments defined based on spatial or functional relationship of attributes.

3.7 The proposed methodology

It was decided to adopt the method of minimum service quality criteria used for classifying overall service quality in the hotel industry for the proposed methodology of the current study. The method of minimum service quality criteria as used in the hotel industry is illustrated here. The service environment is evaluated using an ordered categorical scale of five points. Each point in the scale is defined using a set of objectively defined criteria as minimum requirements for evaluating the particular service context at the standard denoted by the value on the ordinal scale. A value of importance for satisfying each individual criterion is included using a system of points. Depending on the relative importance of satisfying different criterions different values of points are given. Criterions are defined using service levels of attributes that are evaluated using an objective measure (e.g. Availability of lounge for hotel guests, area of the lounge, availability of cable TV channels etc.). Only the service components that can be evaluated objectively is included. Number of criterions used for evaluating the overall service environment vary depending on different organizations implementing the scheme. Minimum criteria for a certain standard of grading (1-5) consist of a selected subset of the total set of criterions. It is compulsory to fulfil the minimum criteria of a given standard in order for the service environment to be evaluated at the grade (one star, two star,…,five star) associated with the respective standard. The sum of points of all the satisfied criterions is used to represent the total value of service quality. Points required to achieve a certain standard is the total of points from minimum service criteria plus points from optional criteria if defined. The ordinal grading scale is defined as stages of facility provision such as "basic", "standard", "comfort", "first class" and "luxury".

Overall objective of such a standardised classification scheme is consumer protection. It also provides comprehensive information for customers to easily determine the type of accommodation available, services to offer and at what price, to enforce minimum quality levels and reduce the incidence of unacceptable quality. It ensures tourist accommodation meets acceptable standards of public safety.

3.7.1 Implications for the current study

This study identifies the following implications from the above scheme for the proposed methodology of overall service quality standards for airport terminals.

- Identification of minimum service standards at each service category: Minimum service quality criteria provide objective definition to each service quality standard. Given the variety of services that airport terminals can offer, it is practically impossible to define or agree on an exact mix of service components and levels for standardisation. The idea of minimum service standards on a set of key service components is more meaningful and applicable across a wider range of airport terminal systems. More importantly a defined set of minimum service criteria is simple to understand by airport stake holders, thus increasing the usefulness of the scheme.
- Defining a system of points for satisfying different service criteria: A points systems makes the standard more flexible. The objective of this is to give establishments flexibility for considering market specific important service features. The decision to consider optional criteria in an airport service environment also be on similar basis.
- Definition of the scale of rating (evaluation): Most hotel classification schemes have used a five point scale with symbols (starts or diamonds). The lower bound of the rating scale

represent a basic level of facility provision. However the basic level does not indicate a poor level of service delivery. Subsequent service levels are defined as higher standards of comfort or convenience in terms of the service levels of facilities (attributes) (e.g. Basic, Standard, comfort, first class, and luxury). A categorical scale representing stages of facility provision is more appropriate for defining objective overall service quality standards in this study.

Classification methods applied in the hotel industry have not used any theoretical approach for determining the key components of the framework. The key components can be identified as 1) the methodology for identifying the set of attribute service levels as minimum criteria for overall service quality standards, 2) methodology for determining the values of points attached to each service criterion. The existing classification systems have been established mainly based on expert opinion and continuous incremental improvements over time. Thus the methodology of this research will propose a theoretical framework for determining the following parameters necessary to define a system of overall service standards for airport terminals.

1. Identification of key service attributes and objective measurement of service
2. Determining the value of attribute relative importance
3. Determination of minimum service quality criteria

3.8 Identification of key service attributes and objective measures of service

Identification of key service quality attributes to be considered in the study is a challenging task given the complexity of a typical airport terminal environment. The motive of identifying a set of key service attributes is twofold.

1. The objective of the methodology is to identify minimum service criteria. Therefore it is important to identify the set of most important attributes for determining overall service quality.
2. Resource limitation for the study and complexity of survey instrument impose a maximum limit on the number of attributes that can be considered for a study of this nature. Therefore researches have to limit the number of attributes in order to make the best value of information collected during the study.

Previous research have used various methods to determine a subset of service attributes that is most influential towards passenger evaluation of service quality. Seneviratne and Martel (1991) identified the following guides for selecting attributes of service performance in transit industries:

- Reflect specific management objectives
- Be simple to define and quantify
- Not require extensive and expensive data collection
- Be reasonably sensitive to changes in terms of improvements or management action

Methods to identify key service components include techniques such as literature review, expert panel opinion survey, focus group interview and pilot survey of passengers.

An extensive literature review can bring in information from a multitude of perspectives of the subject depending on the amount of work done previously. The information gathered from the review can be analysed either quantitatively or qualitatively depending on the way the information is organised in different studies. Meta-analysis is a term used to identify techniques comparing and contrasting the findings of previous studies quantitatively. It is the statistical analysis of a large collection of study results for the purpose of integrating the findings (Wolf, 1986). The qualitative technique is the conventional narrative discussion of the study findings. The applicability of statistical techniques such as meta-analysis is limited when previous studies are excessively dissimilar in terms of techniques and variables used. In such circumstances qualitative review techniques can generate better results.

Focus group is a qualitative technique particularly popular in marketing, social sciences and medicine for determining important parameters of a question in debate. It comprises eight to twelve persons who are led by a moderator in an in-depth discussion on a particular topic or concept. The aim of focus-group research is to learn and understand what people have to say about a topic and understand their arguments. Activities in a focus group can include brainstorming, ranking, debating or attempting to reach a consensus. Researches criticize various misinterpretations of focus group activity with narrow outcomes such as a set of ratings or rankings. The application of qualitative techniques such as focus group demands a high skilled professional not only for knowing the subject being discussed but also to effectively lead the group.

Expert panel opinion survey is also a form of focus group technique, depending on the intension of use by the researcher. Several airport service quality studies have used expert opinion for developing a list of most influential attributes (Correia et al., 2007; Park, 1994; Tsai et al., 2011; Yeh & Kuo, 2003). These studies have used either a rating exercise or an interview process to determine key service attributes. Compared to general user opinion, expert opinion brings in more experience and specific knowledge based information. Furthermore the researcher can widen the perspective of the outcome by including experts from different backgrounds related to the subject matter. However the main criticism for this approach is that expert's opinion being biased and lack of understanding on true user issues. Nevertheless expert opinion can be a better option when the concept of the study is better understood by experts than the general users.

Pilot survey is another alternative for determining a set of influential factors. This approach can include direct questioning or rating of a preselected set of attributes by passengers. In the former approach the researcher would survey a sample of users based on more open ended questions in order to determine a larger pool of salient factors. Further analysis or surveys can be performed afterwards to narrow down the list. Researches can also predefine a set of attributes based on expert input or literature review and ask the respondents to pick or rate the most important attributes. This technique has its advantages such as it is more accurate in terms of representing end user opinion. The disadvantage of the approach is obviously higher resource intensiveness for conducting the survey.

The approach taken by this research for determining the most influential set of attributes is an extensive literature review. According to the literature review, passenger perceived service quality within an airport terminal has been extensively studied. Previous studies have used several of the above mentioned techniques to determine key service attributes. Most popularly used techniques include literature review and expert opinion surveys. Both quantitative and qualitative analysis was used to finalize a list of key service attributes for this study. Previous work that has produced quantitative results on key attributes such as rating/weights or rankings were selected.

Table 3-2 shows a synthesis of attribute relative importance from 15 studies selected as explained above. It was not possible to carry out a conventional meta-analysis as the techniques used for determining relative importance weights have significant differences. The table indicates study number as a reference to the details given in Appendix Table H 1.

In order to make better comparisons between different studies, the value of relative importance obtained from a study is normalised. Values were normalized with respect to the value of the highest important attribute of the same study. Table 3-2 shows the normalised values. The average value is calculated based on the number of studies a given attribute is considered. The attributes in Table 3-2 is ordered according to the average value of importance. The distribution of relative importance values for each attribute is shown in Figure 3-7. Observation of Figure 3-7 indicates that values of importance obtained from different studies have a high variation for most of the attributes. The variation in importance weights can be attributed to the differences in survey and analysis methods used, temporal difference across studies and regional differences. However there is comparatively less variation observed for attributes with higher importance value (curb, washroom facilities, processing time, and information).

Table 3-2: Synthesis of relative importance weights

	Study number (Refer Appendix Table for literature review summary)															Average weight
	1	4	7	9	10	11	12	15	17	18	20	22	23	26	29	
Curb facilities				1				1								1.00
Cleanliness of Washroom facilities		0.93	0.81													0.87
Information					0.84			0.81	0.33	1.00		1	0.88		0.97	0.83
Processing times	0.29	0.9						1	1	0.78		1				0.83
Flight Info Screens - clarity / quality of information	0.58	0.95	0.84				0.55	0.85	0.84	0.73	0.93	1	0.96	0.74	0.97	0.83
Washroom and Shower facilities in terminal	0.26	0.93	0.81					0.89	0.98	0.88			1			0.82
Check-In facilities			0.7	0.58	0.47			1	1	0.78	0.88	1			0.9	0.81
Security screening	1		0.53			0.15		1	1	0.98					0.88	0.79
Airline information counter								0.82		0.73						0.78
Baggage Delivery times	0.29		0.7						1	0.78	0.95					0.74
Telephone and fax locations								0.77	0.34	0.88			0.97			0.74
Terminal signage, boarding, transfer and arrivals	0.58	0.95		0.93	0.34	0.23	0.3			0.73	0.93	1	0.88	0.9	0.97	0.73
Rental facilities	0.26									0.88	0.88		0.89			0.73
People mover								0.76	0.48		0.88					0.71
Lounges				0.61		0.59					0.93				0.65	0.69
Clarity of Boarding Calls and Airport PA's	0.58	0.95	0.67				0.13			0.73	0.93			0.74		0.68
ATM facilities								0.74	0.15	0.88			0.82			0.65
staff attitude	0.35	0.98	0.62		0.84							0.51		0.58		0.65
Availability of lifts/escalators/moving		0.9						0.77	0.86			0.05		0.62		0.64
parking						0.12					1			0.73		0.62
Choice of Shopping - tax free and other outlets	0.26				0.52	0.26				0.88	0.74	0.77	0.61	0.81		0.61
Choice of bars, cafes and restaurants	0.26				0.53	0.26		0.76	0.5		0.89	0.77	0.84			0.60
Seating facilities throughout terminals	0.35						0.14	0.84	0.98	0.88				0.37		0.59
Ease of Transit through Airport		0.88	0.61	0.93	0.34	0.23	0.3					0.71		0.91	0.4	0.59
Availability of luggage trolleys (airside & landside	0.26				0.21			0.84	0.74	0.88						0.59
Terminal cleanliness, floors, seating and public areas	0.35	0.93	0.41		0.64											0.58
Bureau de change facilities	0.26							0.75	0.23	0.88			0.78			0.58
Internet facilities and Wi-Fi availability								0.73	0.1	0.88						0.57
Quiet areas, Day rooms, Hotel facility, rest areas								0.57	0.02		0.97					0.52
water fountains							0.32	0.75	0.17				0.84			0.52
Crowding		0.74										0.11		0.64	0.58	0.52
Terminal comfort, ambience and design	0.35				1	0.12						0.5		0.52	0.38	0.48
TV and Entertainment facilities								0.68	0.26							0.47
Children's play area and facilities provided								0.65	0.06				0.56			0.42

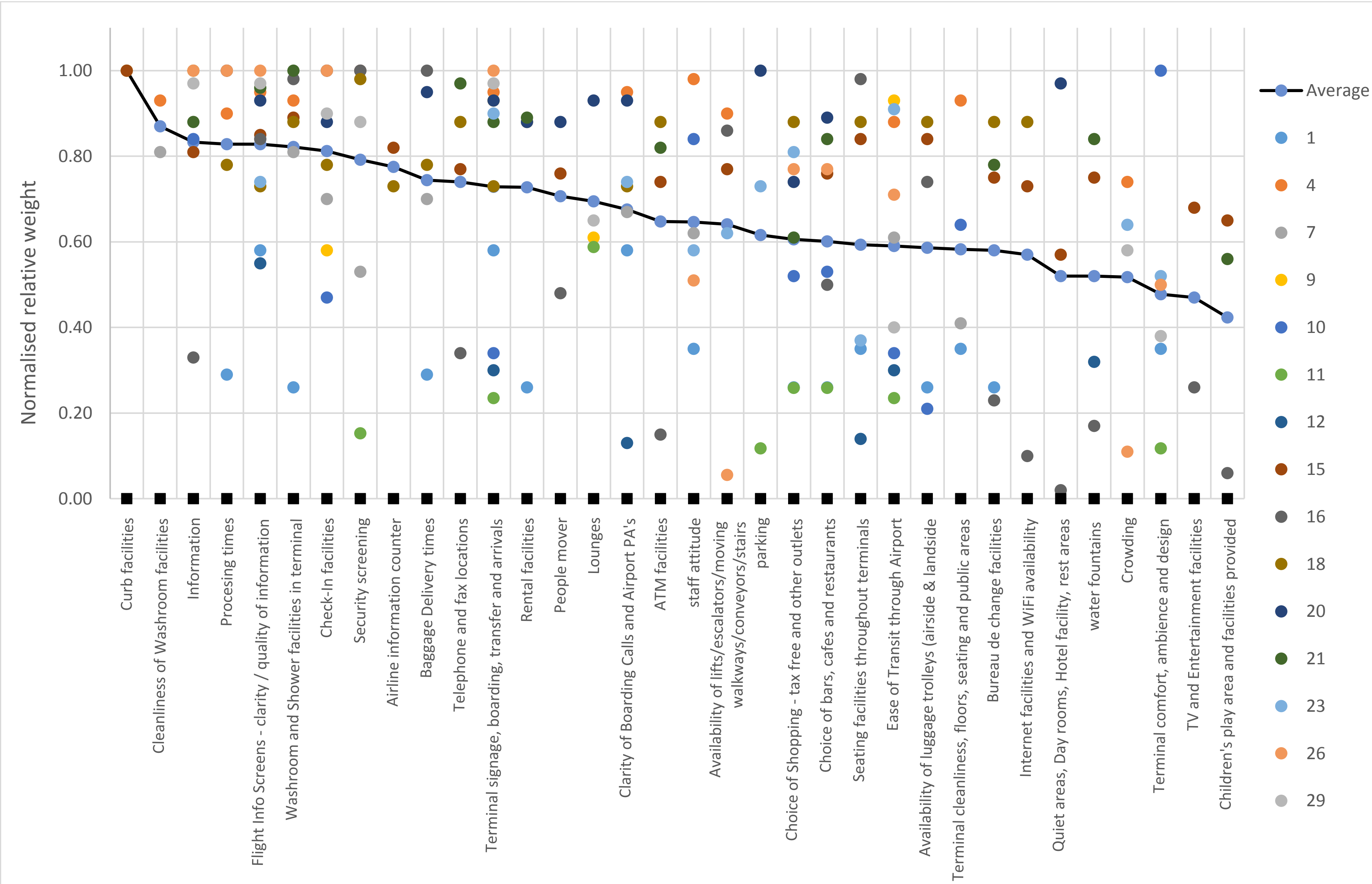


Figure 3-7: Variation of relative importance weights

Alternatively Table 3-3 shows the ranking of each attributes based on the value of relative importance. Ranking is also a good method to compare across different studies as it ignores the differences between various scales use to define importance weights. However one need to keep in mind the difference between ranks and weights. Weights are expressed on a ratio or an interval scale but ranking is defined on an ordinal scale. Nevertheless we can use this as an alternative method to obtain an understanding about the order of importance among key service attributes. In Table 3-3 attributes are ordered according to average ranking. Figure 3-8 shows the variation of rank for each attribute. According to Figure 3-8 the variation in ranking is relatively less than the variation in the value of importance. Figure 3-9 shows a comparison of the overall ordering of attributes achieved by two methods. The comparison shows that the ordering of attributes based on the two methods are correlated. It was decided to use the ordering of attributes obtained by average rank values as a guide for determining the set of key service attributes for this study.

In order to limit the length of the passenger survey, this study limited the number of attributes to 25 and 20 for departing and arriving flow paths respectively. Because departing passengers encounter more service components, extra number of attributes were included for evaluating that flow path. Table 3-4 and Table 3-5 shows the selected attributes as most influential for objectively evaluating the overall service quality at departing and arriving flow paths respectively. The selected critical service attributes are grouped based on the physical layout of the facilities within each flow path.

Table 3-3: Synthesis of attribute ranking

	Study number (Refer Appendix Table for literature review summary)															Average rank
	1	4	7	9	10	11	12	15	17	18	20	22	23	26	29	
Curb facilities				1				1								1.00
Cleanliness of Washroom facilities		3	2													2.50
Processing times	4	4						1	1	4		1				2.50
Washroom and Shower facilities in terminal	5	3	2					2	2	3			1			2.57
Flight Info Screens - clarity / quality of information	2	2	1				1	3	4	5	4	1	3	4	1	2.58
Security screening	1		7			4		1	1	2					3	2.71
Lounges				3		1					4				4	3.00
Baggage Delivery times	4		3						1	4	3					3.00
Terminal signage, boarding, transfer and arrivals	2	2		2	7	3	3			5	4	1	5	2	1	3.08
Check-In facilities			3	4	6			1	1	4	6	1			2	3.11
Information					2			6	9	1		1	5		1	3.57
parking						5					1			5		3.67
Clarity of Boarding Calls and Airport PA's	2	2	4				5			5	4			4		3.71
staff attitude	3	1	5		2							4		8		3.83
Ease of Transit through Airport		5	6	2	7	3	3					3		1	6	4.00
Terminal cleanliness, floors, seating and public areas	3	3	8		3											4.25
Seating facilities throughout terminals	3						4	4	2	3				10		4.33
Rental facilities	5									3	6		4			4.50
Choice of Shopping - tax free and other outlets	5				5	2				3	7	2	9	3		4.50
Choice of bars, cafes and restaurants	5				4	2		8	6		5	2	6			4.75
Telephone and fax locations								7	8	3			2			5.00
Terminal comfort, ambience and design	3				1	5						5		9	7	5.00
Availability of luggage trolleys (airside & landside	5				8			4	5	3						5.00
Airline information counter								5		5						5.00
Availability of lifts/escalators/moving		4						7	3			7		7		5.60
Crowding		6										6		6	5	5.75
People mover								8	7		6					7.00
Bureau de change facilities	5							9	11	3			8			7.20
water fountains							2	9	12				6			7.25
ATM facilities								10	13	3			7			8.25
Internet facilities and Wi-Fi availability								11	14	3						9.33
Quiet areas, Day rooms, Hotel facility, rest areas								14	16		2					10.67
TV and Entertainment facilities								12	10							11.00
Children's play area and facilities provided								13	15				10			12.67

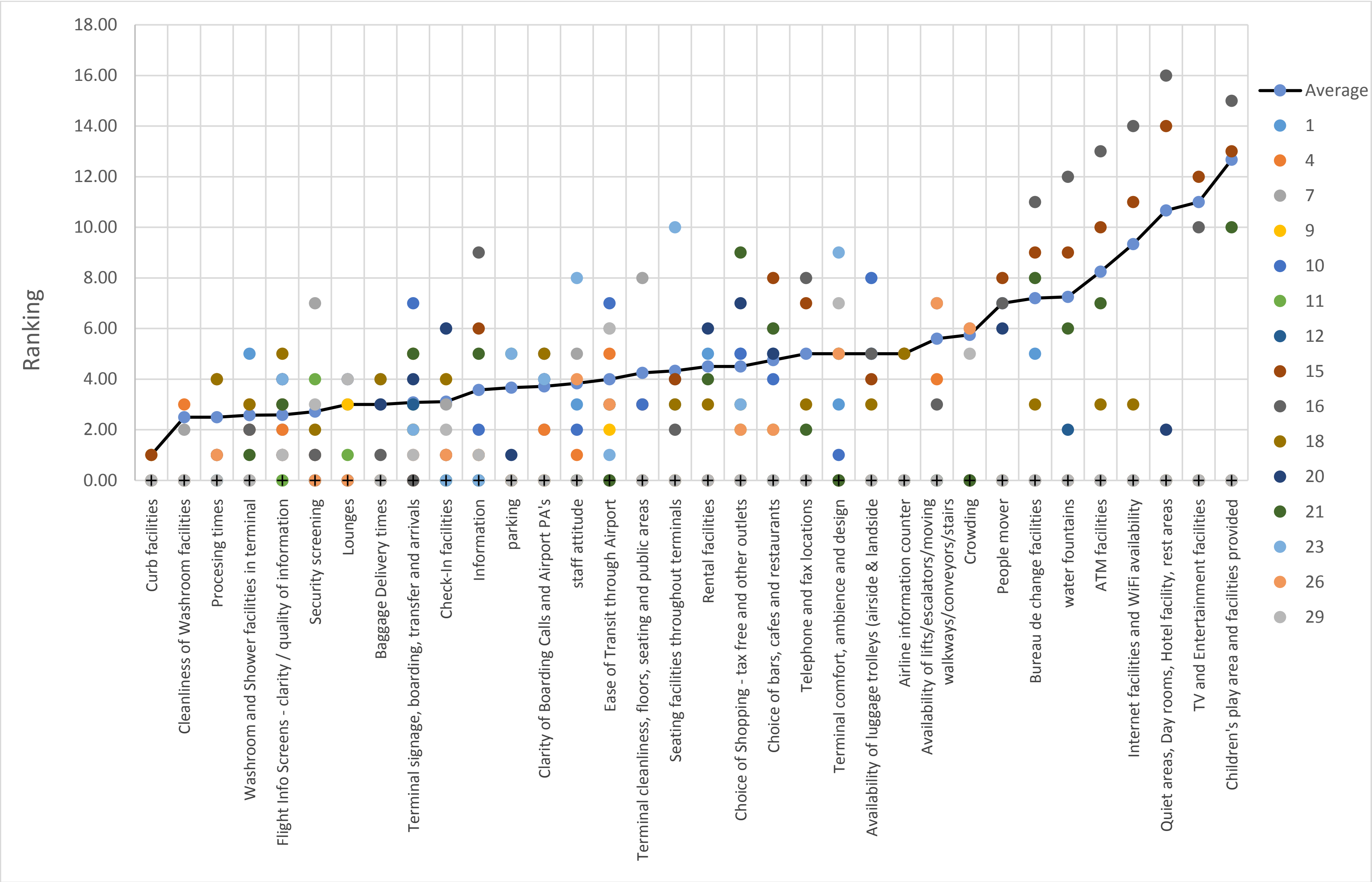


Figure 3-8: Variation in attribute ranking

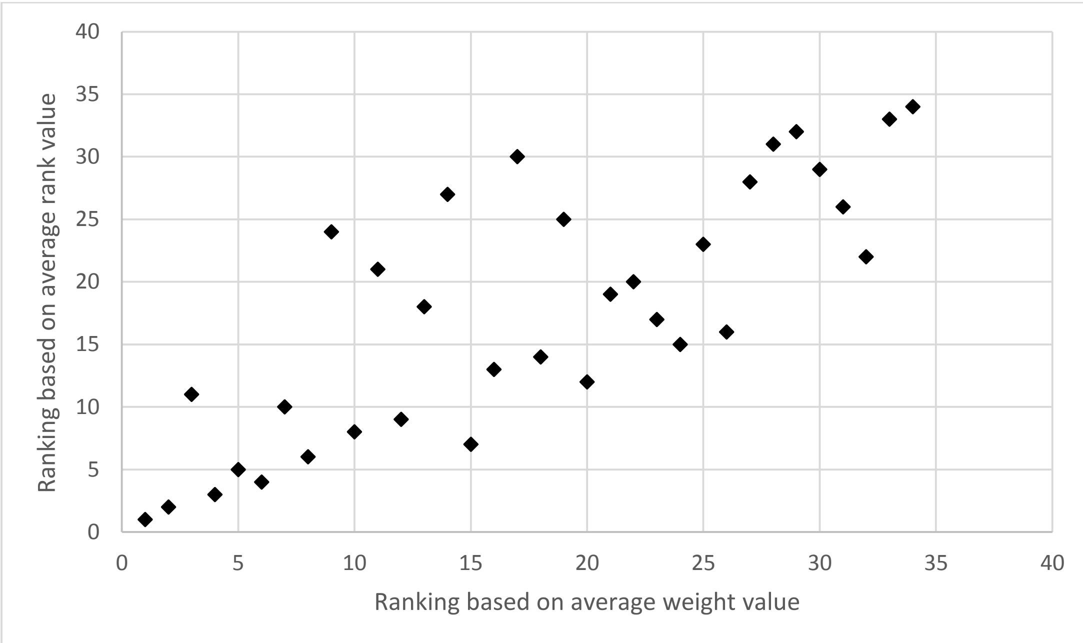


Figure 3-9: Comparison of attribute importance

Table 3-4: Most influential service quality factors for departing passengers

Curb	**Check in hall**	**Common Amenities**	**Lounge facilities**	**Circulation**
Curb front space for passenger un-loading	Check-in process time	Automated services (ATM)	Availability of seating	Signage for circulation (Way finding)
Distance to check-in	Staff assistance	Flight information display	Retail shopping	Time and distance information
Weather protection	Automated kiosks	Information booths/desks	Restaurants	Changing levels (floors)
Baggage carts	Check-in counter signage	Availability of washrooms	Mobile device usability	Walking convenience
Porters	Security screening	Hydration stations	Internet connectivity	Electric carts

Table 3-5: Most influential service quality factors for arriving passengers

Baggage claim	Arrival curb/hall	Circulation	Common Amenities
Signage	Signage	Signage for circulation	Restaurants
Delivery time	weather protection	Changing levels (floors)	Information booths/desks
Baggage belt location	Curb front space for passenger loading	People conveyance within the terminal	Availability of washrooms
Space availability	Transit information desk	Electric carts	Hydration stations
carts and porters	Automated services (ATM)	Time to nodes	Internet connectivity

3.9 Determining minimum service quality criteria

For the purpose of this study, minimum service quality criteria is defined as a state of overall service condition that ensure a certain minimum level of service quality required for the corresponding standard. It is also assumed that the overall quality standard defined by the minimum service quality criteria can be provided by a combination of service levels delivered by a selected sub set of key service attributes. Thus with the above assumption the problem can be approached as an assignment of objectively defined service levels of a given set of attributes into subsets that define minimum service criteria for corresponding overall service standards.

In order to provide a solution to the classification problem identified above, following important parameters of the framework must be defined.

1. Objective measurement of attribute service availability
2. Attribute range of service availability
3. State of attribute service availability
4. State of overall service availability

5. Overall service quality grading scale

3.9.1 Objective measurement of service availability of attributes

It is important at this point to define objective measurement of service availability of attributes. Availability of service refers to the levels of service provided by a certain attribute. Connotations to the notion also can include service performance, amount of service provision. As mentioned above availability of service can be measured as perceived by users (perceived performance) or objectively (objective service). The attention of this research is on the objective service measurement. Given an attribute's availability of service can be measured objectively, the measurement can be using a either a ratio scale or a categorical (nominal) scale. Examples for ratio scale of measurements are time, distance and density (crowding). Service level of attributes such as internet, washrooms or signage cannot be measured using ratio scales. However categorical scales can be used to define the service level of these attributes (example: availability/not availability of Wi-Fi, availability/not availability of dynamic signs). Table 3-6 and Table 3-7 shows objective service measurements for attributes in arriving and departing passenger flow paths respectively. Definition of service levels using an objective measurement is necessary to determine the attribute range of service availability for a given attribute.

Table 3-6: Objective measurement of service availability-arriving flow path

Function	Attribute name	Measurement	
		Continuous	**Categorical**
Baggage claim	Signage-baggage claim	• Visibility index	• Baggage carousel display (yes/no) • Disability access (yes/No)
	Delivery time	• waiting time	
	Baggage belt location	• Distance to curb	
	Space availability	• Area per passenger	
	Baggage carts	• Number of carts	• Free carts / paid carts
Arrival hall	Signage- arrival curb	• Visibility index	
	Weather protection		• Availability or not availability
	Curb front space for passenger loading	• Area per passenger • Number of parking positions	
	Transit information		• Availability or not availability
	Automated services		• Availability or not availability
Common amenities	Restaurants		• Variety
	Information booths/desks		• Availability or not availability
	Availability of washrooms	• Number available	• Disability access (yes/No) • Availability of amenities
	Hydration stations	• Average distance to nearest primary facility	• Availability or not availability • Disability access (yes/No)
	Internet connectivity		• Free service / paid service • Wi-Fi / internet booths
Circulation	Signage for circulation	• Visibility index	• Disability access (yes/No)
	Time and distance information		• Availability or not availability
	Changing levels (floors)	• Tradity differential	• Availability of elevator/escalator
	Walking convenience	• Distance	• Moving walk ways available or not
	Electric carts	• Availability or not availability	

Table 3-7: Objective measurement of service availability-departing flow path

Function	Attribute name	Measurement type	
		Continuous	Categorical
Curb area	Curb front space for passenger un-loading	• Area per passenger • Number of parking positions	
	Distance to check-in hall	• Walking distance • Walking time	
	Weather protection		• Availability or not availability
	Baggage carts	• Number of carts	• Free carts / paid carts
	Porters		• Availability or not availability • Paid service/free service
Check-in hall	Check-in process	• Process time • Area per passenger	• Disability access (yes/No)
	Staff assistance	• Number of kiosks	• Availability or not availability
	Automated kiosks		• Availability of kiosks
	Check-in counter signage		• Availability or not availability • Dynamic signage / static
	Security screening	• Processing time	• Screening method • Disability access (yes/No)
Common amenities	Automated services (ATM)		• Availability or not availability
	Flight information display	• Number of display banks • Average distance to nearest primary facility	• Disability access (yes/No) • Type of display technology
	Information booths/desks		• Availability or not availability
	Availability of washrooms	• Number available	• Disability access (yes/No) • Availability of amenities
	Hydration stations	• Average distance to nearest primary facility	• Availability or not availability • Disability access (yes/No)
Lounge areas	Availability of seating	• Number of seats • Area per passenger	• Type of seating (standard/recliners)
	Retail shopping		• Variety
	Restaurants		• Variety
	Mobile device usability		• Charging stations (yes/no) • Workstations (yes/no)
	Internet connectivity		• Free service / paid service • Wi-Fi / internet booths
Circulation	Signage for circulation	• Visibility index	• Disability access (yes/No)
	Time and distance information		• Availability or not availability
	Changing levels (floors)	• Tradity differential	• Availability of elevator/escalator
	Walking convenience	• Distance	• Moving walk ways available or not
	Electric carts	• Availability or not availability	

3.9.2 Attribute range of service availability

Range of service availability is defined as the range of service level differentiation available for a given attribute. Level of service (LOS) standards available for attributes such as time, distance and density are an example. Transport Canada and IATA have defined level of service standards for space availability at check-in, hold rooms, baggage claim and circulation. Correia (2005) defined service standards for check-in process time, space at check-in area, space availability at curb front, service time at security check, seats availability at lounge areas, space availability at lounge areas, baggage claim processing time, baggage claim frontage, total walking distance and orientation. The level of service (LOS) scale has five ordinal categories labelled “A” (excellent service) to “F” (system break down). The level of service standards are defined only for attributes with ratio scales. However service attributes with categorical service measurements do not have LOS standards defined similar to above attributes. Nevertheless it is possible to assume that the range of service availability can be objectively defined for attributes with categorical service measurements as well. Measurement types given in Table 3-6 and Table 3-7 can be used for the definition of service standards.

Let the range of service availability be defined using the ordered categories such as “not-available/not-adequate”, “basic (adequate)”, “average” and “high”. The above definition of the range is kept generic for simplicity and to cover both categorical and ratio scaled attribute types. Basic level of service provision is defined as just enough service level for providing adequate service. It is very important to note that basic level of service provision does not mean poor level of service provision. The corresponding LOS standard for “basic” is “level of service D”. IATA and Transport Canada definitions of level of service standards identify level of service D as providing adequate service conditions (TRB, 2010, 2011). For attributes such as availability of washrooms, basic level can be defined based on established design standards for building safety and health requirements. Average service level is defined as the mid-level. Corresponding LOS standard is level of service-C. Level of service C is defined as "Good level of service, condition of stable flow; provides acceptable throughput; related systems in balance". Greater than average service level is defined as higher service levels. In terms of level of service scale level of service-B or greater is considered equivalent.

Definition of service levels for attributes with categorical measurements need to be based on the service level differentiation available in a certain group of airports. A basic level need to be defined as the reference level. Basic level would consist of features that is just adequate to provide the basic service intended from the attribute. For example in terms of flight information display the basic level can be defined as availability of flight schedule displays at a few critical nodes such as check-in hall and boarding lounge. Higher service levels can be identified with reference to the basic level. This can be based on the type and volume of additional features made available for enhancing passenger convenience. A survey of a representative sample of airport terminal service environments can reveal the range of such differentiation of service levels available for a particular attribute. This information then can be used to develop objective definitions for a range of service availability.

The definition of ordinal service standards on the range of service availability can be achieved by either expert judgement or more appropriately using passenger input. Methods such as psychometric scaling can be used in this regard. Determination of the range of service availability is not covered within the scope of this research. However in order to propose the methodology of this study, it is assumed that each attribute considered for overall service quality evaluation has a specific range of service availability defined.

3.9.3 Definition of minimum service quality criteria

Let A denote the set of all attributes considered for evaluating the overall service in an airport terminal. Let *n* denote the total number of attributes considered for evaluating the airport terminal service environment. The above can be shown as:

$$A = \{a_1, a_2, \dots, a_{n-1}, a_n\}, |A| = n \quad (4)$$

Where a_k resents the k^{th} service attribute considered, k = (1, 2… n)

Set *A* for departing passenger flow path can be defined using all the attributes given in Table 3-4.

Set *A* for arriving passenger flow path can be defined using all the attributes given in Table 3-5.

$n = 25$ for departing passenger flow path and $n = 20$ for arriving passenger flow path.

Then, let i_k denote the number of service levels identified for k^{th} attribute, then the attribute range of service availability can be represented by an ordinal variable Y_k with i_k categories given by:

$$Y_k \in \{0,1,2, \dots, i_k - 1\} \quad (5)$$

Where:

$Y_k = 0$ is not-available/not-adequate and $Y_k = 1$ is the basic (adequate) level

Example:

Let Y_{ckw} denote the range of service availability of check-in waiting time. Correia (2005) defined a five level (A to E) LOS standard for check-in counter waiting time using data collected at the Calgary international airport. LOS standards defined waiting time is given by:

LOS A –less than 7minutes, LOS B-between 7 to 18 minutes, LOS C-between18 to 26 minutes, LOS D-between 26 to 34 minutes and LOS E-greater than 34 minutes.

Then Y_{ckw} can be defined using the above LOS standards as follows:

$Y_{ckw} = 0$: not adequate = LOS less than D (waiting time greater than 34 minutes)

$Y_{ckw} = 1$: Basic (adequate) = LOS D (waiting time between 26 to 34 minutes)

$Y_{ckw} = 2$: Average (good) LOS less than C (waiting time between 26 to 18 minutes)

$Y_{ckw} = 3$: High = LOS equal or higher than B (waiting time less than 18 minutes)

3.9.3.1 State of attribute service availability

State of attribute service availability is defined as the level of service currently provided by an attribute in concern. Let S_{ak} denote the state of attribute service availability of the k^{th} attribute.

Example:

At any given moment service level of the attribute check-in waiting time can take any value within the range of service availability defined by Y_{ckw}. Therefore the state of attribute service availability for check-in waiting time can have a value of 0, 1, 2 or 3 depending on the service level provided at the time of evaluation.

3.9.3.2 State of overall service availability

The state of overall service availability is defined as the level of overall service quality offered by combining the service quality states of all the attributes considered for evaluation given by (A) above. Then the state of overall service availability S_o is given by:

$$S_o = \{S_{a1}, S_{a2}, \dots, S_{a(n-1)}, S_{an}\} \quad (6)$$

Example:

Consider an overall service environment defined using three service attributes such as check-in waiting time, Internet viability and availability of seating at lounge areas. Then A is given by $A = \{Checkin\ waiting\ time, Internet\ availability, seating\}$

The range of service availability for each attribute in A is defined as follows:

Y_k= 0: not available, Y_k= 1: basic, Y_k= 2: average, Y_k= 3: high.

Assume the service level of the attributes were evaluated and they were found to be available as follows:

Check-in waiting time not adequate level: Y_1= 0

Internet availability at high level: Y_2= 3

Seating at lounge area at average level: Y_3= 2

Then according to Equation 6 the state of overall service availability S_o is given by:

$S_o = \{0,3,2\}$

3.9.3.3 Scale for representing overall service quality grading

Another important aspect to consider is the scale used to define grades of overall service quality standards. It is necessary to establish the grading scale to represent stages of facility provision rather than stages of perceived quality. In most service sectors it is popular to use a five point ordinal scale. For simplicity this study will demonstrate the methodology for a three point ordinal scale. The grading categories are defined as basic, average and above-average. The labelling of the categories are chosen in order to express an objective meaning.

The overall service grading is anchored at the lower bound of the ordinal scale (basic level). Basic level is defined as an overall service state where at least the essential service attributes are provided at a service level just adequate for basic operations of the passenger terminal.

The average level of overall service is intended to be equivalent to the LOS C of the conventional level of service grading methodology. Above average service level represents high or excellent overall service conditions. This is equivalent to LOS B or above in the level of service grading system.

As explained earlier, for hotel classification schemes and level of service definitions, conventional practice is to use either lettering or stars as labelling. The number of service grades to be used for overall service standards is a function of the range of service availability in the service attributes. Definition of three ordered service grades is considered sufficient for developing the research methodology. Additional intermediate levels can be added in a later implementation stage based on more information regarding the range of service availability of service attributes currently available in the airport industry.

The minimum service quality criteria for a certain overall service quality standard is a specific state of overall service availability. This will ensures a certain minimum state of attribute service availability of all the attributes considered for overall service quality evaluation (*A*).

Let S_{omr} denote the overall service state for the minimum service criteria of r^{th} overall service quality standard. Let S_{amkr} denote the minimum state of attribute service availability of the k^{th} attribute required to provide the r^{th} overall service standard. Then the minimum service criteria for the r^{th} overall service standard is given by:

$$S_{omr} = \{S_{a1mr}, S_{a2mr}, \dots, S_{a(n-1)mr}, S_{anmr}\} \quad (7)$$

3.10 Theoretical framework

Objective of developing the theoretical framework is to determine the minimum service quality criteria (S_{omr}), given the set of attributes considered for evaluation of overall service quality (*A*), the range of attribute service availability (Y_k) for all the elements of *A* and the ordinal overall service quality standard *r*.

This study will use the variation of the value of relative importance of attributes in order to define the minimum service criteria of overall service quality standards. The value of relative importance of an attribute is defined as the value of the effect caused by each attribute on the user's preference for overall service quality. A hypothesis is made that the effects of an attribute significantly vary towards higher level of preference compared to the effects at lower level of preference values. Three types of variations in attribute effect are assumed to exist. They are increasing, decreasing and constant. This variation can be further classified according to the magnitude of the overall relative importance of the attribute such as low, moderate-low, moderate-high and high importance. The objective of categorising attributes based on the magnitude of the value of relative importance is to identify essential service attributes and non-essential service attributes. Higher values of relative importance is expected to be observed for essential service attributes. Similarly, lower values of relative importance is expected to be observed for non-essential attributes. The objective of categorising attributes based on the type of variation in relative importance is to identify attractive attributes and non-attractive attributes. Non-attractive attributes are expected to show a decreasing trend in the effect size towards higher levels of preference. Attributes with either increasing or constant effect size are considered as attractive attributes. Figure 3-10 shows the expected variation of attribute effects on the level of preference.

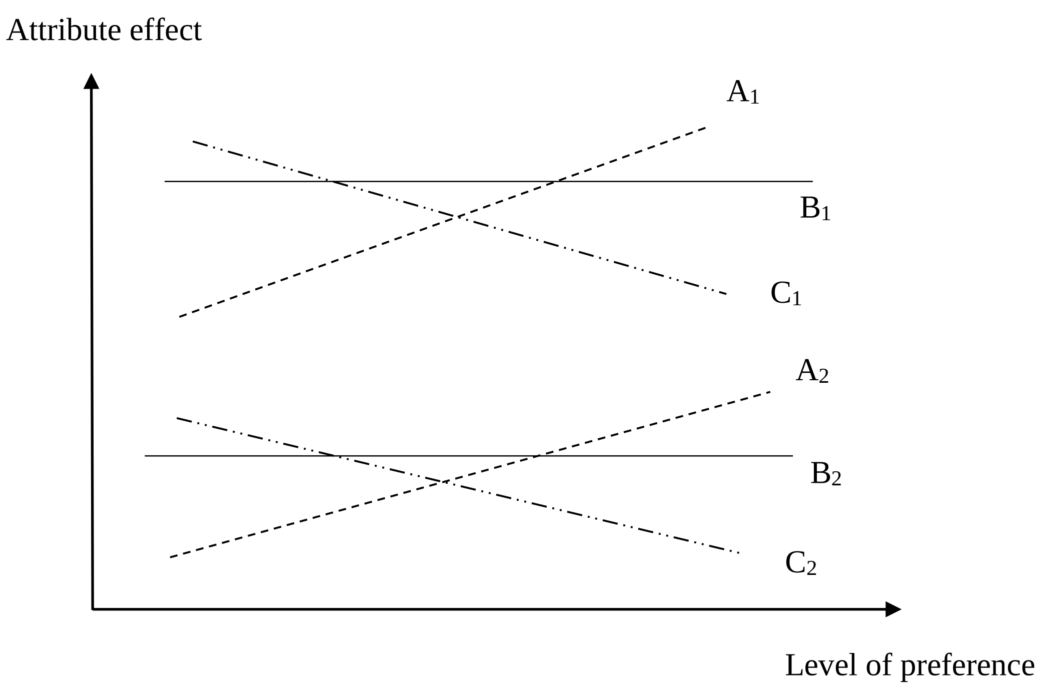


Figure 3-10: Expected variation of attribute effects with respect to level of preference

- A_1 and B_1: Attributes with a relative importance of high and moderate-high are included. Relative importance significantly increase or constant towards high level of preference. These are defined as essential and attarctive attributes Service level increments must be considered as minimum criteria at higher overall service levels.
- A_2 and B_2: Attributes with a relative imortance of low and mederate-low are included. Relative importance significantly increase or constant towards high level of preference. These are defined as non-essential and attractive attributes. Hence their marginal effect on lower end of the preference scale is low. Due to the attraciveness they tend to have higher marginal effect at uper levels of preference.
- C_1: Attributes with a relative importance of high and moderate-high are included. Relative importance significantly decrease towards higher level of preference. These are defined as essential and non-attractive attriutes. Thus, their importance gradualy decrease towards higher level of prefernce. Due to their higher overall importance, they must be considered for minimum criteria at all service grades. However inceremnts of attribute service levels is not required for mimimum criteria at higher overall service grades.
- C_2: Attributes with a relative imortance of low and mederate-low are included. The relative importance significantly decrease towards higher level of preference. These are defined as non-essential and non-attractive attributes.

Assuming the exsitance of the above hypothesied marginal effects of attributes, it is possible to determine a stratergy of allocating attribute service levels as minimum service criteria for overall service quality standards. Table 3-8 shows the allocation of attribute service levels as minimum service criteria for successive overall service quality standards used for this study. The model shown in Table 3-8 is developed based on the variation of the valaue of attribute relative importance shown above.

Table 3-8: Identification of minimum service criteria

Attribute relative importance		Overall facility grading		
Overall importance	Marginal importance on preference rating	Basic	Average	Above average
(Moderate-High), (high)	Increasing	Basic	Average	High
	Constant	Basic	Average	High
	Decreasing	Basic	Average	Average
(Moderate-low),(low)	Increasing	Optional	Basic	Average
	Constant	Optional	Basic	Average
	Decreasing	Optional	Optional	Optional

In order to determine the value of attribute relative importance and its variation, it necessary to define a suitable functional relationship between the attribute service levels and the level of preference for overall service quality. It was decided to use the linear additive relationship. This model has been successfully used in the past for determining the relative importance of service attributes. The functional form is shown in Equation-8.

$$Overall\ service\ quality = W_1(SQA_1) + W_2(SQA_2) + \cdots + W_k(SQA_k) \quad (8)$$

Where:
W_k is the value of relative importance for k^{th} attribute, SQA_k is the level of service quality at k^{th} attribute.

3.11 Passenger survey

The objective of the passenger survey is to collect data required to establish the functional relationship assumed in Equation-8. Following techniques were identified as available methods to determine the relationship between the level of preference for overall service quality and service level of attributes.

1. Direct rating by airport users
2. Regression techniques using revealed preference data of airport users
3. Stated preference survey of airport users

Direct rating has been used in several previous studies in order to determine relative importance of attributes. The critical limitations of this approach is that it does not allow the respondent to make trade-offs in a multi attribute scenario. Regression analysis using preference data collected at airport terminals is another approach used in previous work. Critical limitation of this approach with respect to the objectives of this study is discussed under section 3.6.1.

This study is using a stated preference survey technique in order collect data. A stated preference survey would allow the analyst to vary the service availability of attributes hypothetically. In a stated preference context, service availability for multiple attributes can be varied simultaneously with minimum multicollinearity effects. The analyst has better control over the number and type of attributes that can be used in the survey as oppose to being restricted to the set of attributes available on site. Using hierarchical techniques stated preference methods are capable of handling larger number of attributes than conventional methods. However stated preference technique is not without limitations and drawbacks. Respondents dot behave in real life as the same way they react to a hypothetical scenario. This is one of the most common criticisms directed at this technique. Sometimes the hypothetical scenarios may be perceived to be unrealistic by the respondents due to certain unrealistic combinations of attributes. Such situations can lead to respondents not taking the exercise seriously. Higher data requirement is also a drawback of stated preference methods. Giving a lot of attention for generating hypothetical scenarios and presenting it in a way that respondents can easily understand the hypothetical context can minimize most of the limitations mentioned above. Use of trained surveyors is also helpful to improve consistency and quality of collected data.

3.12 Stated preference survey (SP)

Stated preference techniques fall under the broader class of psycho-physical experiments intended to measure the attitudes of respondents (McFadden, 1986). Stated preference survey techniques are a popular method used to analyse behavioural intentions of users in various fields including transportation, marketing, environmental valuation etc. Stated preference data represents choices "made" or stated given hypothetical situations (Hensher et al., 2005). The counterpart of stated preference data is revealed preference (RP) data. RP refers to situations where the choice is actually made in real market situations. The objective of both RP and SP data analysis is to determine the functional form of the utility associated with a concept (hypothetical or real) using attributes attached to the concept and the users. In the particular context of the study, stated preference data is considered to be advantageous than RP data. A further discussion on the comparison of RP and SP data can be found in Hensher et al. (2005).

Stated preference survey encompasses a range of techniques (Bateman, 2002). Some of the techniques that can be considered for this study include:

1. Choice experiments
2. Contingent ranking
3. Contingent rating
4. Paired comparisons

Choice experiments involve the respondent making a choice between a given set of alternatives defined using a predefined set of attributes. Contingent ranking involves the respondent ranking a set of alternatives (more than two) in the order of preference. In a contingent rating exercise respondents are presented with a number of scenarios one at a time and they are asked to rate each one individually on a semantic or numeric scale. Paired comparison is also called grade pairs, and the respondent is given a choice between two scenarios and asked to indicate the relative preference on a semantic or numeric scale. The objective of the survey and data analysis of this study is to determine the relative importance of attribute service levels on the level of preference. Therefore contingent rating and paired comparison are the methods that can be considered for this study. Out of the two paired comparison method was selected with the following advantages. It gives more information as the response can be analysed as choice and rating data.

Contingent rating only shows one profile to the respondent for rating. It is difficult to establish a proper reference for the ratings given, unless a known reference is maintained (E.g. Current state). In order to maintain consistency, it is required to present a full profile to the respondent using all the important attributes. A partial profile rating would leave room for the respondent to make their own assumptions about key attributes not present in the context given, thus critically affecting consistency. Therefore contingent rating method is not suitable for survey designs with excessive number of attributes. Paired comparison exercises can overcome this limitation as the rating is obtained relative to the non-chosen alternative. This gives a known anchor to the rating obtained. Figure 3-11 shows an example question used for the survey. More details about survey design and data collection are discussed in Chapter-5 of this thesis.

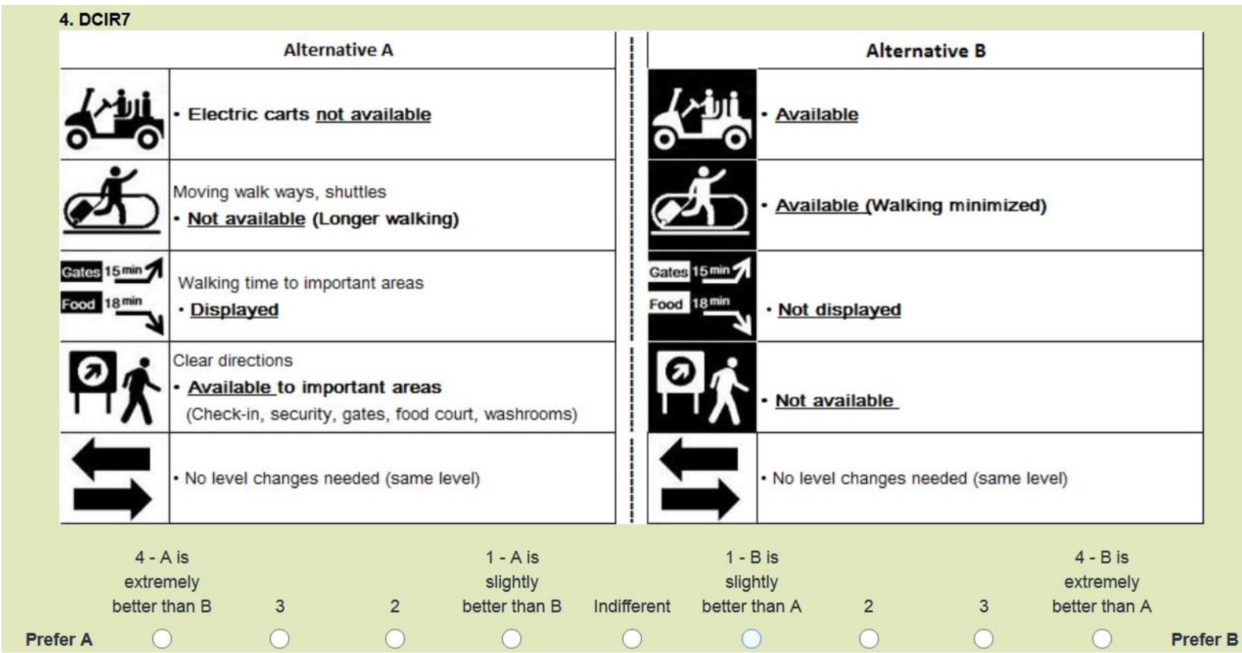


Figure 3-11: Example question in the survey

Rating on the relative preference obtained on the ordinal scale will be analysed using the generalised ordinal regression analysis in order to determine the variation of relative importance with respect to preference level. The choice response can then be analysed using a discrete choice model. The attribute coefficients obtained from the choice model can be used to obtain the value of relative importance. The theoretical framework of the generalised ordinal regression analysis and the discrete choice model is explained in the proceeding sections.

3.12.1 Paired comparison

Paired comparison is also known as graded pairs comparison (GPC). The graded pair comparison is an alternative format that have been applied with variations in other fields such as health economics (Johnson et al., 2000; Lauridsen et al., 2005), in environmental economics, transportation (Bateman, 2002) and in marketing. The graded pairs comparison responses are interpreted as ordinal ratings of utility differences between two alternatives in the choice set (Bateman, 2002; Lauridsen et al., 2005). Let U_i represent the utility associated with an alternative. This utility is measured relative to the utility of a reference alternative in the same choice set. The utility (relative) associated with an alternative is composed of two components such as observed utility and unobserved utility. Observed utility denoted by V_i is the portion observed by the analyst using various alternative (attributes) and individual related characteristics. Unobserved utility denoted by ε_i is the portion cannot be observed by the analyst with the available information, hence taken as an error. The most common assumption on the relationship between V_i and ε_i is they are independent and additive. Hence utility can be expressed as:

$$U_i = V_i + \varepsilon_i \tag{9}$$

Where U_i is the overall utility of the alternative, V_i is the observed portion of the utility, ε_i is the unobserved portion of the utility and i denotes the i^{th} alternative. V_i comprises of the service levels of attributes and their coefficients representing the relative contribution towards observed utility. In some literature, the contribution of a specific attribute to overall utility of an alternative is called a "part-worth". The most simplest and common functional form for observed utility is linear additive function given by:

$$V_i = \beta_{0i} + \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + \beta_{3i}X_{3i} + \ldots . + \beta_{ki}X_{ki} \quad (10)$$

Where: β_{0i} is the alternative-specific constant, which represents on average the role of all the unobserved sources of utility. Because an unlabelled choice experiment is used β_{0i} for the two alternatives will be equal. β_{1i} is the weight (or parameter) associated with attribute X_1 of alternative i. In the particular case of this study the alternatives are unlabelled. This means there is no difference between the left side and right side alternatives except for the attribute levels. Thus in such situations an alternative specific constant does not exist. Nevertheless the attention of this study is on the part-worth or the coefficients associated with attributes and levels (β_{ki}: $k \neq 0$).

If we can represent the utility of an alternative according to Equation-9, then the utility difference between two alternatives is given by:

$$U_A - U_B = V_A - V_B + \varepsilon_A - \varepsilon_B \quad (11)$$

Assuming ε_a and ε_b are identically and independently distributed $\varepsilon_a - \varepsilon_b$ can be replaced by ε_j for the n^{th} choice set. If $U_A - U_B$ is denoted by dU_n for the n^{th} choice set, and substituting for V_A and V_B from Equation-10 we get:

$$dU_j = \left[\sum_{h=1}^{k} \beta_{kn} X_{kAn}\right] - \left[\sum_{h=1}^{k} \beta_{kn} X_{kBn}\right] + \varepsilon_n \quad (12)$$

$$dU_j = \left[\sum_{h=1}^{k} \beta_{kn} X_{kA-Bn}\right] + \varepsilon_n \quad (13)$$

β_{0A} and β_{0B} are equal and they cancel off. It has to be noted in the above equation that respondent's individual characteristics are not included in the utility equation. Respondent's individual characteristics do not vary across the choice set and they fall out of the equation. The utility difference (dU_n) cannot be observed directly. However we observe the ordinal rating given by the respondent to indicate the strength of relative preference. The appropriate approach, therefore, is ordered logit or probit, which incorporates both the discreteness and the natural ordering of the data. This study uses ordered logit model, which assumes the error term is distributed according to the logistic distribution. The rating scale represents both the direction of preference (A or B) and strength of preference. Considering the rating categories are ordinal we can use an ordinal logistic regression model. The objective of the logistic analysis is to investigate how different service quality attributes are affecting the variation of preference. In the next section generalised ordinal regression model and the proportional odds model is introduced.

3.12.2 Ordinal logistic regression model

As explained in the previous section, the utility difference (dU_n) cannot be observed. What we observe is a courser ordinal response by the respondents. A categorical variable is referred to as "ordinal" rather than "interval" when there is a clear ordering of the categories but the absolute distance among them are unknown (Agresti, 1984).

Let $\tilde{Y}$ be an underlying continuous latent variable that follows a regression model given by:

$$\tilde{Y} = \alpha_0 + \sum_{k=1}^{k} \alpha_1 X_1 + \varepsilon \tag{14}$$

Where:

α_{ki} is the weight (or parameter) associated with predictor variable X_k . ε is the random error variable. Let $\gamma_0 < \gamma_1 < \cdots < \gamma_{J-1} < \gamma_J$ be thresholds in the distribution of the latent variable $\tilde{Y}$. Let Y be the observable categorical variable. Then the link between the ordinal variable Y and the continuous variable $\tilde{Y}$ is given by:

$$Y = J \text{ if } \gamma_{J-1} < \tilde{Y} < \gamma_J \quad (J=0,1\ldots.J) \tag{15}$$

Then the probability of $(Y \leq J|X)$ can be obtained by:

$$\begin{aligned} P(Y \leq j|X) = P\left(\alpha_0 + \textstyle\sum_{k=1}^{k} \alpha_1 X_1 + \varepsilon \leq \gamma_J\right) &= P\left[\varepsilon \leq \gamma_J - \left(\alpha_0 + \textstyle\sum_{k=1}^{k} \alpha_1 X_1\right)\right] \\ &= F\left[\gamma_J - \left(\alpha_0 + \textstyle\sum_{k=1}^{k} \alpha_1 X_1\right)\right] \end{aligned} \tag{16}$$

Then the probability of response falling in category J: $P(Y = J|X)$ is given by:

$$P(Y=j|X) = F\left[\gamma_J - \left(\alpha_0 + \sum_{k=1}^{k} \alpha_1 X_1\right)\right] - F\left[\gamma_{J-1} - \left(\alpha_0 + \sum_{k=1}^{k} \alpha_1 X_1\right)\right] \qquad (17)$$

Ordinal regression models are mainly formulated using a series of binary regression models. Ordered categories are transformed into binary categories by grouping them in a way the ordering is taken into account. One of the most popular approaches is the cumulative approach where it makes a split between categories *r* and *r +1* yielding the new response categories (1,2....r) and (r+1, r+2.... k), where k is the number of ordered categories in the original response scale. Thus we can end up with k-1 binary splits in the response scale.

Therefore by assuming logistic distribution for the error in equation-13, the generalized ordered logit model for the cumulative approach can be obtained as given by:

$$\log \frac{P(Y > j|x)}{P(Y \leq j|x)} = \alpha_{0j} + \sum_{k=1}^{k} \alpha_{1j} X_{1j} \qquad (j = 1, 2, \dots, j-1) \qquad (18)$$

By considering the attribute utiltiy difference across the alternatives as indipendant variables and the ordinal rating obtained as the dependent variable, it is possible to model the observed categorical ratings using the equation-18. Thus by substituting the indipendant variables in equation-18 with the attibute utility differences given in equation-13 we can obtain the following relationship between the ordinal rating categories and the indipendant variables:

$$\log \frac{P(Y > j|x)}{P(Y \leq j|x)} = \beta_{0j} + \sum_{k=1}^{k} \beta_{kj} X_{k(A-B)} \qquad (j = 1, 2, \dots, j-1) \qquad (19)$$

3.12.3 Determining the variation of attribute effect size based on levels of preference

The β coefficients can be considered as the effect of each attribute utility difference on the rating threshold at each siccessive split. By comparing the maginitude of these β values it is possible to determine the variation of attribute effect on the level of prefernce. Statistical significance of the variation of the effects can be obtained using the following method.

In the general model specified in Equation 19 regression coefficients are allowed to vary across different splits. A special type of ordinal regression model is the model incorporating the proportional odds assumption. The proportional odds assumption restricts the regression coefficients to be the same across different splits. We can establish whether coefficients differ significantly across different splits by performing the Brant test. The Brant test was performed using the "brant" command of the SPost routines(Long & Freese, 2014) in Stata 12.0. Brant test performs separate binary logistic regressions at each split and compares the coefficients and provides both a global test of whether any variable violates the proportional odds assumption, as well as tests of the assumption for each variable separately (Brant, 1990). Based on this comparison this research intend to clssify attributes into the service quality categories defined ealier in the methodology. Attributes having either a significant increase or a decrease in coefficients would violate the proportional odds assuption with a significant test staistic. Thus an attibute that violates the protional odds assumption can be considered to have a varing maginal effect on preference. Atrributes that satisfy the prptional odds assumption can be considered to have constant marginal effect on preference.

3.12.4 Choice analysis

Choice analysis is about explaining the variability in behavioural response for a sampled population of individuals. One basic assumption underlying choice modelling is that individuals compare alternatives and choose the one that generates greatest satisfaction or utility (utility maximization rule). The formulation of utility for choice analysis is identical to the utility expression obtained in section 3.12.1 Equation-9.

The behavioural rule underlying choice modelling is the probability of an individual choosing alternative *i* is equal to the probability that the utility of alternative *i* is greater than (or equal to) the utility associated with alternative *j* after evaluating each and every alternative in the choice set of *n* = 1, . . . *i*, . .*j* alternatives. This can be represented in the following notation:

$$Prob_i = Prob\left(U_i \geq U_j\right) \forall j \in j = 1, \dots, j; i \neq j \quad (20)$$

Substituting U_i and U_j with equation (9) and rearranging the terms we have the following equation for $Prob_i$.

$$Prob_i = Prob\left(\varepsilon_j - \varepsilon_i \geq V_i - V_j\right) \forall j \in j = 1, \dots, j; i \neq j \quad (21)$$

By assuming ε_i and ε_j are independent and identically distributed (IID) and setting extreme value type-1 distribution to ε_i and ε_j, we can derive the following functional form for the choice probability. Reader can referred to Swait et al. (2000) for the full derivation of the model. Choice analysis performed in this study makes an important assumption regarding the error term (ε) of the utility expression. It assumes that the error term is independently and identically distributed (IID). IID condition is also associated with the property called Independence of Irrelevant Alternatives (IIA). It is very important to consider the possible violation of this condition. This study is using an unlabelled binary choice experiment with identical attributes and levels across the two alternatives. Therefore this assumption is unlikely to be violated (Washington et al., 2003).

$$Prob_i = \frac{expV_i}{\sum_{j=1}^{j} expV_j} \tag{22}$$

$$Prob_i = \frac{exp\left(\beta_{0i} + \sum_{k=1}^{k} \beta_{ki} X_{ki}\right)}{\sum_{j=1}^{j} exp\left(\beta_{0j} + \sum_{k=1}^{k} \beta_{kj} X_{kj}\right)} \tag{23}$$

Where: *exp* is for exponential function.

β parameters can be estimated using maximum likelihood estimation technique. Conditional logistic regression function of Stata 12.0 was used to analyse the survey data.

3.12.5 Calculation of attribute importance values

In the above methodology, discrete choice model estimates the attribute coefficients representing the part-utility of each independent variable for determining the overall utility U_i of the alternative. Each functional area within a flow path is analysed separately. These coefficients can be used as an approximation of the relative importance placed on each attribute by the average respondent. However it is not possible to directly compare these coefficients across separate models. Thus the coefficients are normalized with respect to a reference value to enable comparison. In the discrete choice analysis, the reference value ($Refval\_dc_j$) for the j^{th} functional area is taken as the absolute value of the maximum coefficient in the utility function, given by:

$$Refval\_dc_j = \max\{|\beta_{j1}|, |\beta_{j2}|, \ldots, |\beta_{ji}|\} \quad (24)$$

, where (1, 2...i) is the set of independent variables in the equation.

Then the relative importance of the i^{th} attribute of the j^{th} functional area w_dc_{ji} is obtained by:

$$w\_dc_{ji} = {|\beta_{ji}|}/{Refval\_dc_j} \quad (25)$$

Equation 25 can be used to determine the value of attribute relative importance for all the attribute service levels considered for the evaluation of the overall service quality.

3.12.6 Classification of attribute service levels based on the value of importance

The values of relative importance calculated using Equation 25 is used to classify the attribute service levels into categories based on the importance for overall service quality as defined in the model given in Table 3-8. There are four categories are identified in Table 3-8. They are low importance, moderate to low importance, moderate to high importance and high importance. A criteria for classifying the importance of attribute service levels is developed based on the distribution of the attribute values of relative importance considered for a given flow path. A distribution for the attribute relative importance value is defined by pooling the attribute importance values of attributes from all the functional areas.

Let W_dc be the distribution of relative importance values obtained for a given flow path. Let $\overline{w\_dc}$ be the mean and σ_{wdc} be the standard deviation of the values of relative importance for the above flow path.

Where:

$$\overline{w\_dc} = \frac{\sum_{i=1}^{n} w\_dc_i}{n}$$

$$\sigma_{wdc} = \sqrt{\frac{\left(w\_dc_i - \overline{w\_dc}\right)^2}{n}}$$

Where: w_dc_i is the value of relative importance of the i^{th} attribute service level in the overall flow path, n is the total number of attribute service levels considered for evaluation.

Then the values of attribute relative importance can be classified as follows:

Low importance: $(w\_dc_i < \overline{w\_dc} - \sigma_{wdc})$,

Moderate to low importance: $(\overline{w\_dc} - \sigma_{wdc} < w\_dc_i < \overline{w\_dc})$,

Moderate to high importance: $(\overline{w\_dc} < w\_dc_i < \overline{w\_dc} + \sigma_{wdc})$,

High importance: $(w\_dc_i > \overline{w\_dc} + \sigma_{wdc})$.

Section 3.12.2 showed the use of generalized ordinal regression analysis to analyse the rating data and determine the type of variation in the attribute coefficients with respect to the level of preference for overall service quality. Section 3.12.4 showed the calculation of attribute relative importance weights and determining their classification based on level of importance. Given the attribute range of service availability is established as defined in 3.9.2, Table 3-8 can be used to determine the minimum service criteria for successive overall service quality grades.

3.13 Comparing the results from discrete choice and ordinal regression

According to Equation 19 and Equation 23, it is possible to observe that the models used to analyse the choice (discrete choice model) and the level of preference (generalized ordinal regression model) both use the values of utility that the users attach to each attributes for explaining the variation in responses (choice and rating of preference). Thus a comparison of the results obtained from the two analysis methods will enable us to determine consistency of results in terms of attribute importance for choice and level of preference. A value of relative importance for each attribute service level is calculated based on the results of the ordinal regression analysis for the purpose of this comparison.

Similarly for the ordinal regression reference value (*Refval_or*$_j$) for the j^{th} functional area is given by:

$$Refval\_or_j = \max\{\bar{\beta}_{j1}, \bar{\beta}_{j2}, .., \bar{\beta}_{ji}\} \tag{26}$$

Where (1,2,.., i)is the set of independent variables in the regression equation,

$\bar{\beta}_{ji}$ is the average coefficient of the i^{th} variable of the j^{th} functional area over all the cumulative splits given by:

$$\bar{\beta}_{ji} = \left(|\beta_{ji1}| + |\beta_{ji2}| + |\beta_{ji3}|\right)\Big/_3 \tag{27}$$

Then the average relative importance of the ith attribute of the jth functional area w_or_{ji} is obtained by:

$$w\_or_{ji} = \bar{\beta}_{ji}\Big/_{Refval\_or_j} \tag{28}$$

In the calculation of relative importance all coefficients are converted to absolute values.

w_dc_{ji} and w_or_{ji} is used to compare the relative importance of service attributes across different functional areas in a given flow path for choice and preference rating respectively.

3.14 Conclusion

This research has proposed a new framework for determining overall service quality standards for airport passenger terminals using objectively defined criteria. The new framework adopts the concept of minimum service quality criteria as a practical approach for objectively defining overall service standards. The variation observed in the value of attribute relative importance is used as the basis for allocating attribute service levels as minimum service criteria for overall standards.

A stated preference survey technique was used. This technique gives a better control over the type of attributes need to be considered for the survey. Also it enabled the surveyors to gather responses outside of the airport environment as well. Graded pair comparison format is proposed as the main survey tool for data collection. This format provides both choice data and strength of preference data. Strength of preference data is analysed using generalized ordinal regression model. This analysis is used to determine nonlinear effects of attribute importance on the level of preference. This information is to be used as the basis for classifying attributes and attribute levels as minimum service criteria for each overall service quality standard.

Chapter Four: Cluster analysis

4.1 Introduction

At first glance the main difference between airports are observed in the overall magnitude of the facility, traffic volume and passenger types. At a more detailed level, parameters such as design hour passenger volume, proportions of passenger types, design hour flight schedules and aircraft types dictate the mix of infrastructure present in an airport terminal. The variables mentioned above along with other operational characteristics differ significantly from one airport to another. The diversity of the airport passenger service environment also varies in correlation to the above variables. The main objective of this research is to define overall service quality standards based on objectively measured service attributes. It is extremely difficult to cover a wide range of airport service conditions with one set of overall service quality standards. Thus identification of comparable airport groups and defining service quality standards within them will make the process more effective.

A review of current knowledge revealed that most classifications use region/location or total annual enplane/deplane passenger volume as variables for categorization. Classifications developed using gross measures such as the above are inadequate for categorizing airports in order to define overall service quality standards. Therefore more specific classification criteria need to be established. Variables used for classification must represent the overall scope of the service environment. However obtaining data on characteristics of airport passenger services and facilities can be very difficult and expensive. Nevertheless it is possible to use more easily accessible data such as passenger characteristics as surrogate variables for classification.

4.2 Objective of the analysis

The objective of this chapter is to demonstrate the development of an airport classification scheme to be used with service quality evaluation, standardization and benchmarking. A secondary objective is to use already available sources of data on passenger and facility characteristics as inputs for analysis. Cluster analysis was used to develop the classification. Several cluster analysis techniques were tested and K-means clustering technique generated the optimum results. K-means is an iterative partitioning method. Iterative partitioning methods divide the data set iteratively to a given number of clusters until there is no significant improvement in the solution.

The remainder of the chapter will discuss current classifications schemes of airports, introduction to cluster analysis and sources of data. Finally the analysis methodology is presented followed by results. IBM SPSS Statistics 22 was used for the analysis.

4.3 Current methods for airport classification

Airports are classified in a number of ways based on a variety of criteria. The type of classification varies depending on the particular purpose for which the classification is made. The following list contains different classifications and criteria used.

1. Current operational capacity, in terms of total annual passenger traffic (European Union, 2005; Federal Aviation Administration, 2010b)
2. Airport functional role (intercontinental hub, regional, leisure destinations) (B. Graham, 1998; Malighetti et al., 2009)
3. Geographical location (national or regional capital)(Transport Canada, 2010)
4. Airport competition (Air Transport Group, 2002)

Most classifications use a combination of region/location or total annual enplane/deplane passenger volume as variables for their clustering. Appendix Table A1 and

shows the classification scheme used by Transport Canada and FAA, USA respectively. Airport council International uses a five group classification for its Airport Service Quality (ASQ) program. The ACI classification is based on total annual passenger volume. The five groups are 5million or less, 5million-15million, 15million-25million, 25million-40million and 40millon above. B. Graham (1998) used airport functions, ranging from leisure destinations to intercontinental hubs, in capital cities to classify European airports. The classification contains seven groups. A study on airport competition in Europe (Air Transport Group, 2002) considered ownership (private or public) and association with a specific network among other variables for classification. It looks at a classification based on characteristics of competition among airports. The objective of the study was to provide the European Commission with information to update the approach towards the application of state aid rules in public financing of airport infrastructure (European Union, 2005). This classification had four categories.

4.4 Cluster Analysis

Cluster analysis is a generic name for a wide variety of procedures that can be used to create a classification. These procedures form clusters or groups of highly similar entities. More specifically, "A clustering method is a multivariate statistical procedure that starts with a data set containing information about a sample of entities and attempts to reorganize these entities into relatively homogenous groups" (Aldenderfer & Blashfield, 1984).

There is a large body of literature on cluster analysis and its applications in various fields (Everitt et al., 2001). According to Aldenderfer and Blashfield (1984) there are seven families of clustering methods developed. They are the hierarchical agglomerative, hierarchical divisive, iterative partitioning, density search, factor analysis, clumping and graph theoretic. This study uses hierarchical agglomerative and iterative partitioning techniques, both of which are commonly used clustering techniques. Furthermore, the availability of software incorporating those techniques is also an advantage. According to the type of data used in this study and type of classification expected, these methods have proven ability to generate sufficiently accurate results.

4.4.1 Proximity Measure

The proximity measure is of central importance in attempting to identify clusters that may be present in data. It is used to determine how close or far apart individual data points are to each other. Many clustering investigations have an n×n matrix called the "similarity/dissimilarity matrix" (where n is the number of cases) as their starting point. Elements of the similarity/dissimilarity matrix are, in some sense, quantitative measures of closeness referred to as dissimilarity, distance or similarity between two points.

There are two groups of proximity measures, continuous and categorical. Since airport passenger data can be considered to be continuous, only those proximity measures applicable to continuous data are considered. Everitt et al. (2001) described six proximity measures for continuous data. They are grouped into two types, distance measures (euclidean distances) and correlation measures. Distance measures will be used to represent proximity. It should be noted that distance measures, in general, have certain drawbacks when used for clustering. Aldenderfer and Blashfield (1984) provided a good discussion on the drawbacks related to distance measures. This study, however uses annual passenger volumes (international, domestic, transfer, etc.) as variables to describe cases; thus, there is no significant scale difference between variables, and no significant difference between standard deviatons among variables. Therefore, the most critical of the drawbacks are avoided.

The squared euclidean distance is used as the proximity measure for this study. It is the most commonly used distance measure for cluster analysis, which can be attributed to the fact that the squared euclidean distance gives progressively higher weights to data points that are further apart. The euclidean distance between two data points *i* and *j* with *p* number of variables is given by:

$$d_{ij}{}^2 = \sum_{k=1}^{p} (x_{ik} - x_{jk})^2 \qquad (29)$$

Where:

d_{ij} is the euclidean distance between two data points *i* and *j*,

x_{ik} is the value of k^{th} variable of the data point *i*

x_{jk} is the value of k^{th} variable of the data point *j*

P is the number of variables

Figure 4-1 shows the Euclidean distance d_{ab} between two data points A and B using two variables X and Y.

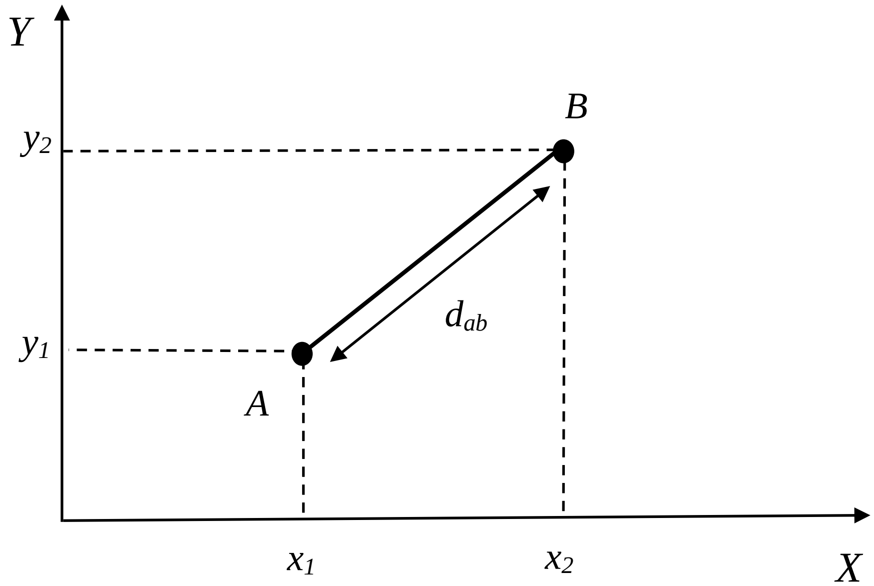


Figure 4-1: Euclidean distance between two data points

4.4.2 Clustering method

As previously mentioned, this study uses techniques from two categories of cluster analysis methods, i.e., hierarchical agglomerative and iterative partitioning techniques. It is understood in cluster analysis that there is no overall best clustering technique, but that each method has its own strengths and weaknesses (Hardy, 1996). The application of different clustering techniques and criteria for determining the best number of clusters can, therefore, suggest different values. Hence, investigators have to be cautious about accepting the results of any clustering method uncritically, without comparing with alternative methods (Hardy, 1996).

Therefore, four techniques will be used for the cluster analysis in this study. They include three algorithms for hierarchical clustering and k-means clustering for the iterative partitioning technique. The following subsections provide brief descriptions of these techniques.

4.4.3 Hierarchical Clustering

Hierarchical clustering uses an $n \times n$ similarity matrix (where n is the number of data points) and most similar data points are merged in a sequential manner. There are (n-1) steps to cluster the similarity matrix starting from n number of clusters. Therefore it is called an agglomerative method. Commonly used hierarchical clustering methods are Ward's method, shortest linkage, complete linkage and average linkage (Everitt et al., 2001). Figure 4-2 shows a similarity matrix with five data points n_1, n_2, n_3, n_4, and n_5. Similarity values between pairs of data points are calculated using the proximity measure given by Equation 29. Values in cells below and above the diagonal of the matrix are equal. Therefore only the values below the diagonal are shown.

	n_1	n_2	n_3	n_4	n_5
n_1	0				
n_2	d_{12}	0			
n_3	d_{13}	d_{23}	0		
n_4	d_{14}	d_{24}	d_{34}	0	
n_5	d_{15}	d_{24}	d_{35}	d_{45}	0

Figure 4-2: Similarity matrix

4.4.4 Iterative Partitioning Method

Unlike hierarchical clustering, iterative partitioning methods divide the data set iteratively to a given number of clusters. The process begins with an initial partition of the data set into a specified number of clusters and computing of cluster centres. Each data point is allocated to the nearest (distance to centroid) cluster. New centroids of the clusters are then computed after all the data points have been assigned. The steps are repeated until there is no change in cluster membership. One of the greatest advantages of the iterative partitioning method compared to hierarchical methods is the fact that it makes several passes over the data, thereby compensating for a poor initial partitioning; whereas hierarchical methods cannot change the cluster membership once it has been assigned. On the other hand, a critical drawback of iterative method is that it requires an initial partition, which is user specified. Thus, it makes the identification of the optimal partition difficult. Hierarchical clustering methods can be used to specify the initial clusters to start iterative partitioning methods.

4.5 Cluster Analysis in Airport Studies

It is important to discuss some examples where cluster analysis has been applied to airport data. Malighetti et al. (2009) studied 467 Eropean airports in order to identify strategic groups by considering both their characteristics and their positions in the network. They classified each airport into clusters, by employing traditional clustering tools, and into modules, by employing the innovative simulated annealing methodology. Ward's method was used for the cluster analysis. The reason for using Ward's method in this study as oppose to average linkage is its ability to form spherical clusters. This quality helps to identify clusters for medium size airports.

Madas and Zografos (2008) used cluster analysis on 52 European airports to define types of airport capacity related variables. The objective of the classification was the development of an airport classification scheme in order to cope with the characteristics of different airports and to later investigate the compatibility of alternative slot allocation strategies that vary with the identified airport clusters. They identified four main clusters in the data; however, the procedure for the determination of the best number of clusters was not discussed. One drawback of arbitrarily selecting the number of clusters based on subjective judgment is that it may reduce the reliability of cluster membership.

Sarkis and Talluri (2004) used cluster analysis in a study of benchmarking airports based on operational efficiency. Data envelopment analysis (DEA) was used to rate the relative efficiency of every airport relative to each other airport in the sample. Correlation coefficients between each pair of column in the cross-efficiency matrix are used as the proximity value. Clustering method used for the analysis is hierarchical and the linkage rule is average linkage. Best performing airports in each category were selected as potential benchmarks. However, the final number of clusters was decided arbitrarily, based on a judgment regarding the level of similarity within a group.

Burghouwt and Hakfoort (2001) analyzed the evolution of the European aviation network and clustered a broad sample of airports using three variables – average seat capacity, average number of destinations and average number of intercontinental destinations. Their objective was the classification of airports according to the type of connectivity. Ward's method of clustering was used, and five clusters were defined according to results. However, it is not clear how the optimum number of clusters was decided and whether an objective or subjective rule was used. Furthermore, descriptive statistics of the clusters showed considerable overlap between medium- and small-sized airports in all three variables. This overlap in variables could make it difficult to propose a criterion for defining categories.

4.6 Sources of suitable data

Passenger volume data in terms of sector such as international/domestic and in terms of movement such as origin/destination or transfer are regularly recorded by most aviation authorities and in certain regions freely available to public. Airport terminal guidelines identify proportions of different passenger types as factors determining terminal configuration and facilities(Federal Aviation Administration, 2010a). A study done by De Neufville et al. (2002) on optimal configuration of passenger terminal buildings showed the presence of transfer passengers and higher transfer ratios affecting the choice of terminal configurations based on the distribution of passenger walking distances. Following variables were used for the analysis.

1. Origin-destination/transfer passenger volume
2. International/domestic passenger volume

Airports in the United States are considered as the case to be studied for classification. Availability of free access to a detailed data base on passenger volumes handles by a large group of airports is the particular reason for selecting US airports for the study. The study utilizes passenger data collected from the T-100 and airport origin/destination-survey databases of the U.S. Bureau of Transportation Statistics, USA.

Passenger data for the analysis was obtained from the Bureau of Transportation Statistics of the U.S. Department of Transportation (RITA, 2011). The total annual passenger volume data for the year of 2009, including domestic and international passengers, for all U.S. airports with commercial passenger services were obtained from the data libraries T-100 Domestic Market (All Carriers) and T-100 International Market (All Carriers), respectively. Domestic transfer passenger data for the same airports was computed from the data libraries of DB1B Coupon and DB1B Market.

Using DB1B Market and DB1B Coupon data, it was possible to separate origin/destination (OD) and transfer passenger volumes for each airport. Airports with a total annual passenger volume of less than two hundred thousand were excluded from the analysis. These are very small airports that have none or very few transfer passengers and almost zero international passengers. Hartsfield-Jackson Atlanta International Airport (ATL) is found to be an outlier based on passenger variables and the magnitude of the terminal facilities. This is ranked as the largest airport in the world by Airport Council International. Therefore this airport is kept out of the analysis in order to avoid adverse effects caused by outliers in cluster analysis. A sample of 210 airports remained to be used in the analysis.

International transfer passenger volumes were not considered for this analysis, due to unavailability of data for all airports. Figure 4-3 shows the distribution of annual international passenger to annual total passenger ratio.

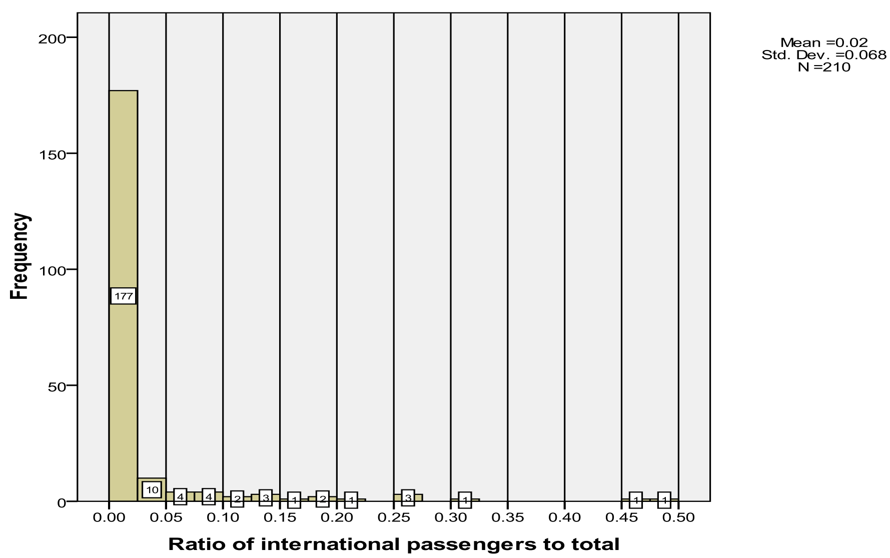


Figure 4-3: Distribution of international passenger ratio

According to Figure 4-3 the average percentage of international passengers in US airports is 2%. Hence the effect from international transfers on the airport categorization can arguably be neglected. The transfer passenger ratio for each airport was estimated using the data from the origin-destination survey. The total annual domestic transfer passenger volume was then calculated by multiplying this ratio by the total annual domestic passenger volume obtained from the T-100 Domestic Market (All Carriers) database.

4.7 Selection of clustering method

Analyses were performed using five different clustering methods, in order to determine the best method of clustering. Three different linkage rules are tested for hierarchical clustering. They are Ward's method, average linkage and complete linkage methods. Two iterative partitioning methods tested are K-means clustering with specified cluster centers and unspecified cluster centers. The variance ratio criterion (VRC) introduced by Caliński and Harabasz (1974) can be used to compare the results of different clustering methods. Milligan and Cooper (1985) found VRC as a best performing method to determine the optimum number of clusters present. Value of VRC for a population of data points is given by:

$$VRC(g) = \frac{trace(B)}{g-1} \Bigg/ \frac{trace(A)}{n-g} \qquad (30)$$

With

$$trace(B) = \sum_{m=1}^{g} n_m(\overline{x_m} - \bar{x})^2 \qquad (31)$$

and

$$trace(A) = \sum_{m=1}^{g} \sum_{l=1}^{n_m} (x_{ml} - \overline{x_m})^2 \qquad (32)$$

Where:

$VRC(g)$ = variance ratio for $\boldsymbol{g}$ number of clusters,

Trace (B) = between group sum of squares (BGSS),

Trace (A) = within group sum of squares (WGSS),

n = number of entities in the data set,

n_m = number of entities in the m^{th} cluster,

$\overline{x_m}$ = P-dimensional vector of m^{th} cluster mean,

$\bar{x}$ = P-dimensional vector of overall sample mean,

x_{ml} = P-dimensional vector of the l^{th} entity in the m^{th} cluster,

P = number of observations for a data point.

This criterion was developed to approximate the best partition that minimizes the within-group sum of squares (WGSS), i.e., the within-group variance. The VRC can be used to determine the best or most economical number of clusters, as well as allowing for some insight about the structure of the data points (Caliński & Harabasz, 1974).

Figure 4-4 shows the variation of the VRC value for different cluster solutions obtained using the different clustering methods. In this experiment, solutions with higher VRC values generate clusters that are more homogeneous within the cluster, and heterogeneous between groups. Attention should be given to the comparison between the different methods and their groups only, as the exact value of the VRC holds little meaning in terms of clusters being good or bad. According to results shown in Figure 4-4, k-means analysis with specified cluster centers (k-mn_SC) appears to be the best among the methods.

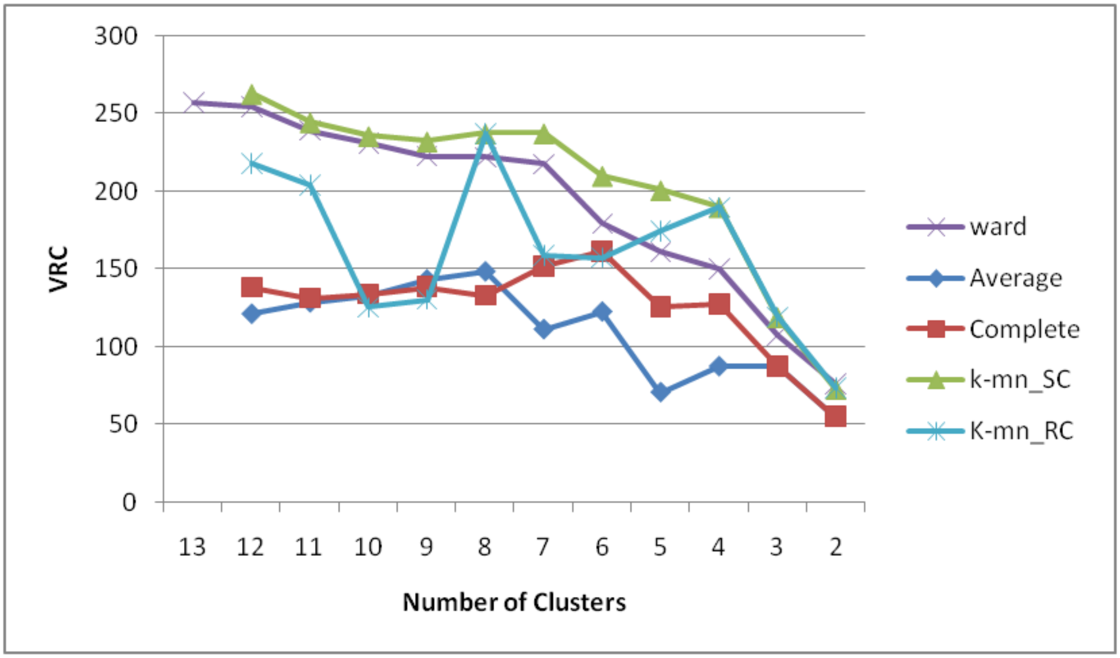


Figure 4-4: Variance ratio criterion for different clustering methods

Cluster solutions generated by average-linkage and complete-linkage have resulted in comparatively low values of VRC. K-means clustering and Ward's clustering method use within group variance as the similarity measure when forming clusters. Hence these algorithms always try to minimize the within group variance in a given solution. Whereas average-linkage and complete-linkage use distance (average distance and longest distance respectively) as the similarity measure, thus they do not minimize the within group variance when forming clusters. This explains the low VRC values obtained by later two methods.

When comparing K-means method and Ward's method, iterative partitioning techniques such as K-means makes several passes over data attempting to optimize the criteria of minimum WGSS and maximum BGSS. Whereas hierarchical techniques such as Ward's method make a single pass over data and do not attempt to minimize WGSS iteratively. This explains the slightly better VRC values obtained by K-means method (K-mn_SC) compared to Ward's method. The cluster centers for the k-means analysis with specified centers method were obtained using results given by Ward's method. Alternative to K-means clustering with specified centers is clustering with random centers (K-mn_RC). User specifies the required number of clusters and allows the algorithm to randomly select cluster centers from the given data. According to above results in Figure 4-4, K-mn_SC has given better clusters than K-mn_RC. This is because when cluster centers are specified it is easy for the iteration to achieve an optimum solution.

4.8 Cluster Data Using Multiple Variables

Cluster analysis can be performed using multiple variables to examine the average similarity of the entities under investigation. The variables selected for this analysis were as follows:

a. Annual domestic origin/destination passenger volume,
b. Annual domestic transfer passenger volume, and
c. Annual total international passenger volume.

The above variables are the basic constituent categories of total passenger volume in any civilian airport. Cluster analysis using these variables shows possible groups of airports similar in profile as well as total passenger volume. A simple scatter plot can be used to generate an initial visualization of clusters (Figure 4-5).

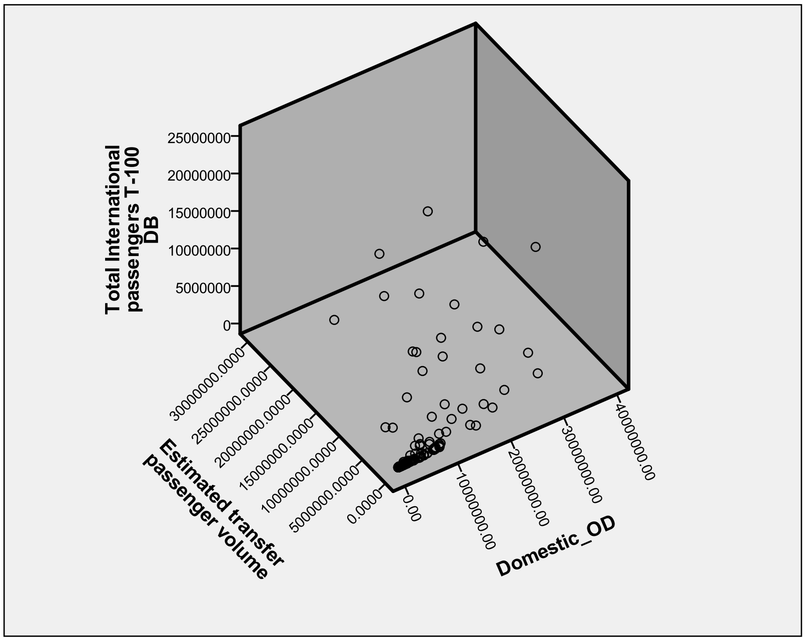


Figure 4-5: Three-dimensional plot of data

According to the scatter plot, there is a large concentration of small airports with a dominant proportion of domestic origin/destination passengers. These airports have extremely low international and transfer traffic. The remaining airports failed to show tight clustering in terms of passenger volumes. However, a cluster analysis can divide the population of airports into the optimal number of groups based on a selected similarity measure. In this particular analysis, a k-means clustering method was used. The number of clusters and their centers were specified using Ward's method.

Pair wise correlation of the three variables was tested using the Pearson correlation coefficient (*r*). Table 4-1 presents the results obtained from the correlation analysis.

Table 4-1: Pairwise correlation of variables

		International	Domestic Transfers	Domestic OD
International Total	Pearson Correlation	1	.457**	.638**
			.000	.000
Domestic Transfers	Pearson Correlation	.457**	1	.643**
		.000		.000
Domestic OD	Pearson Correlation	.638**	.643**	1
		.000	.000	

**Correlation is significant at the 0.01 level (2-tailed)

According to the results in Table 4-1 there is a considerable correlation between domestic OD passenger volume and domestic transfer volume. However, a perfectly uncorrelated set of data is important for cluster analysis. When data is pairwise correlated, principal component analysis (PCA) can help transform the original variables to a set of uncorrelated variables. PCA is also used as a dimension reduction technique in cluster analysis when there are a large number of variables used to represent cases. Principal components are orthogonal vectors found in the multidimensional space of the given data set, where each component is optimized to explain the maximum amount of variation in data. Ward's method was used to specify the initial cluster centers for the k-means clustering method. It was not possible to determine the optimal number of clusters directly using the hierarchical classification, due to the poor clustering of the larger airport entities. The VRC described earlier was used to select the optimal cluster solution.

Figure 4-6 shows the values of the VRC plotted for different cluster solutions. Caliński and Harabasz (1974) suggested choosing the number of clusters (*g*) for which the VRC has an absolute or local maximum or, at least, has a comparatively rapid increase.

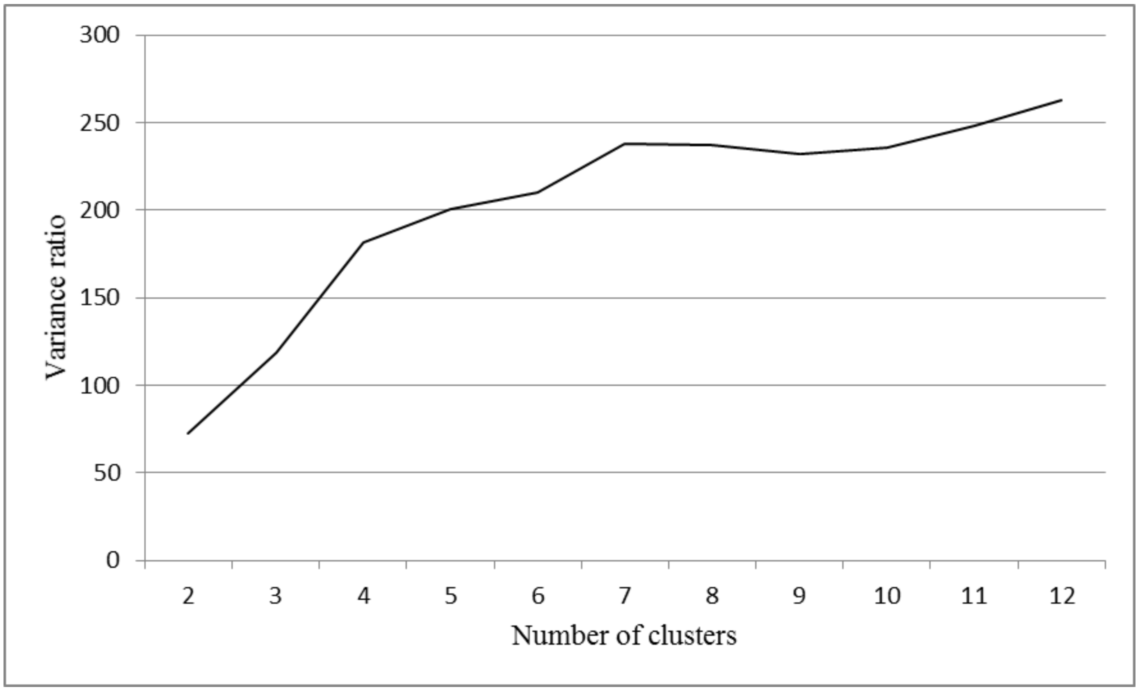


Figure 4-6: Variance ratio criterion

4.9 Interpretation of clusters

According to the above Figure 4-6, seven clusters can be selected as the solution for the number of optimally different groups. Figure 4-7, Figure 4-8 and Figure 4-9 shows the distribution of cluster membership with respect to each variable. According to results, Memphis International, Cincinnati/Northern Kentucky International and Dulles International Airport in cluster#1 are significantly different from the majority of the same group. The reason they are grouped with Cluster#1 is the fact that the average similarity of the three airports are nearest to cluster#1 than any to other cluster at this level of the solution. Hence they will be separated as Cluster #8.

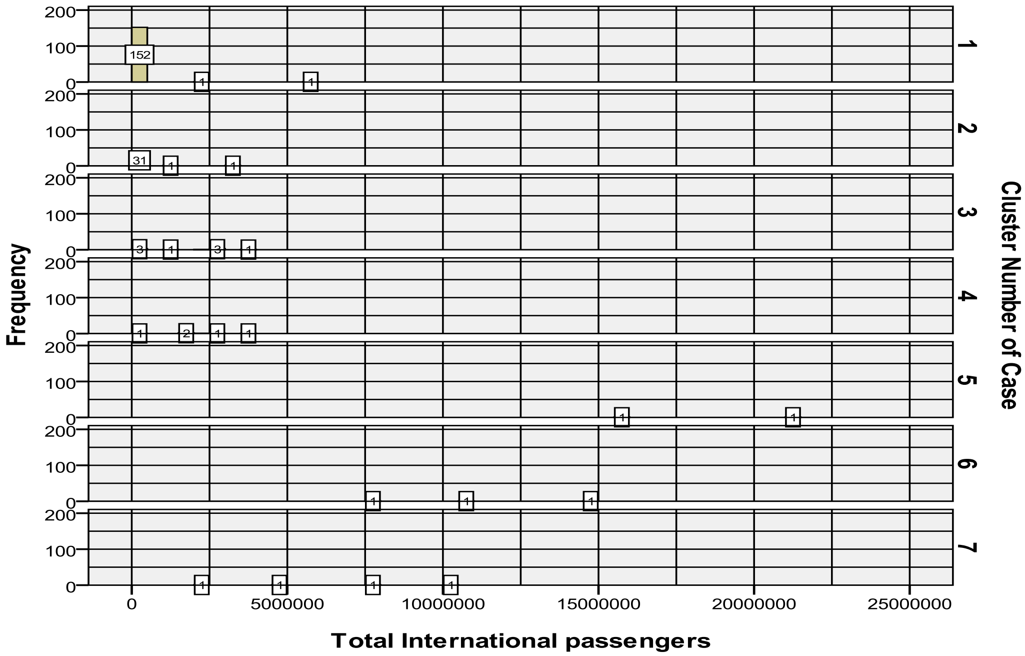


Figure 4-7: Distribution of cluster membership (International passengers)

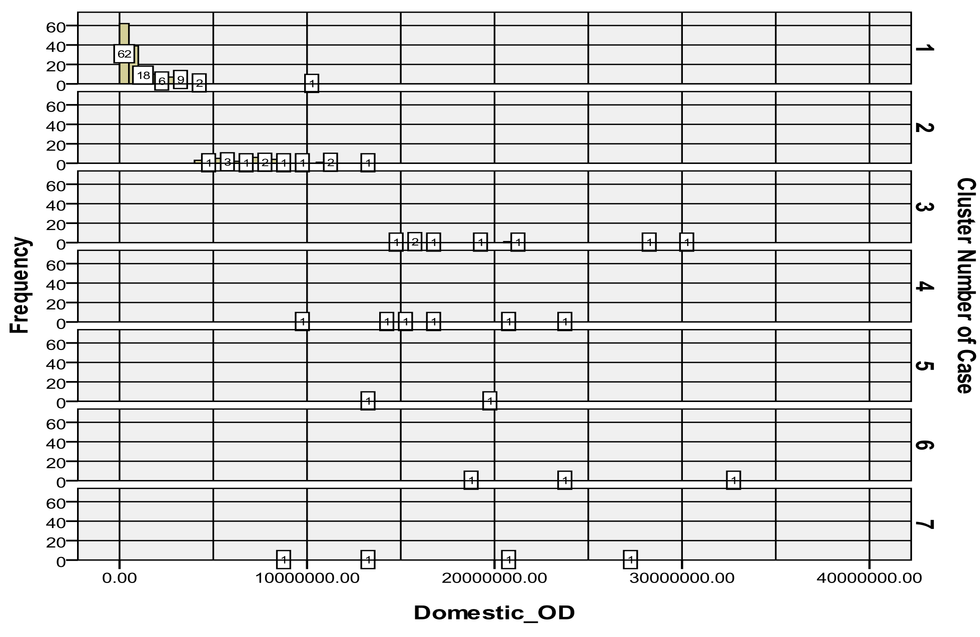


Figure 4-8: Distribution of cluster membership (Domestic passengers)

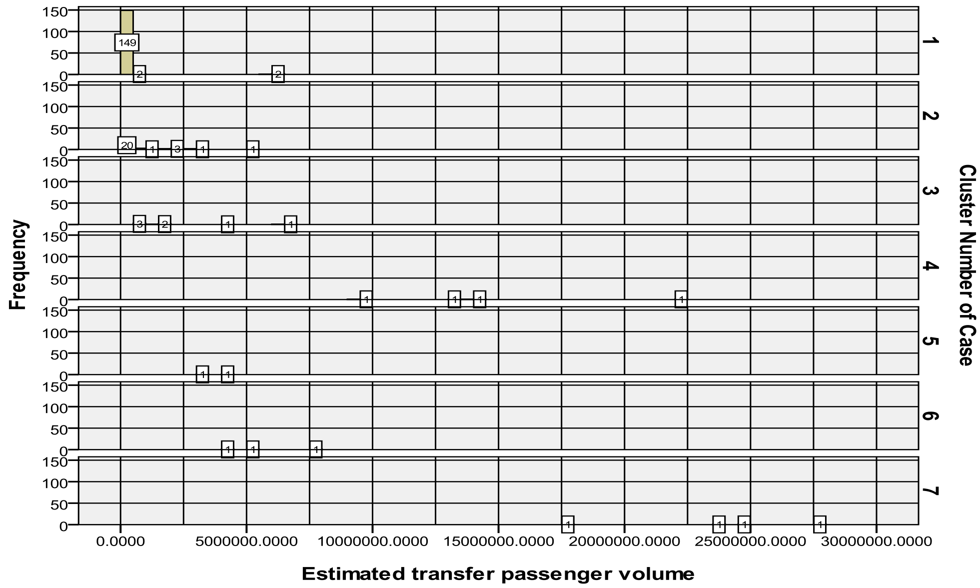


Figure 4-9: Distribution of cluster membership (Transfer passengers)

Summary statistics for each cluster is given in Table 4-2. Figure 4-10 shows average annual total passenger volume in each cluster. Classification ranges used by Airports Council International (ACI) for airport service quality awards are shown by horizontal dotted lines. ACI divides airports total annual volume as very-small 5million or less, small 5million-15million, medium 15million-25million, large 25million-40million and very large 40millon above. Figure 4-11 shows the average values for ratio of international passenger and the ratio of transfer passengers in each cluster. Cluster#1 and Cluster#2 have similar passenger characteristics compared to rest of the clusters. They contain airports having relatively low international passengers and transfer passengers. They are differentiated by the volume of domestic O/D passengers. Clusters #'s 3,4,5,6 and 7 have larger airports where the annual passenger volume is greater than 25 million. These larger airports have larger volumes of international passengers and transfer passengers. However the number of members in these clusters are very low.

Table 4-2: Cluster summary

Cluster number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number of members	151	33	9	6	2	3	4	3
transfer passenger	5.5E +04	1.0E +06	2.7E +06	1.4E +07	3.6E +06	5.6E +06	2.4E +07	6.1E +06
Domestic_OD	9.9E +05	7.2E +06	2.0E +07	1.7E +07	1.7E +07	2.5E +07	1.7E +07	5.9E +06
Total International	2.3E +04	2.2E +05	1.8E +06	2.1E +06	1.9E +07	1.1E +07	6.2E +06	2.2E +06
Total annual (Domestic + International)	1.1E +06	8.4E +06	2.5E +07	3.3E +07	3.9E +07	4.2E +07	4.7E +07	1.4E +07
Ratio of International/total	.01	.02	.07	.07	.48	.27	.13	.11
Ratio of Domestic Transfer/Domestic total	.05	.10	.11	.45	.18	.18	.59	.54

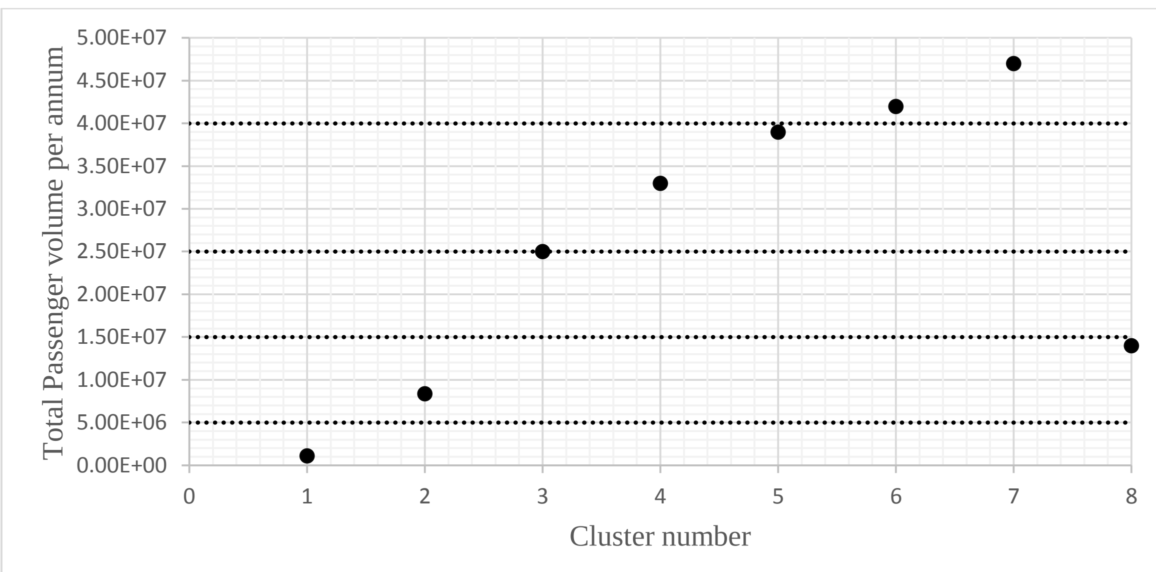


Figure 4-10: Average annual passenger volume

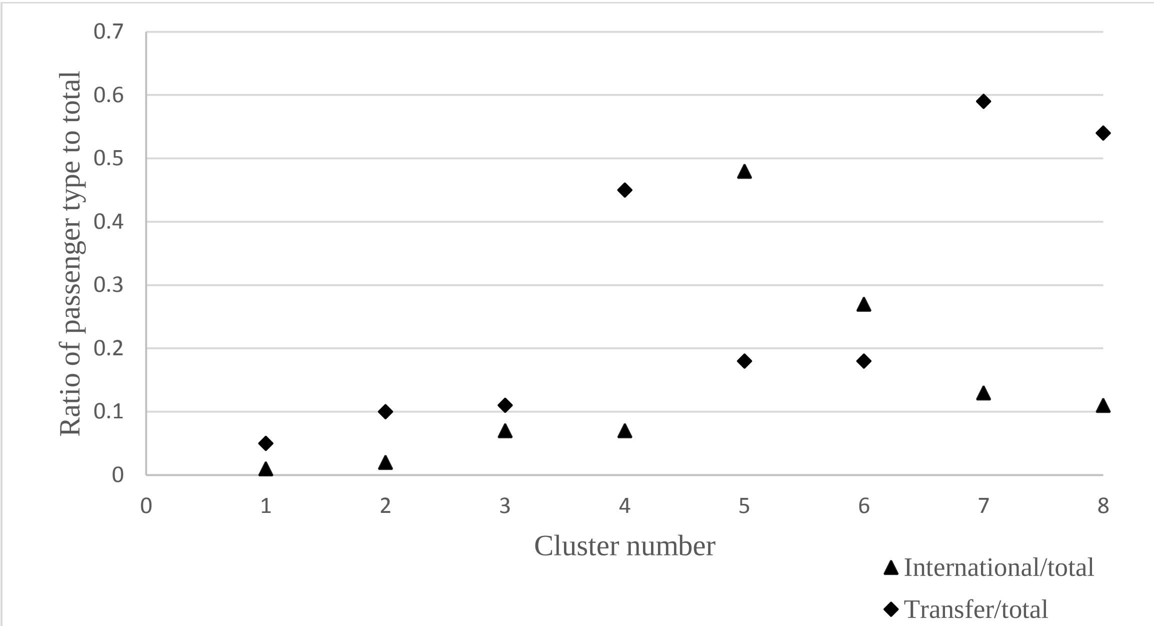


Figure 4-11: Passenger-type ratio

4.9.1 International and Domestic airports

Clearly Cluster#'s1 and 2 are groups where there is a very large majority of domestic passengers. More than 95% of all the airports in both groups combined have 5% or less international passengers annually. International destinations where there are at least 10000 annual enplane/deplane passengers were obtained. Nearly 80% of them are fully domestic airports and another 15% serve only one international destination. The remaining 5% serve between 2 to 5 destinations, most of them are in Canada as trans-border destinations.

4.9.2 Transfer and origin-destination (OD) airports

There is no widely accepted criterion to differentiate transfer airports from OD airports. Some design guidelines use an arbitrary value of 25% or more transfer passengers of total passengers (Horonjeff et al., 2010). From the cluster analysis, Cluster#'s1 and 2 contain most of the low transfer airports. About 90% of Cluster #'s 1 and 2 airports have less than 10% of transfer passengers with a mean transfer ratio of 5%. Whereas the remaining 26 airports belonging to Cluster #s 3 to 7 have an average of 30% of transfer passengers. Therefore there is significant difference between the transfer ration of the first two clusters and the remaining groups. Furthermore, 24 airports out of 26 in the last five clusters (#'s 3, 4...7) serve as hubs for some of the major airlines in the United States. This explains the higher transfer rate observed in those groups of airports. Figure 4-12 and Figure 4-13 shows scatter plots of transfer ratio against the volume of transfer passengers for airports greater than 500000 annual transfer passengers and less than 500000 annual transfer passengers respectively. 90% of cluster 1 and 2 airports fall in to the latter category.

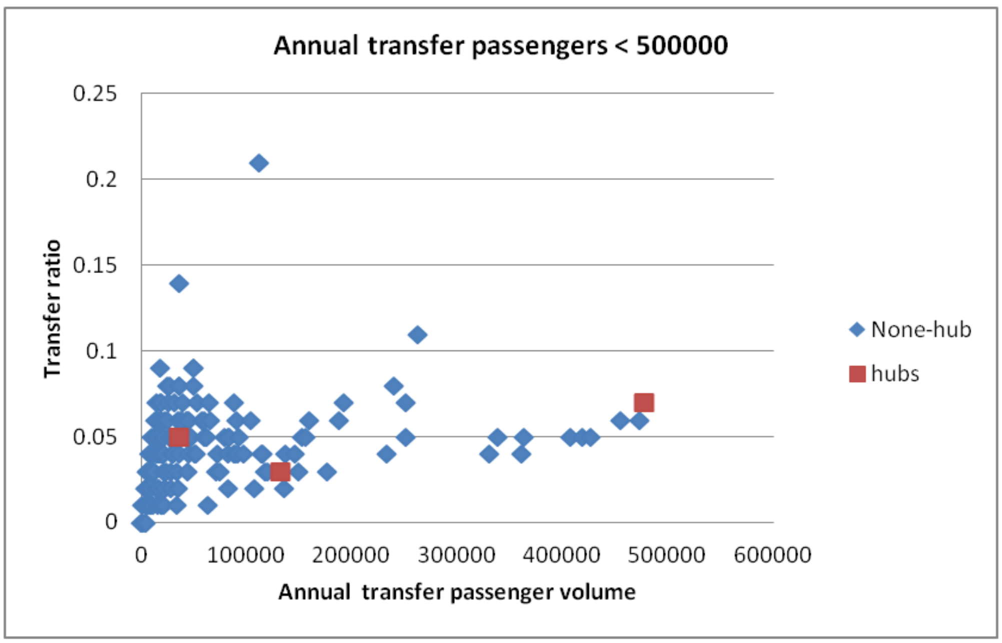


Figure 4-12: Correlation between annual transfer passenger volume and transfer ratio

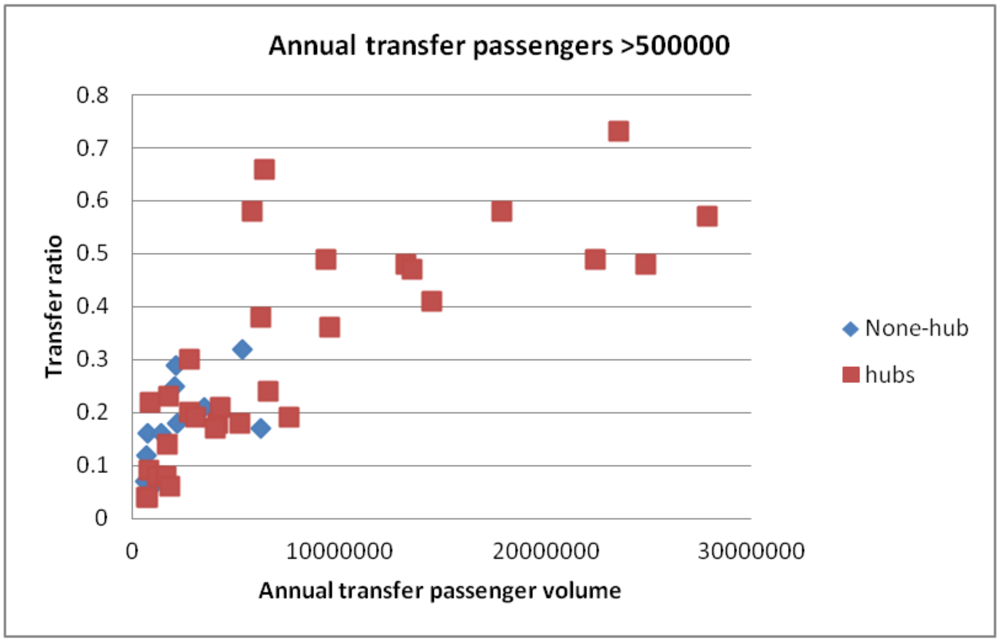


Figure 4-13: Correlation between annual transfer passenger volume and transfer ratio

Airports where the transfer volume (enplaning/deplaning) is less than 500000 annually does not show considerable correlation with the transfer ratio, whereas the other one shows considerable positive correlation. Furthermore there is a considerable difference in the distribution of airports serving as hubs in the two categories. The transfer ratio of most of the none-hub airports remain less than 0.1, whereas airports with hub operations show greater than 0.1 transfer ratio.

When an airline operates a hub at an airport, they run schedules targeting transfer passengers and select destinations from the hub specifically to provide connections for arriving passengers. Hence these airports have a higher transfer ratio. Airports where a higher volume of transfers takes place and hub operations are present need to provide specific infrastructure to facilitate the quick transfer of passengers and their baggage. Whereas in none-hub airports the requirement of infrastructure to facilitate transfers can be different even though considerable amount of transfers happen.

4.10 Identification of comparative groups

From the above analysis it can be seen that cluster 1 and 2 can be combined and identified together as small to medium airports with mostly domestic and origin-destination passengers. With respect to the ACI total passenger volume based classification, cluster#1 can be considered as very small airports and Cluster#2 is small airports.

Remaining airports can be categorized as medium to large airports. Due to the low membership in these categories they can be combined to form one group for service quality assessment. According to Figure 4-11 these airports have different characteristics in terms of passenger ratios. Cluster 4, 7 and 8 have transfer ratio values greater than 25%, thus they can be identified as transfer airports. With respect to ratio of international passengers, cluster#5 and 6 have significantly high values.

Table 4-3 shows the grouping of comparable airports and the IATA code of the member airports of each group. It is important to have sufficient number of members in each group for meaningful comparisons and establishment of range of service availability of attributes. Therefore members in Cluster #3 to 8 are regrouped according to their similarity in total passenger volume, the ratio of international passengers and the ratio of transfer passengers.

Table 4-3: Grouping of comparable airports based on passenger characteristics

Very-small/ Mainly domestic/ Mainly OD			Small/ Mainly domestic/ Mainly OD	Medium to large/ Mainly domestic/ Mainly OD	large/ Mainly domestic/ Transfer-OD	Large/ International-Domestic/ Mainly OD
151-members (Cluster#1)			33-members (Cluster#2)	12-members (Cluster#3+#8)	10-members (Cluster#4+#7)	5-members (Cluster#5+#6)
ISP	GRB	ACV	OMA	*MEM	SLC	MIA
HPN	BTR	HTS	PVD	*DAL	PHL	JFK
SYR	CRP	LRD	BUR	*CVG	DTW	EWR
CHS	FAR	BFL	ONT	TPA	MSP	SFO
LIT	HRL	IFP	BDL	SAN	PHX	LAX
LIH	TLH	LSE	BUF	FLL	DEN	
KOA	MFE	MLB	JAX	BWI	IAH	
DAY	ABE	ITH	ABQ	LGA	CLT	
ROC	VPS	EWN	PBI	BOS	DFW	
ALB	SBA	ACK	CMH	SEA	ORD	
BOI	PIE	ELM	SJU	MCO		
LGB	GPT	SBP	RSW	LAS		
TUL	AMA	ERI	DAL			
BHM	BIL	HDN	IND			
GEG	SGF	DLH	SAT			
ELP	ILM	OAJ	MKE			
MHT	FAI	GUM	PIT			
SDF	MAF	RST	MSY			
RIC	LEX	AEX	AUS			
OKC	MLI	AZO	SJC			
ORF	CID	SCE	HOU			
TUS	FNT	GNV	SNA			
RNO	PHF	BET	RDU			
ANC	ACY	LAN	BNA			
OGG	CAE	IDA	SMF			
RDM	XNA	LNK	OAK			
GJT	LBB	MBS	CLE			
FAY	FAT	CWA	MCI			
EYW	HSV	GTF	STL			
CRW	STT	DRO	PDX			
SHV	SFB	PFN	HNL			
PIA	MDT	EVV	MDW			
BMI	GSP	FCA	DCA			
PSC	JAN	MGM				
FWA	ITO	STX				
JNU	SRQ	TVC				
RAP	PSP	CHO				
ATW	PNS	EGE				
MSO	BTV	BIS				
MOB	MYR	BGR				
JAC	CAK	MRY				
MFR	ICT	AGS				
AZA	MSN	SWF				
AVL	SAV	DAB				
ROA	TYS	AVP				
CHA	DSM	GRK				
SBN	GSO	LFT				
BLI	PWM	ASE				
FSD	GRR	TRI				
EUG	COS	BQN				
BZN						

* These airports have transfer rations greater than 0.25.

4.11 Conclusion

Proper classification of airports is often over looked in many studies related to airport performance evaluations. Even though there are several classifications available at present, only a very few have been developed based on a proper analysis. However none of the classifications had attempted to define airports based on passenger characteristics. Airport industry and researchers have continued to use total passenger based classifications. Hence definitions regarding different airport groups are not specific. Barriers to access relevant data in the airport industry worldwide can be identified as a major reason for the lack of research in order to develop proper classifications or to update the existing methods. The analysis in this study has allowed us to apply cluster analysis and classify a sample of airports using annual volumes of different passenger types. A sample of airports in United States was used for the analysis. Analysis results were able to identify 5 different groups based on total passenger volume and passenger characteristics.

Subjective influence in the cluster analysis was minimized by testing several clustering techniques and selecting the best method based on results. Furthermore optimum number of clusters was selected based on an objective criteria using variance ratio criterion, thus ensuring minimum subjectivity in the process. Interpretation of the clusters showed significant similarity in terms of the mixture of passenger types within resulted clusters and considerable differences between them.

Possible limitations in the methodology presented above lies mainly in the acquisition of relevant data for the analysis. It was not possible to obtain data on international transfers in U.S. airports during the study. Therefore transfer ratio of the airports in the sample was judged based on the domestic transfer volumes. Hence, the ratio of domestic transfer passengers to total domestic passengers was assumed to approximate the total transfer ratio. This assumption may not deviate considerably from the true values in most small- and medium-sized airports, as they have very little international passengers.

Chapter Five: Survey Application

5.1 Introduction

The main objective of this chapter is to illustrate on the methodology used to design the survey and data collection. The objective of the survey is to determine the values of attribute relative importance. In the previous chapter under section 3.10 alternative survey techniques to achieve the above objective was discussed. It was decided in the research methodology to use the stated preference survey technique for data collection.

An introduction to stated preference techniques was given in Chapter 3. Therefore this chapter will describe the process used to design the questionnaire survey and elaborate on the survey application for data collection.

5.2 Design of survey questionnaire

Questionnaire survey is a key method of data collection in many fields. In the medical field questionnaires are the only way of gathering data from patients (Slattery et al., 2011). Questionnaire survey is a main technique used to gather user opinion for service quality evaluation. However, surveys and questionnaires are not synonymous (Slattery et al., 2011). A survey is a general methodology for gathering, describing, and explaining information from samples to construct a quantitative description of a population. Survey research is just 1 of the 3 techniques for the collection of primary data. Other techniques are direct measurement and observation. Questionnaire refer to a specific tool, also known as an instrument, for gathering information in a survey.

Surveys in general can be categorised into two types such as experimental and observational. Experimental surveys involve the investigator intervening and controlling or manipulating the factors of the stimulus or exposure and assignment of subjects. The stated preference survey conducted for data collection in this study is an experimental technique. The main advantage achieved with an experimental method is the ability to control the type of attributes and service levels considered for the survey. Observational surveys does not involve any intervention by the investigator and thus the allocation and assignment of factors is not under his or her control.

It is paramount that careful attention is given to the process of developing the survey questionnaire in order to collect accurate data that is consistent with the objectives of the study. The most important aspect of this stage is to make sure the survey design is consistent with the research problem definition and not vice versa (Hensher et al., 2005). It is important to mention some of the key considerations when designing a questionnaire in general.

5.2.1 Method of data collection

At the beginning of the survey design it is important to refine the research problem and be clear about the type of data to be collected. The objective of the research is to develop a methodology for defining overall service quality standards using objectively defined service level criteria. In the research methodology it was decided to use the value of attribute relative importance as the basis for assigning attributes service levels as minimum service quality criteria of overall service standards. Furthermore in the methodology chapter it was decided to use the linear additive relationship between the level of preference and the attribute service levels in order to determine the values of attribute relative importance. Therefore in order to establish this relationship, data on the variation of attribute service levels and the corresponding variation of the level of user preference for service quality need to be collected. Next it is important to determine the best method to collect the needed data. This is where a consideration between choosing experimental or observational methods become important. It was decided in this study to use an experimental technique such as stated preference technique in order to collect the required data. Unlike observational techniques it minimizes the confounding effects of factors not included in the study.

An important consideration at this stage is the selection of response data type. The questions being asked must correspond to the type of data necessary for the analysis to be conducted. The survey format used is graded pairs comparison. The methodology proposed involves using discrete choice analysis and ordinal logistic regression analysis. Therefore it was decided to use an ordinal rating scale that indicate the level of relative preference for the chosen alternative as the response variable corresponding to the experimentally varied service levels of the attributes.

5.2.2 Survey delivery method

An important consideration at this point is to determine the method of implementing the survey. In the context of a questionnaire survey this specifically relates to the method delivery to the respondent. Several methods are available as listed below:

- In person interviews
- Telephone surveys
- Mail-in questionnaires
- Online surveys

The advantage of in-person and telephone interviews is that it gives the respondent the opportunity to interact with the researcher. This is very important for the respondent to clearly understand the task at hand. Furthermore the researcher interaction can make sure higher quality of the collected data. The drawback of this technique is its inability to reach a large sample of respondents due to the limitation in time and monetary resources. Mail-in and online surveys on the other hand can reach a much larger portion of respondents at a low cost compared to the previous methods. However these survey methods do not allow any interaction with the researcher. This could lead to respondents not answering or providing incorrect response when the task becomes difficult or not clear. Researcher have to take extra care when wording and structuring the questionnaire in order to make the survey self-explanatory. Recent improvements in internet based survey applications have allowed online survey platforms to offer advanced questionnaire formats. They provide respondents more opportunity to interact with the survey. Furthermore same advancements have given researchers the opportunity to implement advance questionnaire operations such as response logic, question and answer randomization and stated preference formats. This has increased the popularity of online surveys in academic and industry fraternity as a viable survey delivery option.

In order to maximize the sample of respondents, a combination of in-person survey and online survey were used in this study for data collection.

5.2.3 Wording the questionnaire

Another important aspect of questionnaire design is the proper questionnaire writing. It is quite apparent that the respondent's proper understanding of the task mainly rely on how the task is presented. One must therefore consider very carefully how the questions are worded. Hensher et al. (2005) have suggested several important aspects of questionnaire writing that was considered in the designing of this research.

5.2.3.1 Appropriateness of the questions

This relates to whether the questions are necessary for the survey or not. Irrelevant questions adds nothing but questionnaire length. Therefore it is important that careful screening be performed to determine the appropriateness of the questions included. There can be situations where the particular question may not directly relate to the hypothesis the research is attempting to prove, but it may be necessary to have it to determine whether a representative sample was surveyed. In the case of this study the questionnaire was developed with the intension of obtaining the following information.

- Paired comparison exercise: This is the main component of the questionnaire. This question is intended to expose the subject to varying conditions of service availability and measure his or her reaction in terms of level of satisfaction.
- Trip frequency: Respondents are asked to indicate how often they travel by air. This information is important, as passenger preference to service availability of attributes can differ based on frequency of travel.
- Traveling Group: This question asks the respondent to indicate whether they generally travel alone or travel with a group (friends or family).
- Purpose of travel and airline ticket class: It is considered that purpose of travel (business or leisure) affects the perception of level of service. Airline ticket class of passengers is also obtained in order to determine different passenger groups in the survey. Generally

business class and first class travellers experience different facilities than other passengers hence their perception can be different on the same service quality factors.

- Gender, age and income class: The objective of obtaining this information serves two purposes. It has been shown in previous research that these factors affect preference for service quality, hence collecting this information will allow us to test significance of their effect on preference on service availability. Secondly this information is necessary to establish the demographic characteristics of the sample of respondents surveyed and determine whether a representative sample of the target population is covered in the survey.

5.2.3.2 Understandability of the questions

Understandability of the questions is very important for collecting quality data form any type of questionnaire survey. There can be several sources of confusion for a respondent when answering a questionnaire. Use of heavy or technical jargon is one common source of confusion. This is particularly important for a stated preference survey where the respondent must be able to understand the hypothetical scenario described in the question. Therefore special care was taken to make sure no technical terms were used to describe attribute service availability. For example, curb-front congestion was described using terms such as “Curb front crowded” and “Curb front not crowded”. Walking distances where indicated using walking time, as it was learnt that respondents have better judgement of distance using walking time than distance. In this survey most of the service attributes considered have categorical measurements of service availability. This posed an additional challenge in terms of wording the scenarios. Service availability of attributes such as washrooms, signage, information etc. need to be clearly described in order to minimize ambiguity among respondents.

In a stated preference survey clear discerptions comes at the cost of lengthy text which can increase respondent's information burden. Therefore extra effort and time was spent in refining the descriptions of attribute service availability. Questionnaire design was tested using students and staff of the department of Civil Engineering of University of Calgary. Furthermore it was submitted to the members of an Engineering professional body to attract reviews on the questionnaire design. The objective of the test survey was to determine the understandability of the questions, time taken to complete the questionnaire. Improvements that were made based on the reviews were: include icons to represent the narration of the attribute service level, differentiation of icon colour to highlight changes in attribute service levels and improve narrations of attribute service levels.

5.2.3.3 Biased or leading questions

These type of questions are biased towards answers already expected by the researcher. This could arise in stated preference survey where one choice or alternative is dominant in terms of all attributes used. In such situations the respondent does not have any opportunity to make trade-offs. The information generated by such questions is minimal. However by inserting a choice set where one set has dominant alternative among a block of choice sets presented to a respondent, the researcher can filter out potential invalid or illogical responses. This is done by eliminating those respondents who failed to give correct answers to the choice set with a dominated alternative. In choice sets with majority categorical or nominal variables this task is not as straight forward as with continuous attributes.

5.2.4 Overall length of the survey

Information burden to the respondent is a critical consideration that affects the quality of the data collected. Answering a questionnaire is something a respondent is voluntarily doing as a favour towards the researcher. Therefore the respondent does not expect to contribute too much time on the task. Thus it is the responsibility of the researcher to extract as much information as possible without making the respondent uncomfortable. There is no exact guide for determining an appropriate duration. Generally it is preferable to maintain a maximum time of 15 minutes to complete a questionnaire. However this can change depending on the location and the activities performed by the respondents when they are intercepted for a survey. In the case of an air traveller this can depend on factors such as departing, connecting, arriving, international or domestic, business or leisure. Departing and connecting international travellers generally have long waiting time at the lounges thus they would be willing to spend little bit more extra time on a survey questionnaire than arriving or domestic passengers. The trial survey helped to determine the average time taken to complete the survey and obtained comments regarding the length of the survey and corresponding information burden to respondents.

5.3 Stated preference experimental design

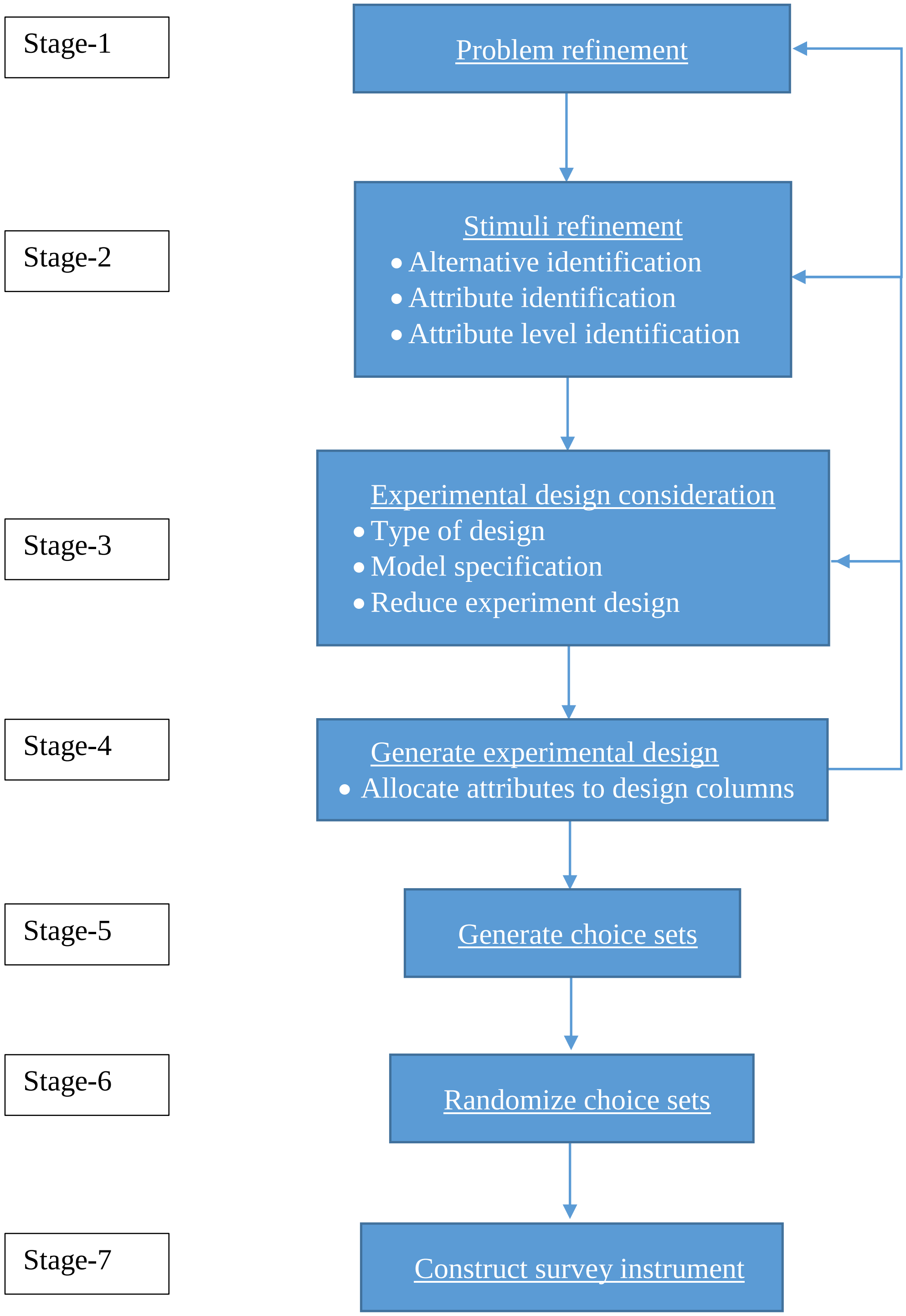
The above discussion gave an overview on the procedure followed in the overall questionnaire design. The specific nature of the stated preference surveys need further in depth examination in terms of designing of the graded pair questions. The foundation of a stated preference survey is the experiment design. An experiment defined in scientific terms involves the observation of the effect upon one variable, a response variable, given the manipulation of the levels of one or more other variables (Hensher et al., 2005). The manipulation of the levels of the variables does not occur in a haphazard manner. Rather a specialized form of statistics is used to determine what manipulations to make and when to make them. Thus the manipulations considered to occur by design. Hensher et al. (2005) provide a detail guide and a discussion on stated preference experimental design. The remainder of this section will discuss on the specific steps taken for the design of SP experiment used in this research.

Figure 5-1 summarizes the process used to generate stated preference experiments. As can be seen from the figure this is a sequential process. Where the first two stages of the process involves refining the understanding of the problem at hand by identifying the behavioural aspects of the problem such as alternatives and attributes levels. In the next two stages the statistical properties of the design is taken to consideration. If the design becomes statistically inefficient or too big to handle that will make the process return to initial stages and readjust the behavioural factors considered. Thus an iterative process is involved until a successful design that satisfies the experiment design criteria established at the beginning of the process is achieved. Remainder of the chapter will explain each of the above stages are implemented in the experiment design process of this research. Since the definition of the research problem was extensively discussed in the previous chapter, experiment design process will proceed from stage-2.

5.3.1 Stimuli refinement

5.3.1.1 Alternative identification

Since the objective of the stated preference survey is to determine the attribute importance against preference in a general airport environment, the alternatives are generic or in other words unlabelled. Thus the alternatives have the same attributes but differ in terms of attribute levels present. Since unlabelled alternatives are used it will be a choice set with two alternatives.



Source: Hensher et al. (2005)

Figure 5-1: Experiment design process

5.3.1.2 Attribute identification

Attributes were identified separately for departing and arriving flow paths separately. Table 3-4 and Table 3-5 under section 3.8 of the previous chapter shows the attributes selected for departing and arriving flow paths respectively. Section 3.8 of the Chapter 3 further illustrates on the selection of attributes.

As can be seen from those tables attributes are divided into groups representing different functional areas of the terminal. There are five categories for departing and four categories for the arriving flow path. An important practical limitation of stated preference applications is that as the number of attributes and attribute levels increases, the size and complexity of the experimental task increases exponentially (Hensher, 1990; Louviere, 1984; Molin & Timmermans, 2009). The implication of increased size of the experimental task is that the respondents have to evaluate more hypothetical profiles and more attributes per alternative with possible information overload (Louviere, 1984; Molin & Timmermans, 2009; Ramirez & Manuel, 2010). Hence the overall service environment within each flow path is broken into more manageable elements based on functional area in the terminal. According to the literature on stated preference exercises a maximum of five attributes having up to three levels is suggested as manageable by most respondents (Bateman, 2002; Chiang et al., 2003; Hensher, 1990). Therefore in each functional category the five most important service attributes are considered.

In this research, separate experiments are designed for each functional category and accordingly a respondent will be subjected to an experiment form every functional category. This approach assumes that when decision makers have to evaluate complex decision alternatives involving many influencing attributes, they first classify the attributes into a set of higher order constructs (Hierarchical constructs) as shown in Figure 5-2.

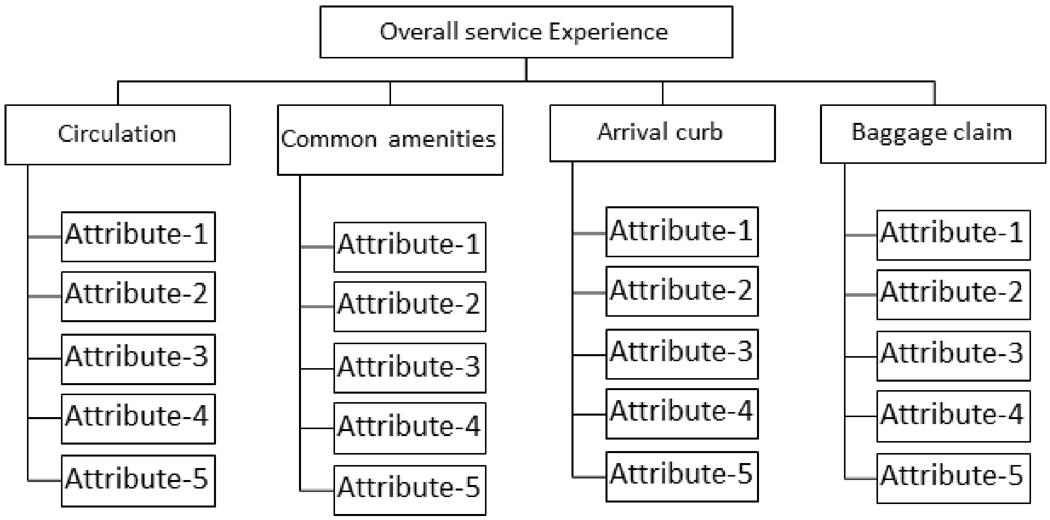


Figure 5-2: Hierarchical service quality construct for the arriving flow path

In a hierarchical construct the categories are made to be independent. In other words the tradeoffs made within a category is more significant than tradeoffs made across categories. The drawback of this assumption is that the attribute service availability is not directly correlated with the utility of the overall service environment, but with the overall utility of sub environments (functional category). The most important advantage of this approach is that it helps to reduce the complexity of the experiment design significantly. However, as passengers move through the airport in a sequence of service areas, they tend to evaluate each service area separately. Furthermore it is unlikely that passengers would process information on all the different service elements simultaneously to make a judgement of service quality due to inherent limitation in cognitive ability.

Based on the above reasons it was decided that series of separate experiments in each functional category can achieve the study objective without a significant loss of information. Previous studies also have used the existence of higher order constructs for evaluating airport terminal service quality using different methods such as AHP and factor analysis (Capter-2: Literature review). In stated preference methods this approach is only used with conjoint analysis (Chiang et al., 2003; Cornelia & Stephan, 2011; Hensher, 1990; Molin & Timmermans, 2009; Ramirez & Manuel, 2010).

When identifying attributes to be used in an experiment, it is important to consider the concept of inter-attribute correlation. Inter-attribute correlation refers to the cognitive perceptions decision makers attach to the attribute descriptions provided. An example is the price-quality relationship for goods. This suggests that decision makers act as if higher-priced alternatives display higher levels of quality. Inter-attribute correlation may result in cognitively unacceptable combinations of attributes within the design. In other words seemingly unrealistic scenarios. A possible result of such combinations is that respondents will stop taking the experiment seriously, thus biasing the results. Careful attention was given when selecting the attributes for each functional category to avoid inter-attribute correlation.

5.3.1.3 Attribute level identification

Previous section explained on the number of attributes considered and how they are arranged for the experiment. Having identified the attribute structure for the experiment, next it is important to decide on the attribute levels. Attribute levels give definition to the attributes used in the experiment.

The most important criteria in defining attribute levels is to minimize ambiguity. Most of the attributes being categorical and descriptive poses an extra challenge for this research in terms of minimising ambiguity. Appendix Table B 1 through to Appendix Table B 9 shows the attribute levels defined for the experiment design. In order to minimize ambiguity attribute levels has to be as specific as possible. Attributes such as waiting time can be directly expressed using objective measurement values. However quantitative measures such as distance is better understood in terms of walking time than distance, therefore walking time was used instead of walking distance. Ideally it is necessary to define service levels for all attribute using objectively defined criteria. However qualitative description of service levels had to be included for certain attributes due to limitations imposed by the stated preference survey design. Using narrations that are concise and clear is important for the respondent to clearly understand the hypothetical scenario. Therefore area or crowding related attributes such as curb space was expressed using verbal terms such as "sufficient space available" and "sufficient space not available". Crowding is considered to be better understood using verbal terms than exact density values. Furthermore the survey design used verbal terms such as "adequate", "in adequate", "clear", "not-clear" with attributes such as availability of washrooms, flight information display and signage in order to avoid lengthy narrations needed for defining service levels objectively. Including qualitative terms for service levels may introduce subjectivity when respondents interpret the hypothetical scenario. This drawback could have been avoided if pictures of service conditions was used instead of text to describe attribute service levels. Given the excessive number of attributes included in the survey, including pictures would make the overall survey design too complex.

Number of attributes levels to assign and the determination of attribute end points is an important and a challenging task in any stated preference survey. One approach to identify the attribute level extreme is to examine the experience related to that an attribute by the decision makers being studied. Information from literature review was used as a source of secondary data in order to determine attribute extreme levels. For attributes such as waiting time at check-in and baggage claim was obtained from level of service studies by Correia and Wirasinghe (2007) and

Correia and Wirasinghe (2010) respectively. There is no specific source of secondary information in order to determine the service availability range for most other attributes. Therefore airport passenger terminal design guides provided by TRB (2010) , Horonjeff et al. (2010) and Edwards (2005) was used to determine approximate range of service availability. This also highlights the need for a database of airport terminal design features for critical service attributes. Such a data base can provide critical insight for new facility design projects as well as aid in setting unified facility standards for a wider range of key service attributes. Number of levels to use when defining an attribute is also as important as determining the extreme points. Obviously the number of levels to include in the experiment will depend on two main factors. They are the range of attribute service availability and the overall experiment size. The minimum number of levels to have is two. A relatively wider range of service availability would allow more than two service levels to be included. It is import that levels are defined in a way that respondents distinguish between different levels. However too many levels per attributes will result in an unnecessarily large experiment design.

5.3.2 Experiment design consideration

This stage of the design determine the statistical characteristics of the experiment. There are two common classes of experiment design available.

1. Full factorial design
2. Fractional factorial design
    a. Main effects and selected interaction effects
    b. Main effects only design

A full factorial design is defined as a design in which all possible treatment combinations are enumerated. A treatment combination is a combinations of attributes, each with unique levels. Treatment combinations thus describe the profile of the alternatives within the choice set. The advantage of the full factorial design is that it allows the estimation of all main-effects and all interaction effects. However the drawback of this design is that it require the enumeration of a very large number of treatment combinations in the case of this research. Table 5-1 gives the number of treatment combinations required for a full factorial design. Implementation of such as design requires a larger sample of respondents. The experiment size can be reduces by considering a fractional factorial design.

Table 5-1: Number of treatment combinations for full factorial design

Functional area	**full factorial**	**Total**
Departure - Circulation	2x2x2x2x3	48
Departure - Curb	2x2x2x2x3	48
Departure - Lounge	3x3x2x2x2	72
Departure - Common amenities	2x2x4x4x3	192
Departure - Check-in	3x3x2x2x2	72
Total		**432**
Arriving - Circulation	2x2x2x2x3	48
Arriving - Curb	2x2x2x2x2	32
Arriving - Common amenities	2x2x4x4x3	192
Arriving - Baggage claim	3x3x3x2x2	108
Total		**380**

Fractional factorial design is a design that uses only a fraction of total number of treatment combinations required. The fraction to be used can be decided based on the number of main-effects and interaction parameters to be estimated using the design. The attention of this study is on main-effects only. This enables to use the minimum number of treatment combinations called a main effects only design. When using the main effects only design, an assumption is made that the interactions effects are in significant. According to Hensher (1994) majority of the variability in behavioural response is explained by main effects and a few two-way interactions.Louviere (1988) states that for cases involving real data main effects explain the largest amount of variance in response data, often 80% or more, two-way interactions account for the next largest proportion of variance, around 3%–6% and three-way interactions account for even smaller proportions. Furthermore none of the service quality evaluation studies using regression analysis have found significant interaction effects affecting the behavioural outcome. Hence in this research the complexity of the survey deign can be curtailed using a main effects only design without a significant loss of information.

5.3.2.1 Calculating the degrees of freedom required

The degrees of freedom for an experiment are the number of observations in a sample minus the number of independent (linear) constraints placed upon it during the modelling process (Hensher et al., 2005). The independent linear constraints are the parameters that estimate in the statistical model. In any statistical model there is certain minimum amount of information required to estimate the parameters needed. It is important to determine this value in order to determine the minimum number of treatment combinations needed for the design. Therefore to determine the minimum number of treatment combinations necessary for a fractional factorial, it is necessary to establish how many degrees of freedom are required for estimation purposes. The required degrees of freedom will depend on the number of parameters need to be estimated. Hence at this point it is important to specify the type of model intended to be estimated from data.

The generalized ordinal regression model and the discrete choice model is used in this research. They are given here as follows:

$$\log \frac{P(Y > j|x)}{P(Y \leq j|x)} = \beta_{0j} + \sum_{k=1}^{k} \beta_{kj} X_{k(A-B)} \qquad (j = 1, 2, \dots, j-1) \tag{33}$$

Where:

J is the j^{th} binary split (cumulative) in the ordinal scale,

$X_{k(A-B)}$ is the difference of the k^{th} attribute,

β_{kj} is the parameter for k^{th} attribute.

$$Prob_i = \frac{exp\left(\beta_{0i} + \sum_{k=1}^{k} \beta_{ki} X_{ki}\right)}{\sum_{j=1}^{j} exp\left(\beta_{0j} + \sum_{k=1}^{k} \beta_{kj} X_{kj}\right)} \tag{34}$$

Where:

X_{ki} is the attribute value for the k^{th} attribute in the i^{th} alternative,

β_{kj} is the parameter for k^{th} attribute in the i^{th} alternative.

Since the experiment is an unlabelled, coefficients in the choice model will not differ among alternatives. Therefore number of independent parameters to be estimated in both the choice and ordinal regression model is the same.

5.3.2.1.1 Attribute dummy coding

All the attributes used in the survey is considered categorical (for analysis purposes the continuous variables such as waiting time and distance are also considered as categorical), thus they need to be dummy coded in order to be entered in the regression model. Ultimately the dummy coding method will determine the total number of parameters need to be estimated. Table 5-2 shows an example of dummy coding of three variable with 1, 2, 3 and 4 levels of service availability.

Table 5-2: Categorical variable coding

Attribute name	Attribute level	Coefficient label and coding		
Signage for circulation		Sig1_2		
	1	1		
	2 (reference)	0		
Changing levels (floors)		chnglvl1_2	chnglvl1_3	
	1(reference)	0	0	
	2	1	0	
	3	0	1	
Washroom Availability		Wsh1_4	Wsh2_4	Wsh3_4
	1	1	0	0
	2	0	1	0
	3	0	0	1
	4(reference)	0	0	0

As can be seen from the example, for attributes with *m* number of service levels there are *m*-1 number of dummy coefficients need to be estimated. Coefficient label has two parts; first part in text refers to the attribute name (e.g. Chnglvl:- level changing) and the second part refers to the given attribute level and reference level (e.g. Chnglvl3_1:- coefficient of attribute level-3 with reference to level-1). Reference level considered for other attributes are indicated in Appendix Table B 1through to Appendix Table B 9.

The required number of minimum treatment combinations for an unlabelled experiment is given by the formula:

$$Number\ of\ minimum\ treatment\ combinations = 1 + \sum_{k=1}^{k}(L_k - 1) \qquad (35)$$

Where:

K is the number of attributes considered,

L_k is the number of levels in the k^{th} attribute.

Table 5-3 shows the minimum number of treatment combinations needed for separate experiments.

Table 5-3: Requirement of minimum treatment combinations

Functional area	**∑(L-1) +1**	**Total**
Departure - Circulation	(1+1+1+1+2)+1	7
Departure - Curb	(1+1+1+1+2)+1	7
Departure - Lounge	(2+2+1+1+1)+1	8
Departure - Common amenities	(1+1+3+3+2)+1	11
Departure - Check-in	(2+2+1+1+1)+1	8
Arriving - Circulation	(1+1+1+1+2)+1	7
Arriving - Curb	(1+1+1+1+1)+1	6
Arriving - Common amenities	(1+1+3+3+2)+1	11
Arriving - Baggage claim	(2+2+2+1+1)+1	9

5.3.3 Generation of the experimental design

Experiment design specifies for each treatment combination, the attribute levels to be shown in each attribute and in each alternative. In the previous section, the type of model and the required minimum number of treatment combinations were specified. The task is to select the right set of treatment combinations (fractional factorial) from the total set of treatment combinations (full factorial). In addition to satisfying the minimum number of treatment combinations the generated design must be orthogonal. Orthogonality of an experiment design refers to attribute levels being uncorrelated. Since generic parameters are considered, it is sufficient to have within-alternative orthogonality (Hensher et al., 2005). Hence the treatment combinations are generated for one alternative first and then same treatments can be randomly shuffled to create the second alternative. Initial set of orthogonal fractional factorial design is obtained using the OrthoganalDesign option in SPSS statistical software. Table 5-4 shows the set of orthogonal fractional factorial generated for the first alternative. Table 5-5 shows the second alternative generated by randomly assigning the treatments of the first alternative.

Table 5-4: Orthogonal fractional factorial design for the initial alternative

Treatment #	Restaurants	Information	Washrooms	Hydration stations	Internet
1	3	1	2	1	3
2	3	2	1	2	2
3	2	2	1	1	1
4	4	2	4	1	1
5	4	2	2	1	2
6	1	2	2	2	1
7	4	1	1	2	3
8	1	1	3	1	2
9	3	2	3	2	1
10	3	1	4	1	1
11	1	2	4	2	3
12	2	1	4	2	2
13	2	2	3	1	3
14	1	1	1	1	1
15	4	1	3	2	1
16	2	1	2	2	1

Table 5-5: Randomizing treatment combinations for choice set creation

Treatment #	Restaurants	Information	Washrooms	Hydration stations	Internet	Random assignment	Restaurants	Information	Washrooms	Hydration stations	Internet
	Alternative A						Alternative B				
1	3	1	2	1	3	**15**	4	1	3	2	1
2	3	2	1	2	2	**4**	4	2	4	1	1
3	2	2	1	1	1	**7**	4	1	1	2	3
4	4	2	4	1	1	**2**	3	2	1	2	2
5	4	2	2	1	2	**14**	1	1	1	1	1
6	1	2	2	2	1	**10**	3	1	4	1	1
7	4	1	1	2	3	**13**	2	2	3	1	3
8	1	1	3	1	2	**3**	2	2	1	1	1
9	3	2	3	2	1	**12**	2	1	4	2	2
10	3	1	4	1	1	**16**	2	1	2	2	1
11	1	2	4	2	3	**9**	3	2	3	2	1
12	2	1	4	2	2	**1**	3	1	2	1	3
13	2	2	3	1	3	**5**	4	2	2	1	2
14	1	1	1	1	1	**6**	1	2	2	2	1
15	4	1	3	2	1	**11**	1	2	4	2	3
16	2	1	2	2	1	**8**	1	1	3	1	2

In the random assignment, care was taken to avoid pairing same two treatments twice. Furthermore care was taken to avoid assigning randomized treatment combination next to its replicate treatment combination (pairing same treatment in both alternatives). Also the paring was done in a way that maximise the difference between treatment combinations. Table 5-5 shows the complete experiment design for the “arrival common amenities” functional category. The each row represents a treatment combination and columns represents the attribute service level. As can be seen from the tables the minimum number of treatment combinations generated by SPSS OrthogonalDesign is more than the required. In order to maintain orthogonality of the experiment design the procedure has to create additional treatments than the minimum required. Appendix

Table B 10 through to Appendix Table B 18 shows the complete experiment designs obtained for all the functional categories in departing and arriving flow paths.

As can be seen from the experiment designs the minimum number of treatment combinations obtained is eight. It was decided that a given respondent is randomly assigned to either arriving or departing flow path questions. If the respondent is assigned to the departing flow path questions he or she will be evaluating questions from five functional categories and otherwise in the arriving flow path he or she will be evaluating questions from four functional categories. Therefore it is impossible for any respondent to evaluate the complete fractional factorial design for every functional area. Therefore each respondent is allocated with a smaller subset of the complete design. Table 5-6 shows the schedule for the number of randomly assigned testaments from each experiment. As can be seen from Table 5-6, the number of treatment combinations evaluated by a respondent is reduced to 10 and 13 for arriving and departing flow paths respectively. The exact number of treatments to be allocated to a respondent is a trade-off between length questionnaire and the required minimum sample size. The minimum sample size will be achieved when the complete fractional factorial design is allocated to every respondent. However as it is practically impossible due to the excessive number of treatments to be evaluated by one person. Maximum required sample size would result, if only one treatment is allocated to a respondent. This approach will require a larger sample, thus implementing the survey will be difficult. Therefore the number of treatments allocated to a respondent (Table 5-6) was established with respect to an achievable sample size. An alternative to random allocation is blocking the design. Blocking the design would require an additional blocking variable to be included in the design. Inclusion of a blocking variable increased the number of treatment combinations in fractional factorial designs for all functional categories. This was unacceptable given the already larger experiment design, hence blocking approach was not used.

Table 5-6: Random allocation of treatments to decision makers

	Functional area	Number of Treatments generated by Orthoplan	Number of treatments randomly given to a respondent
Arriving	Curb	8	2
	Baggage claim	16	3
	Circulation	8	2
	Common amenities	16	3
	Total treatments	**48**	**10**
Departing	Curb	8	2
	Check-in	16	3
	Circulation	8	2
	Lounge	16	3
	Common amenities	16	3
	Total treatments	**64**	**13**

5.3.4 Generation of choice sets

According to Hensher et al. (2005) a choice set represents the mechanism of conveying information to the decision makers about the alternatives, attributes and attribute levels that defines the hypothetical scenario that was determined using the experiment design phase. Also it is the mechanism by which information is gathers on the choice they make.

In this stage the treatment combinations that was generated earlier is converted into a format that can be presented to a respondent in a way the respondent can easily apprehend the information presented and able to indicate the response in terms of choice and rating. Figure 5-3 shows a choice set created for circulation functional category.

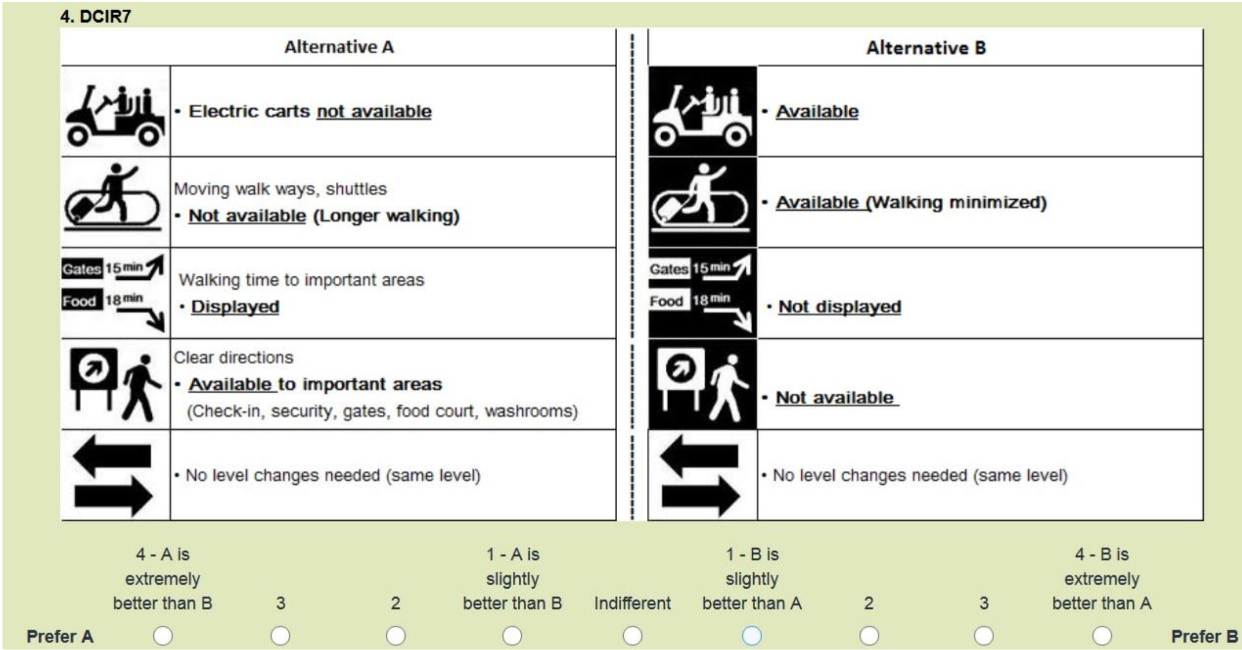


Figure 5-3: Choice set for Circulation

The response is obtained on an ordinal scale that goes from extremely prefer alternative A than alternative B to extremely prefer alternative B than Alternative A. This scale is capable of obtaining both alternative choice and strength of preference. There is no consensus on the appropriate number of rating points to be used in stated preference rating exercise (Juan De Dios & Garrido, 1994). However grated pair comparison studies have commonly used rating scales with nine and five categorical points. The decision of an appropriate number of rating points is a function of the cognitive burden to the respondent and the available amount of information to be extracted at analysis stage. A nine point categorical scale is used in this research as it allows a wider variation in preference rating. Also a nine point scale allows five points on either direction including the indifferent point. Most service quality rating studies and industry applications have used a five point rating scales in order to capture the measurement of user preference.

Appendix Figure B 3 through to Appendix Figure B 10 show sample choice sets from remaining functional categories in the survey. Icons have been used to represent attributes graphically. Using graphics help respondent to differentiate between attributes easily. Furthermore icon shading was changed to highlight the attributes that differ across alternatives. This makes it easy for them to focus on the attributes that affect the choice decision most.

5.3.5 Question randomization

Question randomization refers to randomizing the order of questions presented to respondents in order to avoid any biasness from question ordering. The order biasness can occur due to respondent learning, where the respondent may answer the latter questions differently than the earlier questions as respondent becomes more familiar with the task. Otherwise order biasness can occur due to respondent being tired towards the end of the questionnaire. In this research randomization is achieved in several ways.

- Randomization of attribute order in choice sets: This refers to the randomization of the order of the attributes present in a choice set. This avoids any biasness due to the order in which the attributes are arranged.
- Questionable randomization: This refers to the randomization of the order in which questions (choice sets) are presented to respondents within every functional category. Questions are allocated randomly according to the schedule shown in Table 5-6.
- Randomization of functional category: In the questionnaire every respondent is allocated to either departing or arriving flow path questions randomly. Each respondent will evaluate choice sets from every functional category defined for the particular flow path. The choice sets are grouped according to functional category. Thus there could be biasness due to the

order in which the functional categories are presented. Therefore in order to avoid this effect order of functional categories are also randomized.

5.3.6 Construction of survey instrument

The general considerations of questionnaire design was discussed at the beginning of this chapter. Construction of the survey instrument involves the development of the overall mechanism that is used to take the designed experiment and other supporting questions to the various respondents in the target population.

This survey used an online survey platform to construct the questionnaire survey. SurveyGizmo is a versatile online survey platform that allowed the range of randomization required by the experiment design. Choice sets were created separately as image files and inserted to the web page. Question randomization of the SurveyGizmo platform allowed the random allocation of either of two flow paths and random assignment of choice sets from each functional category. This online format was used for both online and airport passenger survey. A tablet computer was used to present the questionnaire to the respondents in the airport survey. The availability of touch screen technology in the tablet computer was convenient for the respondents to navigate and indicate their response easily.

Appendix Figure B 1 shows the consent page of the questionnaire survey. Appendix Figure B 2 shows the description of the hypothetical context in which the respondent will have to make his or her decision. The decision context used for this research is an airport passenger terminal the respondent would use for his or her future travel. The decision context used in the survey is as follows:

"*Imagine the situation of arriving from a flight* (*or departing*),

Imagine a situation where you are given a choice between two alternative airport terminals (alternative A and B) for an air travel in the future. Terminals are described by the level of comfort/convenience offered by a set of facilities. By assuming everything else regarding the travel is equal between the two alternatives, please consider the following pairs of alternative scenarios and indicate the most preferred alternative and the level of preference from the scale provided."

Independence of choice sets is also an important consideration in stated preference survey methods. This requires decision makers to treat the decision made in each choice set as an independent decision to the decisions made in all other choice sets. Thus the hypothetical scenario presented in each choice set is not to be compared to the hypothetical scenario presented in any other choice set observed. Since multiple choice sets are presented to the respondents, they were advised to refrain from comparing choice sets given. An advice is given in text after explain the hypothetical context, and also in it was verbally explained to the respondents in the airport survey.

The questionnaire concluded by obtaining socio demographic data from respondents. Appendix Figure B 11 shows the questionnaire section including the socio demographic questions.

5.4 Sample size consideration

Determining the minimum acceptable sample size is another important step in any type of survey. The objective of the survey is to determine the average opinion of ordinary air travellers in general. Therefore simple random sampling technique is used to select respondents. Sample size requirement is calculated using two techniques. A rule of thumb technique suggests at least 50 respondents each for every choice set in an unlabeled choice experiment (Hensher et al., 2005). Table 5-7 shows the sample size calculation according to the above method for each functional category experiment.

Table 5-7: Sample size according to rule of thumb approach

	Functional area	**Number of Treatments generated using orthoplan**	**Rule of thumb approach**	**Number of treatments given to a respondent**	**Number of respondents-Proportion based approach**
Arriving	Curb	8	400	2	200
	Baggage claim	16	800	3	270
	Circulation	8	400	2	200
	Common amenities	16	800	3	270
Departing	Curb	8	400	2	200
	Check-in	16	800	3	270
	Circulation	8	400	2	200
	Lounge	16	800	3	270
	Common amenities	16	800	3	270
	Total sample size				**540**

Required sample size is divided by the number of choice sets allocated to each individual to obtain the number of respondents needed. This method results in a maximum sample size of 540 respondents. A more theory based approach is to determine the acceptable sample size *n* based on the desired level of accuracy of the estimated proportions given by the following Equation 36:

$$n \geq \frac{q}{pa^2}\left[\emptyset^{-1}(1-\frac{\propto}{2})\right]^2 \quad (36)$$

Where, *n* is the sample size, *q* = (1-*p*) and *p* is defined as the true choice proportion of the population, *a* is the deviance between the estimated proportion and true proportion as a percentage, α is the confidence interval and $\Phi^{-1}(1-\alpha/2)$ is the inverse cumulative distribution function of a standard normal taken at 1-α/2. Since the true proportion of choice is unknown p is taken as 0.5. Equation 36 shows that the required sample size varies depending on the allowable error (a) and confidence interval selected. Table 5-8 shows the required sample size with varying error and confidence intervals. Table 5-9 shows the number of respondents needed assuming every respondent is allocated two choice sets. There will be some functional categories that allocate three per respondent and other that allocate two. Assuming two for all will ensure the maximum requirement.

Table 5-8: Sample size based on estimating proportions

		Confidence interval (1-α)			
Percent error (a)	Absolute deviance if P = 0.5	70%	80%	90%	95%
0.2	0.1	27	41	68	96
0.1	0.05	107	164	271	384
0.075	0.0375	191	292	481	683
0.05	0.025	430	657	1082	1537
0.01	0.005	10742	16424	27055	38415

Table 5-9: Number of respondents assuming two choices sets each

		Confidence interval (1-α)			
Percent error (a)	Absolute deviance if P = 0.5	70%	80%	90%	95%
0.2	0.1	13	21	34	48
0.1	0.05	54	82	135	192
0.075	0.0375	95	146	240	341
0.05	0.025	215	328	541	768
0.01	0.005	5371	8212	13528	19207

The rule of thumb approach suggests 270 respondents for each flow path. According to Table 5-9 this will ensure an error deviance of less than 10% with a 95% confidence interval or less than 7.5% of error deviance with a 90% confidence interval. This research will target 270 respondents per flow path (540 total) as minimum number of respondents. This value will ensure higher accuracy for functional categories with three choice set allocations per respondent. However as much as possible respondents will be surveyed within the resource constraints to ensure a higher accuracy of results than the minimum target.

5.5 Data sources

Data for the survey was collected from two sources. Personal interviews were done at the Calgary International Airport (YYC) passenger terminal from February 2014 to May 2014. Survey was posted online and was circulated among members of several professional bodies in Canada.

Calgary International Airport (IATA: YYC) is the international airport that serves Calgary, Alberta, Canada and the surrounding region. It is situated approximately 17 km northeast of downtown Calgary. The airport offers scheduled non-stop flights to major cities in Canada, the United States, Mexico, the Caribbean, Europe and East Asia. Calgary International Airport serves as headquarters for WestJet and as a hub airport for Air Canada and Air Canada Express. The airport is operated by The Calgary Airport Authority as part of Transport Canada's National Airports System. It is Canada's third busiest airport by passenger traffic and aircraft movements, handling 15,261,108 passengers in 2014. Calgary international airport has one terminal with three concourses (A, B and C). A new international terminal is under construction as part of airport capacity expansion objectives. The survey was conducted mostly at the departures level in common departure lounge, concourse A and concourse C. Entry to concourse B was restricted due to United Sates border protection regulations. Concourse A mainly handles Westjet flights and concourse C mainly handles domestic and international AirCanada flights. Figure 5-4 shows the departures level of the airport. Passengers were intercepted at waiting areas. Randomly chosen passengers are approached by the researcher and a brief introduction is given to the purpose of the survey and average time taken to complete. Once passengers give consent to participate, an explanation on the hypothetical decision context is given before they were exposed to the choice experiment.

In addition to the airport survey data was also collected through online dissemination of the questionnaire. The questionnaire was advertised online in electronic news letters published by the Association of Professional Engineers and Geoscientists of Alberta (APEGA) and the Engineers Canada. APEGA is the regulatory body for the practices of engineering and geoscience in Alberta. Engineers Canada is the national organization of the provincial and territorial associations that regulate the practice of engineering in Canada. Figure 5-5 shows the survey advertisement published in the APEGA electronic newsletter.

Source: http://www.yyc.com/portals/0/MapDisplay.aspx_files/map_level2.jpg

Figure 5-4: Calgary International Airport departures level map

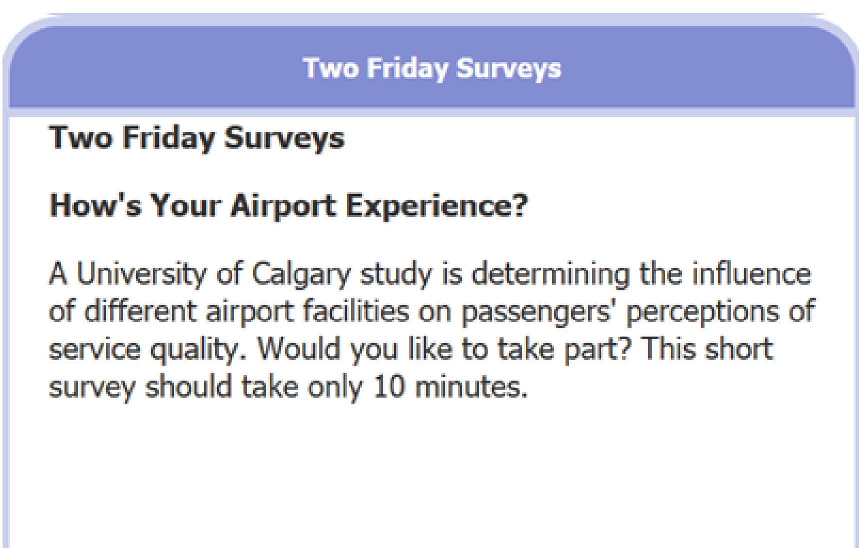


Figure 5-5: Survey advertisement published in the APEGA electronic newsletter published March 28th 2014.

5.6 Conclusion

A stated preference survey was developed to model user satisfaction rating with respect to the service availability of key service attributes. A graded pair comparison technique is used for the first time to derive a service quality model for airport passenger terminals. Extensive attention was given to the statistical properties of the stated preference experiment design in order to obtain unbiased data that is consistent with the intended analysis methodology.

Chapter Six: Survey Data Analysis and Results

6.1 Introduction

Methodology presented in Chapter 3 of this thesis was applied to analyse the data obtained from the stated preference survey. Objective of the analysis is to determine the value of relative importance of different service attributes considered for overall service quality evaluation. Furthermore data analysis was used to determine the effects of sociodemographic variables on the service quality preference of users.

Data was collected form a series of stated preference experiments. Hypothetical scenarios consisted of the service quality attributes of departing and arriving flow paths. Service quality attributes were categorised into functional categories and separate SP experiments were conducted for each functional category. Data analysis and interpretation of results for departing and arriving passenger flow paths will be presented separately.

All the statistical analysis is performed using IBM SPSS Statistics 22 and STATA 12.0 statistical software.

6.1.1 Summary of the methodology

The objective of the methodology is to identify and define minimum service quality criteria for a set of ordered overall service quality standards. Thus the methodology was developed to classify attributes and their service levels based on value of relative importance to preference for overall service quality. Relationship of attribute service levels with preference level is determined by estimating the marginal effect of attribute service levels on preference. Analysis will be performed to determine the overall relative magnitude of the marginal effects and the type of variation observed in marginal effect going from low to high preference.

The data is collected using a stated preference survey. Collected data consists of hypothetical choice scenarios with experimentally varied service levels of attributes. Responses were obtained in terms of choice and relative strength of preference indicated on a categorical scale corresponding to the variation in attribute service levels of the hypothetical service scenarios. Analysis was performed using generalized ordinal logistic regression model and a discrete choice model.

6.2 Overview of data

Data was collected from two sources. Passengers using the Calgary International Airport (YYC) was surveyed at the main terminal of the airport. Additionally survey was circulated among the members of two professional bodies such as the Association of Professional Engineers and Geoscientists of Alberta and the Engineers Canada using a web based questionnaire format. Identical questionnaires were used in the online and the airport survey. Each respondent is randomly assigned to either of departing or arriving flow path questions.

A total of 753 responses were obtained after leaving out invalid and partially completed responses. 386 respondents have taken the departing passenger flow path questions and 367 respondents have taken arriving flow path questions. Overall 42% of respondents are from airport survey and the remaining 58% are form the online survey.

Table 6-1: Summary of sociodemographic characteristics of the respondents

Characteristic	Category	Percentage of respondents		Z value
		Airport Survey (p_1)	Online Survey(p_2)	
Frequency of travel- previous year	1 to 5	44.79%	41.69%	0.61
	6 to 10	24.29%	23.23%	0.27
	11 to 20	21.77%	23.92%	-0.42
	More than 20	9.15%	11.16%	-0.64
Type of travelling group[1]	Travel alone	46.69%	38.04%	1.70
	Travel with group/family	53.31%	61.96%	-1.70
Type of travel[1]	Leisure travel	71.92%	69.93%	0.43
	Business travel	43.85%	51.71%	-1.53
	Other	7.57%	2.28%	2.48*
Ticket class[1]	Economy class	94.32%	92.03%	0.87
	Business class	13.88%	12.07%	0.52
Age group	18 to 25	6.62%	5.92%	0.28
	26 to 35	25.24%	23.01%	0.51
	36 to 45	24.61%	20.27%	1.01
	46 to 55	23.03%	21.41%	0.38
	56 to 65	17.35%	20.27%	-0.72
	66 or above	2.84%	8.20%	-2.20*
Gender	Female	43.53%	27.56%	3.27*
	Male	56.47%	72.21%	-3.22*
Income group	$20,000 or less	2.52%	1.82%	0.47
	$20,000 - $50,000	13.88%	3.19%	3.90*
	$50,000 - $100,000	28.71%	21.87%	1.54
	$100,000 - 150,000	23.66%	24.83%	-0.26
	$150,000 - $200,000	14.83%	12.30%	0.72
	$200,000 or above	6.31%	12.98%	-2.14*

* Significant at p = 0.05 level

[1] Respondents were able to select more than one category, therefore summation of percentages can be more than 100%

Table 6-1 shows the comparison of sociodemographic features of the data obtained from the airport survey and the online survey. Table 6-1 shows the proportions of respondents belonging to each characteristic total sample of 756 respondents. The equality of the proportions were tested using the test statistic given by:

$$Z = \frac{(\widehat{P_1} - \widehat{P_2})}{\sqrt{\widehat{p}}\,\hat{q}(1/n_1 + 1/n_2)} \tag{37}$$

$$\hat{P} = \frac{x_1 + x_2}{n_1 + n_2} \tag{38}$$

Where:

$\widehat{\boldsymbol{P_1}}$ and $\hat{\boldsymbol{P}}_{\boldsymbol{2}}$ are the estimates of proportion parameters in each sample, $\hat{\boldsymbol{P}}$ is the pooled proportion estimate, n_1 and n_2 are the size of each sample, x_1 and x_2 are the number of successes in each sample.

Last column of the tables shows the value of the test statistic for each characteristic. According to the results most of the characteristics does not show a significant difference in proportions between the two data sources. However there is a significant difference in gender and income level. Figure 6-1 shows the comparison of the distribution of respondent age from the two sources and the same distribution for the city of Calgary general population. The distribution of age does not show a significant difference for the data obtained from at the airport and online. However it can be seen that the distribution of respondent's age is significantly different compared to the distribution of age of Calgary general population. The largest difference occur at the extreme end of the distribution. This can be due to two reasons.

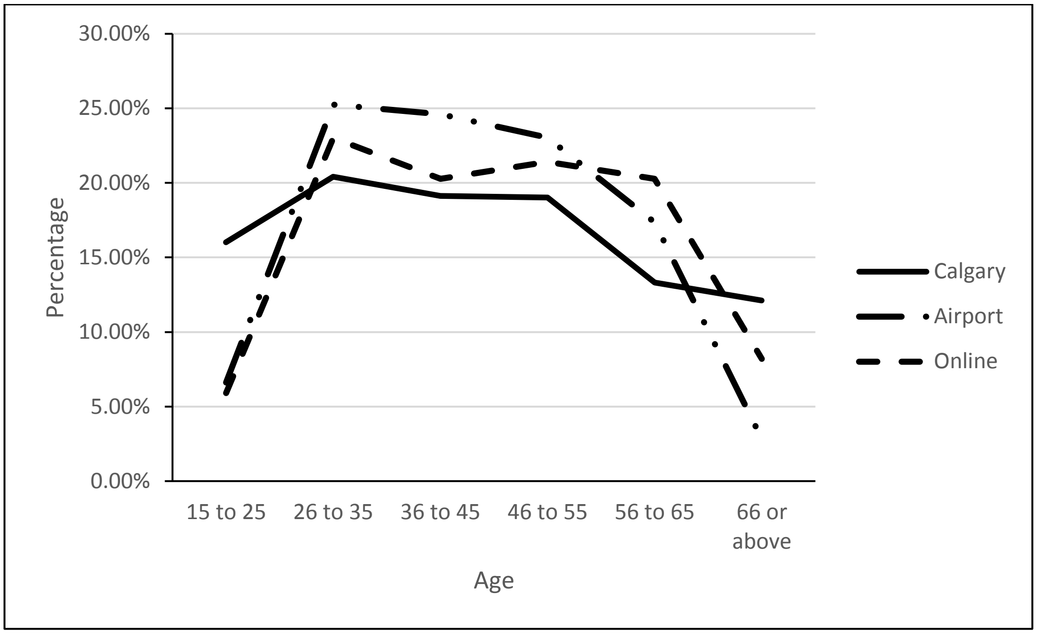


Figure 6-1: Comparison of the distribution of respondent age

The survey did not include respondents less than 15 years of age due to possible inconsistency of their responses from not understanding the task properly. The other reason is that there is relatively few individuals traveling over the age of 66 years. Furthermore it was observed in the airport survey that senior passengers are reluctant to participate in the survey. However the needs of these passengers are important to the aviation industry in general. Therefore future research need to use alternative survey techniques for determining their preference for service quality.

Figure 6-2 shows the comparison of the income distribution of the survey respondents and census data for general population in the city of Calgary.

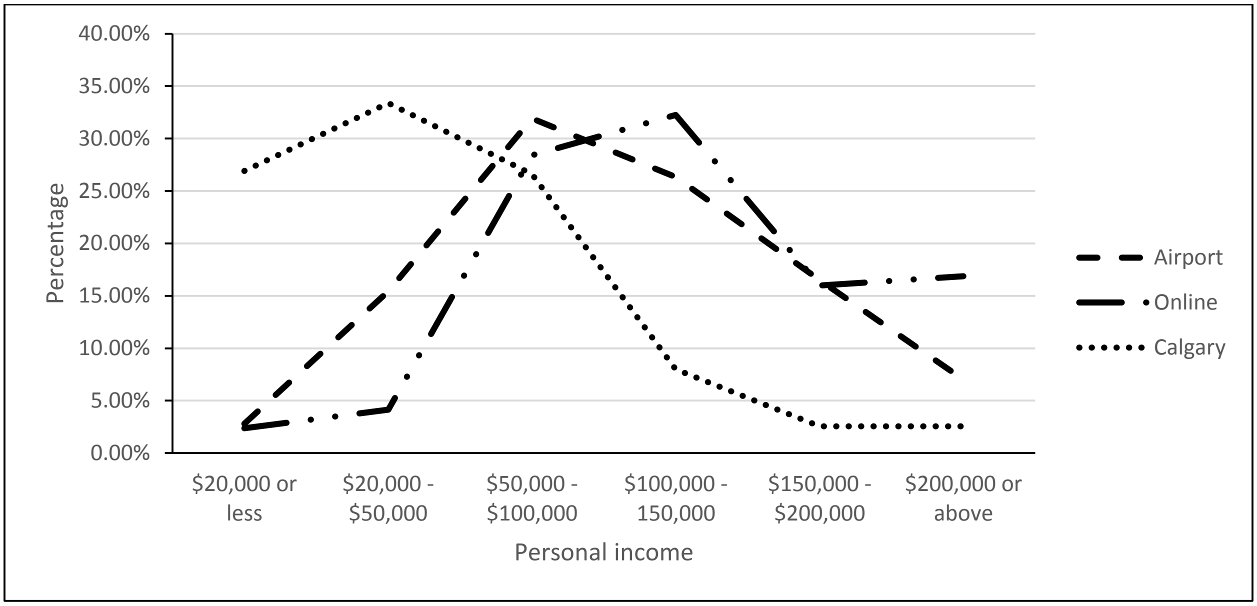


Figure 6-2: Comparison of respondent income distribution

As expected the average air traveller represents a relatively higher income category. The distribution of income for online respondents is slightly shifted to the left. This can caused by the biasness of the online survey that was mainly distributed among engineering professionals. It can be expected that the average income level of engineering professionals is slightly higher than the average income of the air travellers recruited at the airport. A possible reason for relatively low percentage of respondents in the income category of $200,000 or higher is that these passengers are more likely to remain in special airline lounges. The airport survey did not have access to the passengers at airline lounges.

Figure 6-3 shows the comparison of respondent's gender in the two sources of data. Online survey shows a significantly higher participation of male respondents compared to female respondents. Since most of the socio demographic characteristics does not show significant difference between the two data sources, data will be combined for the logistic regression analysis.

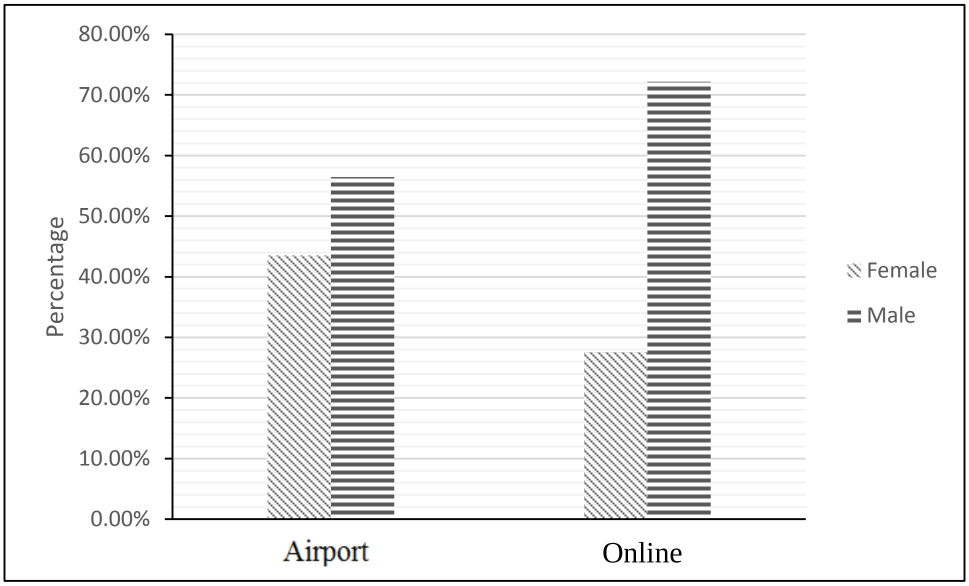


Figure 6-3: Comparison of respondent gender

It is important to investigate the association between the sociodemographic characteristic (SDC). Important pairs of SDC variables were tested for independency. Summary of the independence test is shown in Table 6-2. Detail contingency tables are shown in Appendix Table C 1 through to Appendix Table C 8. Since all the SDC data is in categorical form, association was tested using Pearson's chi-square test of independence. According to the Chi-square statistic all the comparisons show a significant association. The Cramér's V (0 to 1) statistic show that the strength of the association is at most weak to moderate. Most of the associations found in data based on SDC are acceptable and can be expected. However there was no association between gender Vs travel group and income Vs travel group.

Table 6-2: Summary of test of independence

Comparison	Pearson chi2	Cramér's V	Description
Travel group Vs Trip Frequency	45.3 Pr=0.000	0.25	Significant association is present. Weak association. Frequently traveling passengers are more likely to travel alone.
Travel Purpose Vs Trip Frequency	140.54 Pr=0.000	0.43	Significant association is present. Weak to moderate association. Frequently traveling passengers are more likely to travel for business.
Ticket class Vs Trip Frequency	30.09 Pr=0.000	0.2	Significant association. Weak association.
Gender Vs Trip Frequency	33.11 Pr=0.000	0.21	Significant association is present. Weak association. Frequently traveling passengers are more likely to be males
Age Vs Trip Frequency	34.02 Pr=0.003	0.12	Significant association. Weak association. Frequency of travel tend to decrease for 15-25 group and over-66 groups. Most frequent traveller are between 46-65 age group
Income Vs Trip Frequency	134.81 Pr=0.000	0.27	Significant association. Weak association. Air traveller in higher income categories are more frequently traveling
Gender Vs Travel group	1.56 Pr=0.211	0.045	No significant association. Gender and travel group can be considered independent
Income Vs travel group	8.2021 Pr=0.145	0.114	No significant association. Gender and travel group can be considered independent

6.3 Analysis of stated preference data

Data is analysed using the generalized ordinal logistic regression model and the discrete choice model. Analysis results will be presented separately for each functional area of the two flow paths. Techniques used for the analysis of choice and preference rating are logistic regression models. Therefore the following assumptions apply for these regression models.

1. The true conditional probabilities are a logistic function of the independent variables.

   The ordinal regression models were estimated using both Logistic link functional and the Probit link function. There was no significant difference in the Log likelihood values of regression models estimated using the two link functions. It was decided to use the logistic link function for analysis.

2. All the relevant independent variables for determining the preference for service quality are included in the model

   Chapter 3 section 3.8 gives a detail description of the methodology used to identify the key service attributes for determining level of preference for overall service quality. Therefore within the limitations of the survey design and application the most relevant variables are included in the analysis. Furthermore it was assumed that only main-effects are relevant for the determination of the level of preference due to limitations of the survey design. Louviere (1988) stated that for cases involving real data, main effects explain the largest amount of variance.

3. The independent variables used in the model are not correlated

According to the methodology the treatment combinations for every experiment was carefully selected using a statistical technique (orthoplan) in order to exclude correlation in the experiment design. However correlation can still appear in the collected data due to possibility of incomplete treatment blocks. Pairwise correlation was estimated using Kendall's tau-b correlation coefficient in order to test the presence of correlation among the independent variables in all regression models estimated.

6.3.1 Analysis of data for departing passenger flow path

Five functional areas were identified for the departing passenger flow path. A separate experiment was conducted for each functional area. The results for each functional area are presented below.

6.3.1.1 Departure lounge

I6 treatment combinations were created for the stated preference experiment design. Table 6-3 shows the summary of responses obtained for the lounge area questions. The response category shows the frequency of preference ratings obtained for either alternative A or B. Respondents were asked to choose the most preferred service quality scenario among alternative A and alternative B. They were also requested to indicate the level of preference for the chosen alternative on the categorical scale given. Response categories for alternative A is defined as follows: 0-indifferent, A1- slightly prefer alternative A over B, A2, A3 and A4-extremely prefer alternative A over B. Definition of response categories for alternative B is identical to the categories of alternative A. Distribution of responses are shown for each choice combination (treatment) used for the survey. In Table 6-3 the treatments are denoted using a code unique to each functional area. Appendix

Table C-10 gives details on each treatment combination. Distribution of responses among the ratings for the overall experiment deign does not show a significant biasness. However indifferent rating has a significantly low frequency of responses.

Table 6-3: Summary of responses -Departure lounge area

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DLNG1	1		2			4	8	31	33	79
DLNG2	7	17	13	9	1	3	11	5	3	69
DLNG3	11	17	11	9	4	3	6	14	4	79
DLNG4	12	19	17	9		9	5	1	1	73
DLNG5	1	6	6	5		7	10	20	8	63
DLNG6			2	1		1	1	10	56	71
DLNG7	2	2	11	16	2	16	15	9	6	79
DLNG8	45	13	3	2						63
DLNG9	13	18	14	7	2	5	7	5	2	73
DLNG10	2	9	13	6	1	6	16	13	3	69
DLNG11	6	9	6	6	1	11	13	18	7	77
DLNG12	1	11	8	7	2	10	17	18	4	78
DLNG13	1	1	4	6	2	7	15	32	7	75
DLNG14	27	31	12	5	1	1	3	1		81
DLNG15	2	7	11	25	2	12	8	8	4	79
DLNG16	32	24	8	5			1	3		73
Total	163	184	141	118	18	95	136	188	138	1181
Percentage	14%	16%	12%	10%	2%	8%	12%	16%	12%	

6.3.1.1.1 Analysis of choice response

Choice response is analysed using the discrete choice model given by Equation 23 of section 3.12.3 in chapter 3. Appendix Table D 1 shows the bivariate correlation analysis results between the independent variables for the departure lounge area experiment. According to the table there is no significant correlation present between different attributes. However there is significant correlation between dummy variable of the same attribute (for attributes with more than one dummy coded variables). This effect is a consequence of using dummy coded variables and it cannot be avoided (Hensher et al., 2005). Indifferent responses are excluded from the choice analysis.

The dependent variable for the choice analysis is the choice between alternative A and alternative B. According to Table 6-3 52% of the respondents have chosen alternative A and 46% have chosen alternative B. Table 6-4 shows the discrete choice model estimated for departure lounge area service quality.

Table 6-4: Discrete choice model for departure lounge area service quality

		Number of obs	2326
		LR chi2(7)	498.52
		Prob > chi2	0.00
Log likelihood = -556.86778		Pseudo R2	0.3092
Attribute label	Coefficient	z	P>|z|
seat1_2[2]	0.56	4.3	0.00
seat3_2	-1.309	-7.46	0.00
retail shops1_2	0.54	5.09	0.00
restaurants1_2	1.206	10.64	0.00
charging stations1_2	0.532	4.58	0.00
intent1_3	1.83	13.59	0.00
intent2_3	0.045	0.31	0.759

The pseudo r^2 indicating the model goodness of fit is 0.31. According to Hensher et al. (2005) pseudo r^2 value between 0.3 and 0.4 represents a good model fit. This can be translated as an r^2 of between 0.6 and 0.8 for the linear model equivalent (Hensher et al., 2005). Furthermore

[2] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

the percentage of correctly predicted responses using the estimated model was 75%. Therefore the model fit is considered to be good. All the service attributes considered for departure lounge service quality was found to be significant at 5% level of significance. However the dummy coefficient for paid internet access was insignificant. The sign of the coefficient in all the independent variables are correct. According to the estimated model, availability of free internet is the most important service quality attribute. However importance for paid internet availability was found to be insignificant. This indicates that passengers highly value the availability of free internet services at the waiting area. Availability of adequate basic seating and availability of restaurants are the second and third most important service quality attributes respectively. Attributes such as variety of seating options, mobile device charging stations and variety of shops are relatively less important than the essential attributes such as restaurants, basic seating and internet. This can be expected as departing passengers schedule their arrival at the airport in order to spend minimum time waiting in lounge areas. Hence the utility placed on non-essential attributes can be relatively less. Therefore airport operators should give propriety for providing good service quality on essential service needs to address the needs of departing passengers in waiting areas.

It is important determine the effects of various sociodemographic characteristics on the preference for overall service quality. Sociodemographic variables that were considered for the analysis are respondent gender, travel frequency (average number of trips per year), travel purpose (business vs leisure), age group. As explained in the methodology chapter, it is not possible to include SDC variables in the choice model for unlabelled experiments unless they are interacted with explanatory variables. Interacting SDC variables with explanatory variables is likely to increase the size of the experiment design. However it is possible to determine whether a certain SDC variable has significantly affected the coefficients of explanatory variables by estimating multiple models and comparing the coefficients. First the data is blocked based on the values of the SDC variable. A separate model is estimated for each block of data. Coefficients of multiple models can be compared in order to determine whether the difference is statistically significant. According to Paternoster et al. (1998) the test statistic to compare the coefficients is given by:

$$Z = \frac{(\beta_1 - \beta_2)}{\sqrt{(se\beta_1{}^2 + se\beta_2{}^2)}} \tag{39}$$

Where, β_1 and β_2 are the coefficients of a given variable in the data group-1 and data the group-2 respectively, $se\beta_1$ and $se\beta_2$ are the standard error of β_1 and β_2 respectively. A one tailed test is performed, and the significance is determined at 5% level. Therefore if Z >1.645, the null hypothesis of $\beta_1 = \beta_2$ is rejected to accept $\beta_1 > \beta_2$. Otherwise if Z< -1.645, the null hypothesis of $\beta_1 = \beta_2$ is rejected to accept $\beta_2 > \beta_1$.

Using the above method coefficients of service attribute will be compared to determine the effects caused by variables such as gender, trip frequency, age, income and trip purpose. Following categories were used to block the data based on each SDC variable. Trip frequency: Low (0-5 per year), medium (6-10 per year) and high (greater than 11 tripper year), age group: young (15-35), middle age (36-55) and senior (56 and above), income class: (less than 100,000), (100,000 to 150,000) and (150,000 and above), gender: male and female, trip purpose: business and leisure. Furthermore the same methodology was used to test the influence caused by data collection methodology (online vs airport). Same regrouping of the above variables will be used for analysing all the functional areas considered for the study.

6.3.1.1.1.1 Effect of data collection method (online vs airport)

Appendix Table E 1 shows the choice models estimated using data blocked based on data collection method. According to the comparison, coefficient for availability of retail shops is significantly more important for the airport respondents than the online respondents. Furthermore the coefficient for availability of restaurants is significantly more important for the online respondents than the airport respondents. Rest of the attributes does not show a significant difference between the two data sources. It appears that online respondents gave significantly higher weight for availability of restaurants than retail shopping. However the respondents in the airport gave similar weights to both retail shopping and restaurants. This can be caused by the immediate real experience of the airport respondents at the time of evaluating the stated preference survey.

6.3.1.1.1.2 Effects of gender

Appendix Table E 2 shows the choice models estimated using data blocked based on gender. According to the table, Male respondents have a significantly higher utility for availability of seating variety and availability of mobile charging stations. However same utilities for female respondents is insignificant for the preference of service quality. However both genders have placed the highest relative importance on the availability of internet. Furthermore both genders have placed a relatively high importance on the availability of adequate seating.

6.3.1.1.1.3 Effects of trip frequency

Appendix Table E 3 shows the choice models estimated using data blocked based on trip frequency. According to the comparison of coefficients, it can be seen that respondents with high trip frequencies have associated a significantly higher importance on restaurants and availability of mobile charging stations in lounge areas. This can be expected as frequent travellers are more often business travellers who work and communicate while traveling. Thus facilities for using mobile devises are more important for them compare to non-frequent travellers who are more often leisure travellers. Frequent travellers may find it convenient to have restaurants inside the airport for having a quick meal while traveling.

6.3.1.1.1.4 Effect of age

Appendix Table E 4 shows the choice models estimated using data blocked based on age. According to the table utility of basic seating increases with age group. This can be expected as older passenger expect to be seated comfortably while waiting than the younger travellers. Remaining attribute coefficients does not show a statistically significant difference in the comparison.

6.3.1.1.1.5 Effects of income level

Appendix Table E 5 shows the choice models estimated using data blocked based on income. According to the comparison shown in the table, utility of seating variety has increased significantly with income class. This indicate that higher income passengers prefer more comfortable options in terms of service quality. Furthermore the utility of restaurants and charging stations also have increased with income class. Higher income travellers are often business travellers that require the use of mobile devices for working during the waiting time in the terminal.

6.3.1.1.1.6 Effects of trip purpose

Appendix Table E 23 shows the comparison of coefficients based on the differences in trip purpose. According to the comparison business travellers have placed a significantly higher utility on the availability of mobile device charging stations. This finding is consistent with the effect on mobile device charging caused by trip frequency and income class. More frequent travellers are more likely to be business travellers and also they are more likely to be in the higher income category. Furthermore business travellers have indicated a significantly higher utility for the availability of adequate seating in the lounge area compared to leisure travellers.

Table 6-5 shows the summarised results of the above analysis. For the rest of the functional areas only table of summary results will be included in the text and the detail discussion will be included in Appendix F.

Table 6-5: Summary of effects from socio demographic variables-departure lounge

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of Seating variety	No difference	**Male-Higher**	No difference	No difference	**Increasing**	No difference
Utility of Adequate seating	No difference	No difference	No difference	**Increasing**	No difference	**Business-Higher**
Utility of Shopping options	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Restaurants	**Online-Higher**	No difference	**Increasing**	No difference	**Increasing**	No difference
Utility of Mobile device stations	No difference	**Male-Higher**	**Increasing**	No difference	**Increasing**	**Business-Higher**
Utility of Internet free	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Internet paid	No difference	No difference	No difference	No difference	No difference	No difference

6.3.1.1.2 Analysis of ordinal rating scale

Data obtained from the ordinal rating scale is analysed using the generalised ordinal regression model. The level of preference is analysed as an indication of the amount of utility diffidence between the two alternatives. More details on the analysis technique is given under section 3.12 in Chapter 3.

Data is rearranged for the analysis by taking the chosen alternative to left hand side, making:

$dU_i = U_{left} - U_{right} \geq 0.$

Rating categories are redefined as “0 = Indifferent”, “1 = slightly prefer” and “4 = extremely prefer”. In this analysis the explanatory variables are coded as the service level difference between the alternative on the left and the alternative on the right. In the case of quantitative variables the difference between numerical values can be used directly. Whereas the difference between categorical variables need to be directionally dummy coded. All the variables used in the survey are considered categorical. An example for the dummy coding technique used for representing the service level difference of a categorical variable is given in Table 6-6. For the two-level variable “signage” level-1(left) Vs level-2(right) is dummy coded as 1, level-2(Left) Vs level-1(right) is dummy coded as -1 and indifference is coded 0. Thus the coefficient Sig1_2 is interpreted as the effect of the utility difference of signage level-1 and level-2 on the level of preference compared to signage being indifferent between the alternatives.

Table 6-6: Dummy coding of variables for paired comparison

Comparison	Coefficient label	Dummy code
level-1(left) Vs level-2(right)	Sig1_2	1
level-1(Right) Vs level-2(Left)	Sig1_2	-1
Indifference	Sig1_2	0

Appendix Table D 2 shows the bivariate correlation analysis for the data used in the ordinal logistic regression analysis. The data does not show the presence of strong correlation among any of the variables used. However similar to the choice data there is significant and moderate correlation between dummy coded variables of the same attribute. This is considered unavoidable when using dummy coded variables. The dependent variable in the ordinal logistic regression analysis is the categorical rating obtained for the chosen alternative. Distribution of responses for each rating is as follows: 0:-2%, 1:-18%, 2:-24%, 3:-32% and 4:-26%. Further descriptive statistics on the dependent variable can be obtained from Table 6-3. Indifferent rating is excluded due to significantly small number of responses.

Table 6-7 shows the obtained generalized ordinal regression model for the level of preference for service quality at departure lounge area. As explained in the methodology this model splits the ordinal response scale into *k-1* cumulative binary splits, where *k* is the number of categories in the scale for level of preference. The change in odds of being ranked above or below each split is then modelled using *k-1* binary logit models. According to the results of the analysis the obtained regression model is significant. However the model pseudo r^2 value indicates the goodness of fit of the model is low. The percentage of correct predictions of the observed data is 43%.

Table 6-7: Generalised ordinal logistic model for departure lounge area

	Number of obs		1163
	LR chi2(21)		345.46
	Prob > chi2		0.00
Log likelihood = -1417.1286	Pseudo R2		0.109
Attribute label	Coefficient	z	P>|z|
Log Odds : Rating>1/Rating=1			
seat1_2[3]	0.125	0.88	0.381
seat3_2	-0.569	-3.1	0.002
retail shops1_2	0.49	4.29	0.000
restaurants1_2	0.665	6.18	0.000
charging stations1_2	0.242	2.05	0.041
intent1_3	0.861	6.33	0.000
intent2_3	-0.13	-0.86	0.390
_cons	1.136	13.38	0.000
Log Odds : Rating>2/Rating≤2			
seat1_2	0.259	2.29	0.022
seat3_2	-0.729	-4.93	0.000
retail shops1_2	0.553	6.01	0.000
restaurants1_2	0.843	9.88	0.000
charging stations1_2	0.441	4.53	0.000
intent1_3	1	8.94	0.000
intent2_3	-0.2	-1.54	0.123
_cons	-0.272	-3.55	0.000
Log Odds : Rating>3/Rating≤3			
seat1_2	0.287	2.13	0.033
seat3_2	-0.62	-3.49	0.000
retail shops1_2	0.683	6.13	0.000
restaurants1_2	1.026	10.9	0.000
charging stations1_2	0.48	4.45	0.000
intent1_3	1.037	7.16	0.000
intent2_3	0.082	0.49	0.625
_cons	-2.028	-17.15	0.000

[3] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

However this level of model fit is in the same range with results obtained in previous research in the field of medicine using similar data and a similar analysis technique (Johnson et al., 2000; Lauridsen et al., 2005). Therefore the goodness of fit of this model is considered adequate for interpreting the results for this study. All the service attributes considered for level of preference for analysis were found to be significant at 5% level of significance in at least one of the cumulative splits of the ordinal regression model. However the dummy coefficient for paid internet access was insignificant at all the cumulative splits of the scale. All the independent variables that are significant have obtained coefficients with correct signs.

In order to establish the variation of attribute relative importance with respect to the level of preference, the attention is given to the comparison of attribute coefficients between different models representing the ordered cumulative splits of the rating scale. In the generalized model, the effect size (coefficient) for each explanatory variable is allowed to vary between models of each cumulative split. The *Brant* statistical test can be used to determine whether the variation is statistically significant. The Brant test was performed using the "brant" command of the SPost routines in Stata 12.0 (Long & Freese, 2014). Brant test performs separate binary logistic regressions at each split and compares the coefficients and provides both a global test, as well as tests each variable separately (Brant, 1990). Appendix Table F 1 shows the results of the *brant test*. The null hypothesis of the test is to assume that the coefficients of the explanatory variables does not vary significantly across multiple binary models. This assumption is also called the parallel odds assumption. Appendix Table F 1 first line shows the test of the assumption for the overall model. The chi-squire test statistic indicates that the overall model satisfies the assumption. However tests on individual variables indicate that coefficient of restaurant attribute varies significantly. Table 6-7 shows that the coefficient on restaurant variable increase with higher cumulative splits. This indicates that this attribute has significantly higher importance for preference variation at the upper end of the scale than the lower end of the scale. Remaining attributes does not show statistically significant variation in their effect size at successive splits of the scale. Therefore those attributes can be considered to have a constant effect on preference.

6.3.1.2 Departure common amenities

I6 treatment combinations were created for the stated preference experiment design. Table 6-8 shows the summary and the descriptive statistics of responses obtained for the lounge area questions. Overall distribution of responses among the ratings does not show a significant biasness. However indifferent rating has a significantly low frequency of responses.

Table 6-8: Summary of responses - departure common amenities

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DCOM1[4]						2	4	11	49	66
DCOM2	7	28	6	12		15	1	1		72
DCOM3	1	5	8	7	1	19	14	10	2	76
DCOM4	1	6	6	5		22	18	7	3	87
DCOM5	8	36	13	18	2	4		1		78
DCOM6	8	17	28	24	1	3	3	1		73
DCOM7	2	2	3	3	3	17	23	10	3	71
DCOM8	5	9	6	12	2	14	6	18	4	78
DCOM9	1	1		2	1	4	13	19	25	70
DCOM10		8	9	21	4	14	7	5	4	67
DCOM11	2	8	5	3	3	9	7	22	17	68
DCOM12	11	32	21	16	1	2	2		2	82
DCOM13	14	29	12	12	3	1	4	2	1	85
DCOM14	56	8	4	3	1		1			66
DCOM15	1	3	3	8	2	14	20	16	4	76
DCOM16	2	1	5	13	1	15	17	22	2	66
Total	119	193	129	159	25	155	140	145	116	1181
Percentage	10%	16%	11%	13%	2%	13%	12%	12%	10%	

[4] Refer Appendix Table C11 for details on treatment combinations

6.3.1.2.1 Analysis of choice response

According to Table 6-8 50% have chosen the alternative A, 48% have chosen alternative B and 2% have indicated indifferent. According to the results of the bivariate correlation analysis between the independent variables, no significant correlation was observed. Table 6-9 shows the discrete choice model estimated for departure lounge area service quality.

Table 6-9: Discrete choice model for departure common amenities service quality

<table>
<tr><td rowspan="4">Log likelihood = -479.636</td><td colspan="2">Number of obs</td><td>2312</td></tr>
<tr><td colspan="2">LR chi2(10)</td><td>643.28</td></tr>
<tr><td colspan="2">Prob > chi2</td><td>0.00</td></tr>
<tr><td colspan="2">Pseudo R2</td><td>0.4014</td></tr>
<tr><td>Attribute label</td><td>Coefficient</td><td>z</td><td>P>|z|</td></tr>
<tr><td>Automated1_2[5]</td><td>0.781</td><td>4.93</td><td>0.000</td></tr>
<tr><td>fltinfo1_4</td><td>2.048</td><td>12.88</td><td>0.000</td></tr>
<tr><td>fltinfo2_4</td><td>0.841</td><td>3.17</td><td>0.002</td></tr>
<tr><td>fltinfo3_4</td><td>1.469</td><td>8.45</td><td>0.000</td></tr>
<tr><td>Info_com1_3</td><td>1.049</td><td>4.59</td><td>0.000</td></tr>
<tr><td>Info_com2_3</td><td>0.413</td><td>2.23</td><td>0.026</td></tr>
<tr><td>wsh1_4</td><td>3.306</td><td>11.47</td><td>0.000</td></tr>
<tr><td>wsh2_4</td><td>1.956</td><td>7.98</td><td>0.000</td></tr>
<tr><td>wsh3_4</td><td>1.495</td><td>7.64</td><td>0.000</td></tr>
<tr><td>water1_2</td><td>0.739</td><td>5.95</td><td>0.000</td></tr>
</table>

[5] The coefficient label has three parts, the attribute name (e.g. Automated: - automated services) and the attribute level and reference level (e.g. automated1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C6 for details on attribute service levels

According to the model fitting information, estimated discrete choice model fits the data well. The percentage of correctly predicted observations of the estimated model is 80%. All the service attributes considered for the departure common amenities service quality were found to be significant at 5% level of significance. According to the estimated model, availability of adequate washroom facilities is the most important service quality attribute. Second most important attribute is the availability of flight information display. Washroom availability before and after security is statistically indifferent. However with respect to flight information display, respondents have placed high importance of having them after security. Availability of mobile staff is significantly more important for service quality than having stationary staff at information counters. Automated services in the terminal and availability of drinking water fountains are given among the least important in terms of preference for service quality.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-10 shows the summary of the analysis. Detail results and discussion is given under appendix section E.1.

Table 6-10: Summary of effects from socio demographic variables-departure common amenities

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of automated services	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Flight info overall	No difference	No difference	No difference	No difference	**Increasing**	No difference
Utility of Fight info before security	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Flight info after security	No difference	No difference	No difference	No difference	**Increasing**	No difference
Utility of Information staff-roaming	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Information staff-stationary	No difference	No difference	No difference	No difference	**Increasing**	No difference
Utility of Washrooms overall	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Washrooms after security	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Washrooms before security	No difference	No difference	No difference	No difference	No difference	No difference
Utility of Water fountains	No difference	No difference	No difference	No difference	No difference	No difference

6.3.1.2.2 Analysis of the ordinal rating scale

Methodology of attribute coding, analysis and hypothesis testing is exactly the same as previous functional areas. Indifferent rating is excluded due to significantly small number of responses. The dependent variable for the ordinal regression is the ratings scale indicate the level of preference. The percentages of responses obtained for each rating is as follows: 0:- 2%, 1:-26%, 2:-23%, 3:-28%, 4:-20%. Further details on descriptive statistics are given in Table 6-8. Bivariate correlation analysis does not show the presence of strong correlation among any of the variables used. Table 6-11 shows the obtained generalized ordinal regression model for departure common amenities.

Table 6-11: Generalised ordinal logistic model for departure common amenities

	LR chi2(30)		376.58
	Prob > chi2		0.00
Log likelihood = -1402.0073	Pseudo R2		0.1184
Attribute label	Coefficient	z	P>|z|
Log Odds : Rating>1/Rating=1			
Automated1_2[6]	0.475	3.61	0.000
fltinfo1_4	0.862	6.25	0.000
fltinfo2_4	-0.025	-0.16	0.871
fltinfo3_4	0.045	0.25	0.806
info1_3	1.201	6.6	0.000
info2_3	0.533	3.64	0.000
wsh1_4	1.303	5.27	0.000
wsh2_4	0.803	4.15	0.000
wsh3_4	0.583	3.51	0.000
water	0.488	5.3	0.000
_cons	0.61	7.14	0.000
Log Odds : Rating>2/Rating≤2			
Automated1_2	0.305	3	0.003
fltinfo1_4	0.778	6.16	0.000
fltinfo2_4	-0.134	-0.93	0.351
fltinfo3_4	0.384	2.5	0.012
info1_3	1	6.94	0.000
info2_3	0.436	3.58	0.000
wsh1_4	1.292	5.68	0.000
wsh2_4	0.569	3.18	0.001
wsh3_4	0.413	2.57	0.01
water	0.51	6.48	0.000
_cons	-0.539	-6.11	0.000
Log Odds : Rating>3/Rating ≤ 3			
Automated1_2	0.756	6.09	0.000
fltinfo1_4	0.73	3.87	0.000
fltinfo2_4	0.681	3.08	0.002
fltinfo3_4	0.734	3.67	0.000
info1_3	1.213	6.44	0.000
info2_3	0.627	3.75	0.000
wsh1_4	2.134	5.94	0.000
wsh2_4	0.762	2.77	0.006
wsh3_4	0.958	3.45	0.001
water	0.602	5.05	0.000
_cons	-2.398	-16.37	0.000

[6] The coefficient label has three parts, the attribute name (e.g. Automated: - automated services) and the attribute level and reference level (e.g. automated1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C6 for details on attribute service levels

According to the pseudo r^2 the model goodness of fit is low. Percentage of correct predictions using the estimated model is 45%. However the estimated model is considered adequate to results interpretation. All the service attributes considered for the level of preference for departure common amenities service quality were found to be significant at 5% level of significance in at least at one of the cumulative splits of the ordinal regression model.

Appendix Table F 2 shows the results of *brant* test. According to the *brant* test results the null hypothesis of proportional odds is rejected for the overall model as well as some variables individually. Results show that coefficients of attributes such as automated faculties, flight information display availability and washroom availability significantly differ among the cumulative binary splits. Variation in the coefficient of automated services indicate that its ability to affect the preference rating at the upper end of the scale has significantly increased. Its effect size on mid-scale has significantly reduced. This indicate that availability of automated services is a non-essential attribute where unavailability is less likely to cause significant negative effect on preference. It's more likely to shift preference at the upper end of the scale. The overall effect size of washrooms on preference is the highest among the considered attributes. Availability of washrooms has shown a significantly higher effect size at the upper end of the preference scale. This indicate that adequacy of washroom facilities causes a higher positive effect on overall preference and that effect is more profound at the upper end of the scale. Similarly inadequacy of washrooms is likely to cause higher negative impact on preference. Effect size of remaining attributes does not vary significantly with preference, thus they can be considered to have a linear effect on preference.

6.3.1.3 Departure check-in area

I6 treatment combinations were created for the stated preference experiment design. Table 6-12 shows the summary and descriptive statistics for the responses obtained for the check-in area questions.

Table 6-12: Summary of responses - departure check-in area

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DCHK1[7]	4	1	1	3		3	5	30	39	86
DCHK2	18	18	13	11	1	5	3	4		73
DCHK3	13	13	18	6	1	3	4	5	5	68
DCHK4	23	19	10	2		4	1	5		64
DCHK5	2	8	6	9	2	8	9	13	7	64
DCHK6					1	2	2	11	54	70
DCHK7	2	6	7	14		14	15	14	9	81
DCHK8	39	11	6	4		1				61
DCHK9	20	31	9	2	2	1	4	2		71
DCHK10	6	8	18	9	2	12	12	6	2	75
DCHK11	6	13	17	16	2	7	5	7	3	76
DCHK12	1	2	1	1	1	6	12	26	24	74
DCHK13		3	4	8	5	2	11	32	15	80
DCHK14	12	35	10	8	3	4	6	3	1	82
DCHK15	13	21	14	8	1	3	3	5	5	73
DCHK16	22	19	9	6	2	7	8	6	4	83
Total	181	208	143	107	23	82	100	169	168	1181
Percentage	15%	18%	12%	9%	2%	7%	8%	14%	14%	

6.3.1.3.1 Analysis of choice response

According to the bivariate correlation analysis there was no significant correlation present between different attributes considered as independent variables. According to Table 6-12, 54% respondents have chosen the alternative A, 44% have chosen the alternative B and 2% have

[7] Refer Appendix Table C12 for details on treatment combinations

indicated indifferent. Table 6 13 shows the discrete choice model estimated for departure check-in area service quality.

Table 6-13: Discrete choice model for departure check-in area service quality

	Number of obs		2316
	LR chi2(7)		529.05
	Prob > chi2		0.00
Log likelihood = -538.13835	Pseudo R2		0.33
Attribute label	Coefficient	z	P>|z|
Chkin1_2[8]	1.028	8.11	0.000
Chkin3_2	-1.478	-7.76	0.000
info_check-in1_3	1.078	10	0.000
info_check-in2_3	0.661	4	0.000
Check in Kiosk1_2	1.183	11.52	0.000
Signage_check-in1_2	0.258	1.99	0.047
Sec_screening1_2	0.899	8.09	0.000

According to the pseudo r^2 value the goodness of fit of the estimated model is good. The percentage of correctly predicted results using the estimated model is 78%. All the service attributes considered for the level of preference for departure check-in area service quality were found to be significant at 5% level of significance. According to the results of the discrete choice model, delay at the check-in process is the most critical attribute for the determining service quality in the check-in hall. The disutility of delay at the check-in process increase almost linearly with additional delay. Second most important attribute for service quality is the availability of automated kiosks. Ability to perform check-in process without delay is the main advantage of automated kiosks. Automated kiosks are preferred by travellers who carry very little luggage and

[8] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

does not require the presence of an airline agent for processing. According to the results, respondents have placed a higher utility of attributes related to quick and convenient processing at the check-in hall.

Availability of mobile airport staff is assigned a significantly higher importance compared to information desks. Roaming airport staff provides passengers a convenient way to get directions and assistance for the check-in process. Convenience in security screening is also found to be a significant determinant of service quality preference. Convenience of security screening procedure is seldom used as a determinant of service quality in previous research. Dynamic sign posting was tested compared to conventional static signs used at check-in counters. Respondents compared dynamic signs that display information such as expected delay and currently boarding flights with conventional static signs. However the importance weight given to dynamic signage is significantly less than the other attributes. Typically signage is considered as a critical service quality determinant in an airport service environment. Thus the result obtained for the dynamic signage attribute is contrary to the common belief on signage importance. It is possible that the attribute description failed to generate enough realism for the respondents to properly evaluate the hypothetical scenario.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-14 shows the summary of the analysis. Detail results and discussion is given under appendix section E.2.

Table 6-14: Summary of effects from socio demographic variables-departure-Check-in

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Disutility of Check-in short wait	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of check-in long wait	No difference	No difference	**Increasing**	**Increasing**	**Increasing**	No difference
Utility of Information staff-roaming	No difference	No difference	No difference	No difference	No difference	**Leisure higher**
Utility of information staff-stationary	No difference	No difference	No difference	No difference	No difference	No difference
Utility of check-in kiosk	No difference	No difference	No difference	No difference	**Increasing**	**Business higher**
Utility of check-in area signage	No difference	No difference	No difference	No difference	No difference	No difference
Utility of security check convenience	No difference	No difference	**Increasing**	No difference	No difference	No difference

6.3.1.3.2 Analysis of ordinal rating scale

Methodology of attribute coding, analysis and hypothesis testing is exactly the same as previous functional areas. Indifferent rating is excluded due to significantly small number of responses. Percentages of responses obtained for the ratings are as follows: 0:-2%. 1:-16%, 2:-20%, 3:-32%, 4:-29%. Table 6-12 gives further details on descriptive statistics of the response variable. Bivariate correlation analysis does not show the presence of strong correlation among any of the variables used. Table 6-15 shows the obtained generalized ordinal regression model for departure common amenities.

Table 6-15: Generalised ordinal logistic model for departure check-in area

	Number of obs		1158
	LR chi2(21)		254.64
	Prob > chi2		0.00
Log likelihood = -1435.655	Pseudo R2		0.0815
Attribute label	Coefficient.	z	P>|z|
Log Odds : Rating>1/Rating=1			
Chkin1_2[9]	0.621	4.45	0.000
Chkin3_2	-0.527	-2.77	0.006
info1_3	0.838	6.73	0.000
info2_3	0.197	1.12	0.263
Kiosk	0.452	4.24	0.000
Signage	0.062	0.5	0.617
Security	0.445	3.75	0.000
_cons	1.248	13.91	0.000
Log Odds : Rating>2/Rating≤2			
Chkin1_2	0.502	4.39	0.000
Chkin3_2	-0.697	-4.76	0.000
info1_3	0.853	8.41	0.000
info2_3	0.129	0.98	0.329
Kiosk	0.562	6.91	0.000
Signage	0.168	1.78	0.076
Security	0.468	5.05	0.000
_cons	-0.015	-0.18	0.853
Log Odds : Rating>3/Rating≤3			
Chkin1_2	0.456	3.41	0.001
Chkin3_2	-0.707	-4.43	0.000
info1_3	0.723	5.98	0.000
info2_3	0.157	1.09	0.274
Kiosk	0.585	7	0.000
Signage	0.367	3.87	0.000
Security	0.673	6.54	0.000
_cons	-1.566	-15.16	0.000

[9] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

According to the results the goodness of fit of the ordinal regression model is low. The percentage of correctly predicted observations using the estimated model is 40%. The estimated model is significant. All the service attributes considered for the analysis were found to be significant at 5% level of significance in at least at one of the cumulative splits of the ordinal regression model. However the dummy coefficient of the information staff attribute level-2 (availability of information desks) was insignificant at all three cumulative splits. Nevertheless the same dummy variable was significant in the discrete choice model. This is an indication that the availability of information desks cannot significantly affect the increase of user's level of preference even though it is significant for choice. Thus it can be considered as a less attractive attribute for service quality. The variation of the attributes effects on level of preference was evaluated using the *brant* test. Appendix Table F 3 shows the results of *brant* test. According to the *brant* test results the null hypothesis of proportional odds cannot be rejected for the overall model as well as all the variables individually. Thus in the experiment for the departure check-in area service quality, the relative importance of attributes considered to remain constant with level of preference.

6.3.1.4 Departure curb

8 treatment combinations were created for the stated preference experiment design. Table 6-16 shows the summary and descriptive statistics of the response categories. Overall distribution of responses among the ratings does shows that ratings have concentrated towards the end of the rating scale. Minimum number of treatment combinations used could be the reason for this observation. Using more treatment combinations could have produced a more even distribution of responses.

Table 6-16: Summary of responses - departure curb area

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DCUB1[10]	63	16	10	1				2	1	93
DCUB2	1	1			1	4	12	18	59	96
DCUB3	19	31	12	14	1	7	3	1	1	89
DCUB4	1		1	2	1	6	10	28	53	102
DCUB5	15	29	21	14	3	1	2	2	1	88
DCUB6	3	2	1		1	13	23	36	15	94
DCUB7	8	36	22	10	2	10	5	3	1	97
DCUB8	14	27	25	12	3	6	3		1	91
Total	124	142	92	53	12	47	58	90	132	750
Percentage	17%	19%	12%	7%	2%	6%	8%	12%	18%	

6.3.1.4.1 Analysis of choice response

According to Table 6-16 54% of the respondents have chosen alternative A and 44% of the respondents have chosen alternative B. According to the pseudo r^2 value the goodness of fit can be considered a good fit. The percentage of correctly predicted observations using the estimated model is 86%. Table 6-17 shows the discrete choice model estimated for departure curb area.

According to results of the analysis, availability of luggage carts is the most important service attribute. Availability of adequate curb space is the second most important service attribute. Hence it is important that airports provide adequate curb space for passenger unloading at the curb. Crowded curb areas cause excessive delay to passengers for unloading. Availability of weather protection is also found to be significantly important for passenger's preference of service quality. It is interesting to observe that the relative disutility of 5-10min walk compared to a 15-20min walk to check-in area being insignificant for service quality.

[10] Refer Appendix Table C13 for details on treatment combinations

Table 6-17: Discrete choice model for departure curb service quality

	Number of obs		1476
	LR chi2(6)		626.72
	Prob > chi2		0.00
Log likelihood = -198.180	Pseudo R2		0.6126
Attribute label	Coefficient	z	P>|z|
space_curb1_2[11]	1.631	8.42	0.000
Distckn1_2	1.077	3.55	0.000
Distckn3_2	-0.797	-1.33	0.184
weathercover1_2	1.215	4.65	0.000
bagc1_2	1.933	10.27	0.000
porter1_2	-0.422	-1.83	0.067

This could be due to respondents do not expecting to walk for more than 5-10mins to access check-in area from curb. Hence they have considered any distance more than their maximum equally onerous. The utility on availability of porters for handling heavy luggage is considered insignificant for service quality. Only very few passengers would require the services of porters for carrying heavy luggage. Most airports including Calgary international airport prove porter service. Calgary international Airport has a very short distance between baggage check and the departure curb. Therefore most surveyed passengers may not have obtained the services of porters, hence they did not attribute significant utility for porters in the hypothetical context as well. Nevertheless this is an essential service for assisting senior passengers and other passengers who carry very heavy luggage.

[11] The coefficient label has three parts, the attribute name (e.g. Curb_space: - Availability of curb space) and the attribute level and reference level (e.g. Curb_space 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C9 for details on attribute service levels

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-18 shows the summary of the analysis. Detail results and discussion is given under appendix section E.3.

Table 6-18: Summary of effects from socio demographic variables-departure-Curb

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of curb space	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of distance to check-in short	No difference	No difference	No difference	**Decrease**	No difference	No difference
Disutility distance to check-in long	No difference	**Female-higher**	No difference	No difference	No difference	No difference
Utility of weather protection	No difference	**Female-higher**	No difference	**Decrease**	No difference	**Business Higher**
Utility of baggage carts	No difference	**Female-higher**	No difference	No difference	No difference	No difference
Utility of porters	No difference	No difference	No difference	No difference	No difference	No difference

6.3.1.4.2 Analysis of ordinal rating scale

Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes. According to Table 6-16 percentages of responses obtained for the categories of the dependent variable are as follows: 1:-13%, 2:-20%, 3:-31% and 4:-35%. Table 6-19 shows the obtained generalized ordinal regression model for departure curb area. According to the results the goodness of fit of the estimated model is low. The percentage of correctly predicted observations is 50%. Appendix Table F 4 shows the results of *brant* test. Brant test results indicate that the model with all five attributes does not satisfy the proportional odds assumption. Examination of the test results for individual attributes show that all the attributes except availability of porters satisfies the proportional odds assumption. Attributes that satisfy the proportional odds assumptions can be considered to have a constant effect on the preference rating.

Table 6-19: Generalised ordinal logistic model for departure curb area

	Number of obs		738
	LR chi2(18)		187.22
	Prob > chi2		0.00
Log likelihood = -884.780	Pseudo R2		0.0957
Attribute label	Coefficient.	z	P>|z|
Log Odds : Rating>1/Rating=1			
space_curb1_2[12]	0.675	4.14	0.000
Distckn1_2	0.837	3.4	0.001
Distckn3_2	-0.422	-0.88	0.379
weathercover1_2	0.752	4.23	0.000
bagc1_2	0.564	3.5	0.000
porter1_2	0.058	0.37	0.710
_cons	1.118	7.39	0.000
Log Odds : Rating>2/Rating≤2			
Curb_space1_2	0.525	4.19	0.000
Distckn1_2	0.808	4.33	0.000
Distckn3_2	-0.438	-1.43	0.151
weathercover1_2	0.524	4.28	0.000
bagc1_2	0.476	3.73	0.000
porter1_2	0.079	0.75	0.455
_cons	-0.08	-0.56	0.573
Log Odds : Rating>3/Rating≤3			
Curb_space1_2	0.351	2.34	0.019
Distckn1_2	0.679	3.16	0.002
Distckn3_2	-0.861	-2.91	0.004
weathercover1_2	0.613	4.88	0.000
bagc1_2	0.537	3.42	0.001
porter1_2	0.507	4.53	0.000
_cons	-1.579	-8.47	0.000

[12] The coefficient label has three parts, the attribute name (e.g. Curb_space: - Availability of curb space) and the attribute level and reference level (e.g. Curb_space 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C9 for details on attribute service levels

6.3.1.5 Departure circulation

8 treatment combinations were created for the stated preference experiment design. Table 6-20 shows the summary of responses obtained for the circulation facilities questions. Table 6-20 shows the summary and the descriptive statistics of the response categories.

Table 6-20: Summary of responses - departure circulation

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DCIR1[13]	67	16	8	1			1	1		94
DCIR2			2	2	1	3	7	13	56	84
DCIR3	15	28	14	9	2	10	11	2	2	93
DCIR4		1	1	2	2	18	26	34	25	109
DCIR5	30	33	16	7	2	3	1			92
DCIR6	2		5	4	1	9	19	32	21	93
DCIR7	12	27	22	13	1	8	6	3		92
DCIR8	3	5	15	15	4	19	22	9	1	93
Total	129	110	83	53	13	70	93	94	105	750
Percentage	17%	15%	11%	7%	2%	9%	13%	13%	14%	

6.3.1.5.1 Analysis of choice response

According to Table 6-20 50% of the respondents have chosen alternative A and 48% of the respondents have chosen the alternative B in terms of the overall experiment. The Bivariate correlation analysis of the independent variables did not show the presence of significant correlation. According to the pseudo r^2 value the goodness of fit can be considered a good fit. The percentage of correctly predicted observations using the estimated model is 85%. All the service attributes considered for departure circulation service quality was found to be significant at 5% level of significance. Table 6-21 shows the results of the discrete choice analysis.

[13] Refer Appendix Table C14 for details on treatment combinations

Table 6-21: Discrete choice model for departure circulation facilities

	Number of obs		1474
	LR chi2(6)		548.53
	Prob > chi2		0.00
Log likelihood = -236.5835	Pseudo R2		0.5369
Attribute label	Coefficient.	z	P>|z|
signage_cir1_2[14]	2.246	9.34	0.000
Ttnod1_2	1.107	3.76	0.000
chnglvl1_2	-0.674	-2.36	0.018
chnglvl1_3	-2.302	-5.14	0.000
walking1_2	1.378	6.31	0.000
eleccrt1_2	0.471	1.74	0.082

According to the results, disutility associated with poor level changing facilities (having to use elevators or stairs) is the most critical in terms of service quality of circulation. Respondents have associated a relatively small disutility for using escalators compared to not having to change levels. According to the finding passengers already expect to change levels while circulating within the terminal and they seems to associate a minimum disutility for using escalators compared to using elevators. Thus it is very important for airports planers to minimize level changing in the vertical configuration of the terminal and provide good level of service at every level change in order to maintain higher passenger comfort. Some airports allow the departing passengers to enter the terminal directly at departures level and spare them from having to change levels. However in some instances due to the complex nature of horizontal and vertical programming of the terminal it is necessary to have level changes for departing passengers. Importance of level changes is rarely

[14] The coefficient label has three parts, the attribute name (e.g. signage_cir: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C7 for details on attribute service levels

highlighted in previous research work. This is partly due to difficulties in measuring the true importance of level changing means with conventional survey techniques such as direct questioning.

Availability of clear signage is also is also found to be a very important attribute for circulation service quality. According to the literature review of this thesis, most of the previous research on airport terminal circulation has identified clear signage as one of the most important service quality attributes. Minimum walking distance and information on walking time and distance to important nodes has also been identified as significant determinants of service quality preference. Results show that utility of having electric carts is found to be insignificant at 5% level of significance. It is understood that provision of electric carts is essential for the convenience of passenger segments needing special assistance for circulation. However the sample of respondents surveyed in this study does not sufficiently represent the above passenger segments. Therefore the importance of providing electric crats may have got underestimated compared to other attributes. This finding contains an important implication for developing specific studies focusing the needs of passengers needing special assistance. It can be seen that studies that survey all passengers in general does not highlight the true importance of these special facilities.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-22 shows the summary of the analysis. Detail results and discussion is given under appendix section E.4.

Table 6-22: Summary of effects from socio demographic variables-departure-Circulation

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of signage for circulation	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Utility of access time/distance info	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Disutility of level changing –Escalators	No difference	No difference	**Increasing**	No difference	No difference	No difference
Disutility of level changing-Elevators	No difference	No difference	No difference	No difference	No difference	No difference
Utility of walking distance	No difference	No difference	No difference	No difference	No difference	No difference
Utility of electric carts	**Online-higher**	No difference	No difference	No difference	No difference	No difference

6.3.1.5.2 Analysis of ordinal rating scale

Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes considered for analysis. According to Table 6-20 percentages of responses obtained for the categories of the dependent variable are as follows: 1:-16%, 2:-24%, 3:-28% and 4:-31%. Table 6-23 shows the obtained generalized ordinal regression model for departure circulation facilities. According to the results the goodness of fit of the estimated model is low. The percentage of correctly predicted observations is 50%. However all the service attributes considered for analysis were found to be significant at 10% level of significance, Appendix Table F 5 shows the results of *brant* test. Brant test results indicate that the model with all five attributes satisfy the proportional odds assumption. Furthermore each attribute individually satisfy the proportional odds assumption. Thus there is no statistically significant evidence to indicate that attributes considered for circulation service quality effect the range of preference differently at different levels.

Table 6-23: Generalised ordinal logistic model for departure circulation

	Number of obs		737
	LR chi2(18)		255.64
	Prob > chi2		0.00
Log likelihood = -873.630	Pseudo R2		0.1276
Attribute label	Coefficient.	z	P>|z|
Log Odds : Rating>1/Rating=1			
signage_cir1_2[15]	1.175	6.83	0.000
Ttnod1_2	0.547	2.9	0.004
chnglvl1_2	-0.451	-1.74	0.081
chnglvl1_3	-0.641	-2.27	0.023
walking1_2	0.813	5.46	0.000
eleccrt1_2	0.322	1.98	0.048
_cons	0.87	6.84	0.000
Log Odds : Rating>2/Rating≤2			
signage_cir1_2	1.342	8.56	0.000
Ttnod1_2	0.493	3.7	0.000
chnglvl1_2	-0.672	-3.47	0.001
chnglvl1_3	-0.929	-4.49	0.000
walking1_2	0.937	8	0.000
eleccrt1_2	0.204	1.82	0.068
_cons	-0.79	-5.47	0.000
Log Odds : Rating>3/Rating≤3			
signage_cir1_2	1.296	5.74	0.000
Ttnod1_2	0.655	4.97	0.000
chnglvl1_2	-0.622	-2.91	0.004
chnglvl1_3	-1.193	-5.4	0.000
walking1_2	0.959	6.07	0.000
eleccrt1_2	0.462	3.81	0.000
_cons	-2.298	-9.65	0.000

[15] The coefficient label has three parts, the attribute name (e.g. signage_cir: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C7 for details on attribute service levels

6.3.2 Analysis of data for arrival passenger flow path

Four functional areas were identified for the arriving passenger flow path. The functional areas considered for the arriving passenger flow path are arrival baggage claim area, Arrival common amenities, arrival curb area and arrival circulation. A separate experiment was used for each functional area. The results for each functional area are presented below.

6.3.2.1 Arrival baggage claim

I6 treatment combinations were created for the stated preference experiment design. Table 6-24 shows the summary and descriptive statistics of responses obtained for the questions.

Table 6-24: Summary of responses – Arrival baggage claim

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
ABGC1[16]	3	5	7	16	4	12	15	11	1	74
ABGC2	2	2	12	22	1	7	13	10	6	75
ABGC3		5	8	13	4	13	11	15	1	70
ABGC4	6	13	17	19	2	8	9	8	2	84
ABGC5	2	2	12	11	3	29	10	6	1	76
ABGC6		3	2	2		10	24	18	4	63
ABGC7	8	11	25	10	2	6	4	1		67
ABGC8	6	19	11	18		14	10	6		84
ABGC9		1				1	3	4	64	73
ABGC10	6	22	15	12		8	11	8		82
ABGC11	3	7	13	11		14	12	19	7	86
ABGC12	3	19	5	2	3	1	9	21	6	69
ABGC13	7	15	16	10	1	5	3	6	1	64
ABGC14	49	10	2	2		1	2			66
ABGC15	10	14	16	21	4	6	5	1	1	78
ABGC16	2	4	10	7		16	16	12	8	75
Total	107	153	170	176	24	151	157	146	102	1186
Percentage	9%	13%	14%	15%	2%	13%	13%	12%	9%	

[16] Refer Appendix Table C15 for details on treatment combinations

6.3.2.1.1 Analysis of choice response

Bivariate correlation analysis of the service attributes did not show the presence of significant correlation among the independent variables considered for the analysis. The dependent variable considered for the choice analysis is the respondent's choice between alternative A or alternative B. According to Table 6-24, 51% of the respondents have chosen alternative A, 47% have chosen alternative B and 2% have indicated indifferent. Indifferent responses were excluded from the analysis. Table 6-25 shows the results of the discrete choice analysis. All the attributes considered for service quality at baggage claim area are significant at the 5% level of significance.

Table 6-25: Discrete choice model for arrival baggage claim facilities

	Number of obs		2326
	LR chi2(8)		349.46
	Prob > chi2		0.00
Log likelihood = -631.398	Pseudo R2		0.2168
Attribute label	Coefficient	z	P>|z|
signage_bag1_2[17]	1.453	9.95	0.000
delt1_2	0.667	5.1	0.000
delt3_2	-1.247	-7.73	0.000
bbltl1_2	0.237	2.18	0.029
bbltl3_2	-0.47	-3.45	0.001
space_bag1_2	0.768	6.91	0.000
bagc1_3	1.595	8.08	0.000
bagc2_3	0.345	1.85	0.065

[17] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C2 for details on attribute service levels.

The goodness of fit according to the pseudo r^2 value is 0.22. This can be considered as moderately good model fit. According to the scale given by Hensher et al. (2005) a pseudo r^2 value of 0.22 is equivalent to a value between 0.5-0.6 in linear regression. The percentage of correctly predicted responses using the estimated model is 71%. According to the results, availability of baggage carts is the most important service attribute in the baggage claim area. However when a fee is introduced there is a significant reduction in the perceived utility of baggage carts. The utility of clear signage is also significant and relatively higher value. Signage in the baggage claim area is provided to easily locate the correct baggage carousel, customs inspection, baggage service and exit to arrival hall. Baggage delivery time and distance from baggage claim to curb front is also significant determinants of passenger service quality. The disutility of waiting for baggage delivery is significantly higher than the disutility of walking for a similar amount of time. Space provision in the baggage claim area is also significant for service quality preference.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-26 shows the summary of the analysis. Detail results and discussion is given under appendix section E.5.

Table 6-26: Summary of effects from socio demographic variables-arrival baggage claim

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of signage	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of baggage delay-short	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of baggage delay-long	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of access time to curb short	No difference	No difference	No difference	No difference	No difference	No difference
Disutility of access time to curb long	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Utility of space provision	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Utility of adequate baggage carts-free	No difference	No difference	No difference	No difference	No difference	**Leisure-Higher**
Utility of adequate baggage carts-paid	No difference	No difference	No difference	No difference	No difference	No difference

6.3.2.1.2 Analysis of the ordinal rating scale

Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes. According to Table 6-24 the percentages of responses obtained for the ordinal dependent variable is as follows: 1:-28%, 2:-27%, 3:-25% and 4:-18%. Table 6-27 shows the obtained generalized ordinal regression model for arrival baggage claim area facilities. All the service attributes considered for analysis were found to be significant at 5% level of significance in at least at one of the cumulative splits of the ordinal regression model. However the dummy coefficient of the baggage belt location attribute level-2 was found to be insignificant in all three cumulative splits. The model pseudo r^2 value is 0.12. The goodness of fit is low. The percentage of correctly predicted observations is 45%.

Table 6-27: Generalised ordinal logistic model for arrival baggage claim

	Number of obs		1163
	LR chi2(24)		393.7
	Prob > chi2		0.00
Log likelihood = -1399.0512	Pseudo R2		0.1233
Attribute label	Coefficient	z	P>|z|
Log Odds : Rating>1/Rating=1			
signage_bag1_2[18]	0.702	5.49	0.000
delt1_2	0.383	2.98	0.003
delt3_2	-0.794	-5.45	0.000
bbltl1_2	0.076	0.71	0.477
bbltl3_2	-0.078	-0.62	0.538
space_bag1_2	0.554	5.3	0.000
bagc1_3	0.769	4.44	0.000
bagc2_3	0.519	3.03	0.002
_cons	0.696	9.62	0.000
Log Odds : Rating>2/Rating≤2			
Signage_bag1_2	0.851	8.75	0.000
delt1_2	0.55	5.26	0.000
delt3_2	-0.588	-4.9	0.000
bbltl1_2	0.21	2.13	0.033
bbltl3_2	-0.128	-1.04	0.297
space_bag1_2	0.576	6.84	0.000
bagc1_3	0.573	4.17	0.000
bagc2_3	0.493	3.24	0.001
_cons	-0.645	-8.91	0.000
Log Odds : Rating>3/Rating≤3			
Signage_bag1_2	1.083	8.48	0.000
delt1_2	0.703	4.62	0.000
delt3_2	-0.789	-4.52	0.000
bbltl1_2	0.296	1.92	0.055
bbltl3_2	-0.123	-0.61	0.545
space_bag1_2	0.785	6.17	0.000
bagc1_3	0.959	5.38	0.000
bagc2_3	0.5	2.08	0.038
_cons	-2.545	-19.61	0.000

[18] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C2 for details on attribute service levels.

In order to establish the variation of attribute relative importance with respect to the level of preference, the attention is given to the comparison of attribute coefficients between different models representing the ordered cumulative splits of the rating scale. Appendix Table F 6 shows the results of *brant* test. Brant test results indicate that the model does not satisfy the proportional odds assumption. Effect size of attributes such as signage, baggage delivery time, space provision and availability of free baggage carts vary significantly. By examining coefficients of the ordinal regression model in Table 6-27 it is possible to observe that the effect size of the above attributes increase towards higher cumulative splits of the scale. Thus these attributes can be considered to have increasing importance for higher preference levels.

6.3.2.2 Arrival common amenities

I6 treatment combinations were created for the stated preference experiment design. Table 6-28 shows the summary and descriptive statistics of responses obtained for the questions.

Table 6-28: Summary of responses – Arrival common amenities

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
ACOM1[19]	2	10	15	24	2	14	16	6	1	90
ACOM2	4	19	19	23	1	7	3	7	2	85
ACOM3	5	33	16	11	3	5	2			75
ACOM4	3	6	6	5	1	14	20	17	2	74
ACOM5		2					4	10	51	67
ACOM6	4	16	25	13	2	5	7	3	2	77
ACOM7	1	8	14	22	2	12	7	7	2	75
ACOM8	3	6	8	3	1	8	7	32	14	82
ACOM9	8	18	21	14	1	9	5			76
ACOM10		4	1	5	3	21	23	12	5	74
ACOM11		2	3	6	1	18	12	16	8	66
ACOM12		1	1	4	3	20	21	6	6	62
ACOM13	4	12	13	15	1	8	2		1	56
ACOM14	54	20	4			2	1			81
ACOM15	8	21	15	19	2	6	3	2	2	78
ACOM16	4	4	6	7	1	2	10	18	6	58
Total	100	182	167	171	24	151	143	136	102	1176
Percentage	9%	16%	14%	15%	2%	13%	12%	12%	9%	

6.3.2.2.1 Analysis of the choice response

According to Table 6-28 54% of the respondents have chosen alternative A and 44% of the respondents have chosen alternative B. Bivariate correlation analysis of the service attributes did not show presence of significant correlation among the independent variables considered for the analysis. Table 6-29 shows the results of the discrete choice analysis. According to the pseudo r^2 value the goodness of fit can be considered a good fit. The percentage of correctly predicted observations using the estimated model is 78%. All the service attributes considered for service quality is significant at 5% level of significance.

[19] Refer Appendix Table C16 for details on treatment combinations

Table 6-29: Discrete choice model for arrival common amenities

	Number of obs		2304
	LR chi2(10)		528.67
	Prob > chi2		0.000
Log likelihood = -534.172	Pseudo R2		0.331
Attribute label	Coefficient	z	P>|z|
cofres1_4[20]	1.544	4.12	0.000
cofres2_4	0.935	4.69	0.000
cofres3_4	0.125	0.52	0.606
info_com1_2	0.834	4.2	0.000
wsh1_4	3.317	13.61	0.000
wsh2_4	1.782	10.35	0.000
wsh3_4	1.819	10.28	0.000
Water1_2	1.085	7.36	0.000
intnt1_3	0.875	3.25	0.001
intnt2_3	0.309	-1.71	0.087

However the dummy coefficient for paid internet and restaurant availability close to arrival gates is found to be insignificant at the 5% level of significance. According to the results of the common amenities functional area, passengers place a higher priority on satisfying basic needs such as food, water and washrooms than other needs such as information and internet connectivity. Parameter for cofres3_4 being not significant and the parameter for cofres2_4 being significant indicate that the utility of the availability of concession after baggage claim is very important for arriving passengers. This result confirms our intuition that at the destination-airport passengers prefer to complete any remaining processing as quickly as possible. Availability of washrooms has the highest utility of services quality preference. It is interesting to find that washroom availability

[20] The coefficient label has three parts, the attribute name (e.g. cofres: - Availability of restaurants) and the attribute level and reference level (e.g. cofres 1_4:- coefficient of attribute level-1 with reference to level-4). Refer Appendix Table C3 for details on attribute service levels.

close to gates and after baggage claim having similar values of importance in terms of the estimated coefficient. A finding is consistent with the result obtained for the analysis of departure common amenities. Internet connectivity and information availability also have a statistically significant effect of preference for service quality. The value of importance given to the availability of internet by arriving passengers is less than that of departing passengers. Furthermore similar to departure lounge service quality, the coefficient corresponding to paid Wi-Fi access (Intnt2_3) is insignificant. This can be expected as arriving passengers do not expect to spend much time waiting at the terminal thus the use of internet facilities is minimum.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-30 shows the summary of the analysis. Detail results and discussion is given under appendix section E.6.

6.3.2.2.2 Analysis of the ordinal response scale

According to Table 6-28 the percentages of responses obtained for the ordinal dependent variable is as follows: 1:-28%, 2:-26%, 3:-28% and 4:-18%. Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes. Table 6-31 shows the obtained generalized ordinal regression model for arrival common amenities. All the service attributes considered for analysis were found to be significant at 5% level of significance in at least at one of the cumulative splits of the ordinal regression model.

Table 6-30: Summary of effects from socio demographic variables-arrival common amenities

Attribute name	Data source (Online/ Airport)	Gender (male /female)	Trip frequency	Age group	Income level	Trip purpose
Utility of overall restaurant availability	No difference	No difference	**Decreasing**	No difference	**Significant decrease at mid-level**[21]	No difference
Utility of restaurant availability after baggage claim	No difference	No difference	**Decreasing**	No difference	**Significant decrease at mid-level**	No difference
Utility of restaurant availability before baggage claim	No difference	No difference	**Decreasing**	No difference	**Significant decrease at mid-level**	No difference
Utility of information provision	No difference	No difference	**Decreasing**	No difference	No difference	No difference
Utility of washrooms overall concourse	No difference	No difference	No difference	No difference	No difference	No difference
Utility of washrooms close to gates	No difference	No difference	No difference	No difference	**Increasing**	No difference
Utility of washrooms in arrival hall	No difference	No difference	No difference	No difference	No difference	No difference
Utility of drinking water fountains	No difference	No difference	No difference	No difference	No difference	No difference
Utility of free internet	No difference	No difference	**Decreasing**	No difference	**Non-linear**	No difference
Utility of paid internet	No difference	No difference	No difference	No difference	No difference	No difference

[21] Refer section 0 in the appendix for detail discussion

Table 6-31: Generalised ordinal logistic model for arrival common amenities

<table>
<tr><td rowspan="4">Log likelihood = -1401.4991</td><td colspan="2">Number of obs</td><td>1152</td></tr>
<tr><td colspan="2">LR chi2(30)</td><td>355.57</td></tr>
<tr><td colspan="2">Prob > chi2</td><td>0.000</td></tr>
<tr><td colspan="2">Pseudo R2</td><td>0.1126</td></tr>
<tr><td>Attribute label</td><td>Coefficient</td><td>z</td><td>P>|z|</td></tr>
<tr><td>Log Odds : Rating>1/Rating=1</td><td></td><td></td><td></td></tr>
<tr><td>cofres1_4[22]</td><td>1.149</td><td>3.67</td><td>0.000</td></tr>
<tr><td>cofres2_4</td><td>0.448</td><td>2.54</td><td>0.011</td></tr>
<tr><td>cofres3_4</td><td>-0.028</td><td>-0.13</td><td>0.898</td></tr>
<tr><td>info_com1_2</td><td>0.332</td><td>1.88</td><td>0.061</td></tr>
<tr><td>wsh1_4</td><td>1.513</td><td>6.21</td><td>0.000</td></tr>
<tr><td>wsh2_4</td><td>0.214</td><td>1.49</td><td>0.136</td></tr>
<tr><td>wsh3_4</td><td>0.586</td><td>3.64</td><td>0.000</td></tr>
<tr><td>Water1_2</td><td>0.716</td><td>5.03</td><td>0.000</td></tr>
<tr><td>intnt1_3</td><td>0.679</td><td>2.95</td><td>0.003</td></tr>
<tr><td>intnt2_3</td><td>0.049</td><td>0.32</td><td>0.752</td></tr>
<tr><td>_cons</td><td>0.599</td><td>7.43</td><td>0.000</td></tr>
<tr><td>Log Odds : Rating>2/Rating≤2</td><td></td><td></td><td></td></tr>
<tr><td>cofres1_4</td><td>0.587</td><td>3.09</td><td>0.002</td></tr>
<tr><td>cofres2_4</td><td>0.322</td><td>2.39</td><td>0.017</td></tr>
<tr><td>cofres3_4</td><td>-0.217</td><td>-1.29</td><td>0.198</td></tr>
<tr><td>info_com1_2</td><td>0.14</td><td>1.14</td><td>0.253</td></tr>
<tr><td>wsh1_4</td><td>1.593</td><td>7.44</td><td>0.000</td></tr>
<tr><td>wsh2_4</td><td>0.064</td><td>0.44</td><td>0.659</td></tr>
<tr><td>wsh3_4</td><td>0.495</td><td>3.18</td><td>0.001</td></tr>
<tr><td>Water1_2</td><td>0.861</td><td>7.19</td><td>0.000</td></tr>
<tr><td>intnt1_3</td><td>0.549</td><td>3.3</td><td>0.001</td></tr>
<tr><td>intnt2_3</td><td>0.065</td><td>0.45</td><td>0.650</td></tr>
<tr><td>_cons</td><td>-0.695</td><td>-8.16</td><td>0.000</td></tr>
<tr><td>Log Odds : Rating>3/Rating≤3</td><td></td><td></td><td></td></tr>
<tr><td>cofres1_4</td><td>0.64</td><td>3.38</td><td>0.001</td></tr>
<tr><td>cofres2_4</td><td>0.232</td><td>1.2</td><td>0.232</td></tr>
<tr><td>cofres3_4</td><td>-0.202</td><td>-0.89</td><td>0.371</td></tr>
<tr><td>info_com1_2</td><td>0.606</td><td>3.93</td><td>0.000</td></tr>
<tr><td>wsh1_4</td><td>1.676</td><td>5.71</td><td>0.000</td></tr>
<tr><td>wsh2_4</td><td>0.291</td><td>1.21</td><td>0.225</td></tr>
<tr><td>wsh3_4</td><td>0.587</td><td>2.46</td><td>0.014</td></tr>
<tr><td>Water1_2</td><td>0.86</td><td>5.62</td><td>0.000</td></tr>
<tr><td>intnt1_3</td><td>0.394</td><td>1.9</td><td>0.058</td></tr>
<tr><td>intnt2_3</td><td>-0.499</td><td>-2.37</td><td>0.180</td></tr>
<tr><td>cons</td><td>-2.5</td><td>-17.11</td><td>0.00</td></tr>
</table>

[22] The coefficient label has three parts, the attribute name (e.g. cofres: - Availability of restaurants) and the attribute level and reference level (e.g. cofres 1_4:- coefficient of attribute level-1 with reference to level-4). Refer Appendix Table C3 for details on attribute service levels.

However the dummy coefficients of the washroom availability attribute level-2 and restaurant availability attribute level -3 were found to be insignificant in all three cumulative splits of the ordinal regression model. The model pseudo r^2 value is 0.11. The goodness of fit is low. The percentage of correctly predicted observations is 43%. Appendix Table F 7 shows the results of *brant* test. Brant test results indicate that the model does not satisfy the proportional odds assumption.

Effect size of attributes such as provision of information and availability of paid internet services have significant variation among cumulative splits. However availability of paid internet service is observed to be insignificant for service quality preference in the analysis of the rating scale. A similar result was obtained for the above variable in the choice analysis as well. By examining Table 6-31 it is possible to observe that the effect size of information provision increase towards higher cumulative splits of the scale. Utility of restaurants or concessions close to gates is insignificant for the rating of preference. Availability of washrooms after baggage claim is found to be insignificant at all cumulative splits of the scale. However the same variable has got a significant coefficient in the choice analysis. Since washrooms availability is essential as a basic need it has been allocated a significant utility in the choice analysis. However in terms of increasing level of preference its utility is insignificant. On the other hand availability of washrooms close to the arrival gate area has significant utility in terms of increasing preference. Hence provision of washrooms close to arrival gates is more attractive for passengers than having them after baggage claim area.

6.3.2.3 Arrival curb area

8 treatment combinations were created for the stated preference experiment design. Table 6-32 shows the summary and descriptive statistics of responses obtained for the arrival curb area questions.

Table 6-32: Summary of responses – Arrival curb area

Treatment	Response category									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
ACUB1[23]			2	2	1	2	7	17	60	90
ACUB2	2	2	5		1	15	20	24	20	89
ACUB3	7	25	16	18		10	5	2		83
ACUB4		3	9	6		20	30	12	2	82
ACUB5	61	14	8	4	1	1	1			90
ACUB6	7	16	34	20	1	4	6	2		90
ACUB7	7	23	26	21	4	5	5	1		92
ACUB8	7	22	18	11	3	17	8	2		88
Percentage	91	105	117	82	11	74	82	60	82	704
Total	13%	15%	16%	11%	2%	11%	12%	9%	12%	

6.3.2.3.1 Analysis of the choice response

According to Table 6-32, 56% of the respondents have chosen alternative A and 43% of the respondents have chosen alternative B. Bivariate correlation analysis of the service attributes did not show the presence of any significant correlation among the independent variables considered for the analysis. Table 6-33 shows the results of the discrete choice analysis. According to the pseudo r^2 value, the goodness of fit can be considered as a good model fit. The percentage of correctly predicted observations using the estimated model is 85%. All the service attributes considered for service quality is significant at 5% level of significance.

[23] Refer Appendix Table C17 for details on treatment combinations

Table 6-33: Discrete choice model for arrival curb area

	Number of obs		1386
	LR chi2(5)		449.02
	Prob > chi2		0.000
Log likelihood = -255.840	Pseudo R2		0.4674
Attribute label	Coefficient	z	P>|z|
Signage_curb1_2[24]	2.598	7.84	0.000
weather1_2	1.335	7.37	0.000
curb_space1_2	1.542	8.69	0.000
TransitInfo1_2	1.488	7.65	0.000
atm1_2	0.843	3.43	0.001

Clear signage was found to be the most important attribute for arriving passengers at the curb area. Curb area is considered as the interface between the modes of ground and air transportation. An air traveller may arrive at this interface tired and disoriented after a long flight. Thus clear signage is essential for the seamless transition to ground transportation. Furthermore attributes such as space availability, transportation service counters and weather protection are also identified as important attributes for service quality. It is important to note that the results obtained for arrival curb area are consistent with the results obtained for the departure curb area. Availability of attributes such as transit information and automated teller machines are also found to be significant determinants of service quality at the arrival curb area.

[24] The coefficient label has three parts, the attribute name (e.g. signage_curb: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-34 shows the summary of the analysis. Detail results and discussion is given under appendix section E.7.

Table 6-34: Summary of effects from socio demographic variables-arrival curb

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of clear Signage	No difference	**Female-higher**	No difference	No difference	No difference	**Leisure-Higher**
Utility of weather protection	No difference	No difference	No difference	No difference	No difference	No difference
Utility of space provision at the curb	No difference	No difference	**Increase**	No difference	**Increase**	**Business-Higher**
Utility of transit information	No difference	No difference	**Increase**	No difference	No difference	No difference
Utility of automated banking machines	No difference	**Female-higher**	Not considered for analysis	No difference	No difference	No difference

6.3.2.3.2 Analysis of ordinal rating scale

According to Table 6-32 the percentages of responses obtained for the ordinal dependent variable is as follows: 1:-22%, 2:-28%, 3:-24% and 4:-25%. Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes. Table 6-35 shows the obtained generalized ordinal regression model for arrival curb area facilities. All the service attributes considered for the level of preference for arrival common amenities were found to be significant at 5% level of significance. The model pseudo r^2 value is 0.15. The goodness of fit is low. The percentage of correctly predicted observations is 46%. However according to the results all the attributes considered for the analysis is significant at the 5% level of significance.

Table 6-35: Generalised ordinal logistic model for arrival curb area

	Number of obs		693
	LR chi2(15)		295.24
	Prob > chi2		0.000
Log likelihood = -809.987	Pseudo R2		0.1542
Attribute label	Coefficient	z	P>|z|
Log Odds : Rating>1/Rating=1			
Signage_curb1_2[25]	0.935	4.25	0.000
weather1_2	0.541	4.03	0.000
curb_space1_2	0.574	4.82	0.000
TransitInfo1_2	0.719	4.75	0.000
atm1_2	0.764	4.61	0.000
_cons	0.759	6.28	0.000
Log Odds : Rating>2/Rating≤2			
Signage_curb1_2	0.909	4.92	0.000
weather1_2	0.716	5.99	0.000
curb_space1_2	0.885	8.75	0.000
TransitInfo1_2	0.923	6.92	0.000
atm1_2	0.724	5.77	0.000
_cons	-0.924	7.35	0.000
Log Odds : Rating>3/Rating≤3			
Signage_curb1_2	1.024	4.14	0.000
weather1_2	1.1	5.92	0.000
curb_space1_2	1.088	7.82	0.000
TransitInfo1_2	1.405	7.19	0.000
atm1_2	0.626	4.32	0.000
_cons	-2.936	-12.05	0.000

[25] The coefficient label has three parts, the attribute name (e.g. signage_curb: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

Appendix Table F 8 shows the results of *brant* test. Brant test results indicate that the model does not satisfy the proportional odds assumption. Attributes with significantly varying coefficients are availability of weather protection, curb space, and ground transportation services. Observing Table 6-35 it is possible to see that coefficients of these attributes increase towards upper end of the preference scale. Furthermore it is possible to observe that the coefficient of ATM machines decrease towards the upper end of the scale.

6.3.2.4 Arrival circulation

8 treatment combinations were created for the stated preference experiment design. Table 6-36 shows the summary and descriptive statistics of responses obtained for the arrival flow path circulation facilities questions.

Table 6-36: Summary of responses – Arrival circulation

Treatment	Response categories									Grand Total
	A4	A3	A2	A1	0	B1	B2	B3	B4	
DCIR1[26]	47	18	8	1	1	1	2	1		79
DCIR2			1	4		3	3	14	57	82
DCIR3	15	26	18	9	3	7	8	3	3	92
DCIR4	2	3	4	1	2	11	17	31	15	86
DCIR5	41	31	13	7	1	1	1	1		96
DCIR6		4	5	3	3	9	17	28	14	83
DCIR7	8	26	14	11	3	15	9	7		93
DCIR8	2	5	8	18	2	28	17	9	4	93
Percentage	115	113	71	54	15	75	74	94	93	704
Total	16%	16%	10%	8%	2%	11%	11%	13%	13%	

[26] Refer Appendix Table C18 for details on treatment combinations

6.3.2.4.1 Analysis of the choice response

According to Table 6-36, 50% of the respondents have chosen alternative A, 48% of the respondents have chosen alternative B and 2% of the respondents have indicated indifferent. Bivariate correlation analysis of the service attributes did not show the presence of any significant correlation among the independent variables considered for the analysis. Table 6-37 shows the results of the discrete choice analysis. According to the pseudo r^2 value the goodness of fit can be considered as a good model fit. The percentage of correctly predicted observations using the estimated model is 82%. All the service attributes considered for service quality is significant at 5% level of significance. However the dummy coefficient for the level changing facility attribute level-2 is insignificant.

Table 6-37: Discrete choice model for arrival circulation facilities

	Number of obs		1378
	LR chi2(6)		437.15
	Prob > chi2		0.000
Log likelihood = -259.004	Pseudo R2		0.457
Attribute label	Coefficient	z	P>|z|
signage_cir1_2[27]	1.885	9.42	0.000
Ttnod1_2	0.641	2.56	0.010
chnglvl1_2	-0.41	-1.51	0.130
chnglvl1_3	-2.115	-5.83	0.000
walking1_2	1.315	7.01	0.000
eleccrt1_2	0.67	2.85	0.004

[27] The coefficient label has three parts, the attribute name (e.g. signage cir: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C1 for details on attribute service levels

The order of attribute importance observed here is very much similar to what was observed in departure circulation data analysis. Thus the results are consistent between the two flow paths. However the coefficient estimated for level changing using escalators compared to no level changes is insignificant for arriving passengers. Whereas the same attribute service level in the departure flow path discrete choice model was significant at the 5% level of significance. The coefficient obtained for the disutility of level changing using escalator was relative small in the analysis of the departure circulation as well. This is an indication that passengers don't associate a disutility for level changing if they are provided with convenient and seamless transition from one level to the other. Currently most airports are vertically separated in terms of departures and arrivals. Thus arriving passengers are required to enter the terminal at departures level and come down to arrivals level using elevators or escalators. The disutility of level changing using elevators is the highest compared to other attributes. This finding reaffirms the importance of level changes as a factor of circulation service quality.

Next differences in attribute effects based on socio demographic characteristics will be tested. Table 6-38 shows the summary of the analysis. Detail results and discussion is given under appendix section E.8.

6.3.2.4.2 Analysis of the ordinal rating scale

According to Table 6-36 the percentages of responses obtained for the ordinal dependent variable is as follows: 1:-19%, 2:-21%, 3:-29% and 4:-29%.. Bivariate correlation analysis did not show the presence of strong correlation among any of the service attributes.

Table 6-38: Summary of effects from socio demographic variables-arrival circulation

Attribute name	Data source (Online/ Airport)	Gender (male/ female)	Trip frequency	Age group	Income level	Trip purpose
Utility of signage for circulation	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Utility of access time/distance info	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Disutility of level changing –Escalators	**Online-higher**	No difference	No difference	No difference	No difference	No difference
Disutility of level changing-Elevators	No difference	No difference	**Decrease**	No difference	No difference	No difference
Utility of walking distance	No difference	No difference	No difference	No difference	No difference	No difference
Utility of electric carts	**Online-higher**	No difference	No difference	No difference	No difference	No difference

Table 6-39 shows the obtained generalized ordinal regression model for departure circulation facilities. The model pseudo r^2 value is 0.12. The goodness of fit is low. The percentage of correctly predicted observations is 44%. However according to the results all the attributes considered for the analysis is significant at the 5% level of significance. The dummy coefficient of the level changing attribute service level-2 was insignificant in the model for the third cumulative split. This shows that provision of escalators for level changing does not have a significant effect on higher levels of preference. Hence this observation of results helps to conclude that level changing is important in terms of an essential service quality determinant of circulation. However its attractiveness is low for generating a higher level of preference when passengers are already satisfied with adequate level of service.

Table 6-39: Generalised ordinal logistic model for arrival circulation

	Number of obs		689
	LR chi2(18)		234.59
	Prob > chi2		0.000
Log likelihood = -820.488	Pseudo R2		0.1251
Attribute label	Coefficient	z	P>|z|
Log Odds : Rating>1/Rating=1			
signage_cir1_2[28]	1.073	6.53	0.000
Ttnod1_2	0.647	3.44	0.001
chnglvl1_2	-0.495	-1.98	0.047
chnglvl1_3	-0.59	-1.98	0.047
walking1_2	0.787	5.34	0.000
eleccrt1_2	0.387	2.37	0.018
_cons	0.858	7.12	0.000
Log Odds : Rating>2/Rating≤2			
signage_cir1_2	1.177	8.1	0.000
Ttnod1_2	0.787	5.28	0.000
chnglvl1_2	-0.553	-2.81	0.005
chnglvl1_3	-0.498	-2.25	0.024
walking1_2	0.911	7.39	0.000
eleccrt1_2	0.41	3.42	0.001
_cons	-0.443	-3.66	0.000
Log Odds : Rating>3Rating≤3			
signage_cir1_2	1.252	6.24	0.000
Ttnod1_2	0.641	4.74	0.000
chnglvl1_2	-0.314	-1.54	0.124
chnglvl1_3	-0.733	-3.23	0.001
walking1_2	0.916	6.09	0.000
eleccrt1_2	0.564	4.71	0.000
_cons	-2.182	-10.99	0.000

[28] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C1 for details on attribute service levels

Appendix Table F 9 shows the results of *brant* test. Brant test results indicate that the model with all five attributes satisfy the proportional odds assumption. Furthermore each attribute individually satisfy the proportional odds assumption. Thus there is no statistically significant evidence to indicate that attributes considered for circulation service quality effect the range of preference differently at different levels.

6.4 Interpretation of analysis results

Previous section gave details on the analysis of the data collected from the stated preference survey of airport users. Two models were used to analyse the data. A discrete choice model was used to analyse the choice response in terms of the overall preference for service quality. The discrete choice model estimates coefficients representing the part-utility of each independent variable for determine the overall utility of the alternatives considered in the survey. According to the methodology presented in Chapter -3 of the thesis these coefficients can be used to determine the values of relative importance among different service attributes considered for determining the overall service quality of the terminal service environment. These values of attribute relative importance will be used to categorize them as high important and low important for overall service quality.

According to the methodology attributes are further classified based on their attractiveness for higher levels of preference. This can be determined by observing the variation in attribute coefficients with respect different levels of preference for service quality obtained using the rating of preference given to the chosen alternative. A generalized ordinal regression model was used to analyse the ordinal rating given by respondents. The generalised ordinal regression model estimated three separate binary logit models corresponding to three cumulative splits of the ordinal rating scale. Coefficient obtained for each independent variable (attribute service level) for the separate binary models are compared to determine any significant variation among them compared to being constant. The objective is to observe either increasing or decreasing trends of the coefficient. Figure 6-4 shows the expected variation in attribute coefficients as hypothesized in the research methodology (section 3.12.2 Chapter 3).

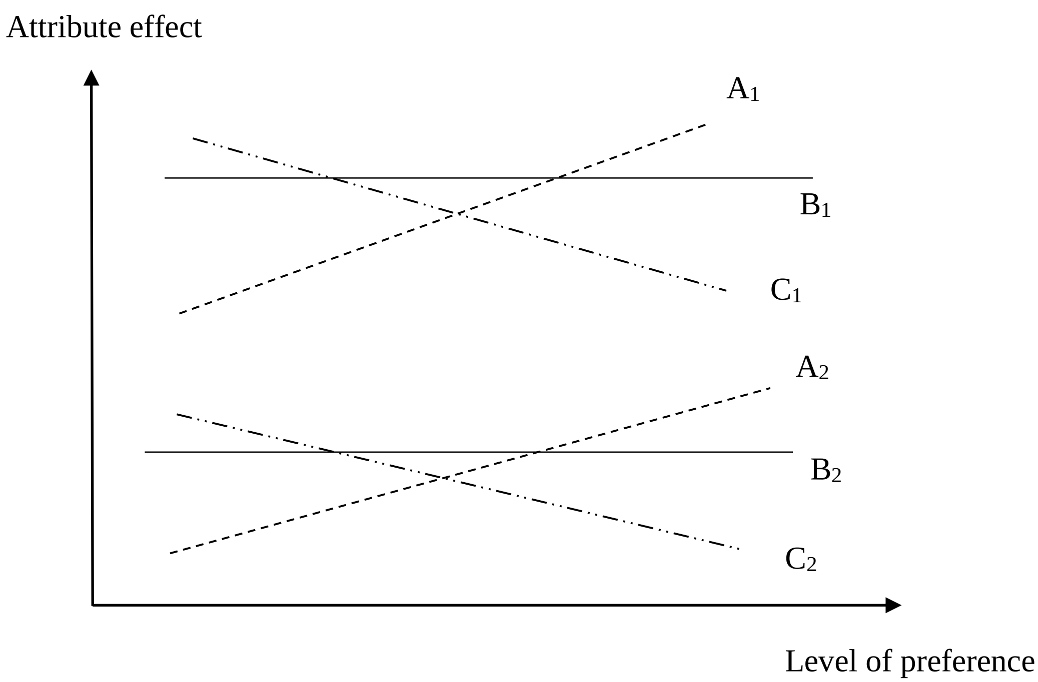


Figure 6-4: Expected variation of attribute effects with respect to level of preferen

6.4.1 Calculating the value of relative importance of service attributes

Relative importance values are calculated according to the methodology presented in the Chapter-3 under section 3.12.4.

6.4.1.1 Calculating the values of relative importance using the discrete choice analysis

Table 6-40 and Table 6-41 shows the relative importance weights calculated using the coefficients obtained from choice analysis for arrival and departing passenger flow paths respectively. Attribute coefficients that are insignificant in the discrete choice model are assigned a value of 0. The results shown in Table 6-40 and Table 6-41 are separated based on the different functional areas considered in the study. Labels used represent dummy variables of attribute service levels are given under the column "Attribute label". Coefficients estimated for each dummy variable is given in the column "estimated coefficient". All the coefficients are converted to absolute values and shown in the table. Value of relative importance is calculated using Equation 25 in section 3.12.4 in Chapter-3 of the thesis. Calculation of the value of relative importance for the attribute of availability of signage in the baggage claim area is shown below.

The reference value ($Refval\_dc_j$) for the baggage claim area is taken as the coefficient with the maximum absolute value in the utility function, given by:

$$Refval\_dc_{baggage\ claim} = \max\{1.45, 0.67, 1.25, 0.24, 0.47, 0.77, 1.6, 0.00\} \quad (40)$$

Therefore

$$Refval\_dc_{baggage\ claim} = 1.60$$

Then the relative importance of the availability of signage in the baggage claim area is obtained by:

$$w\_dc_{signage\_bag} = {}^{1.45}/_{1.60} = 0.91 \quad (41)$$

Table 6-40: Relative importance weights-arrival flow path-choice analysis

Functional area	Attribute label	Estimated coefficient - absolute value $\|\beta\|$	Value of importance (w_dc)
Baggage claim	signage_bag1_2	1.45	0.91
	delt1_2	0.67	0.42
	delt3_2	1.25	0.78
	bbltl1_2	0.24	0.15
	bbltl3_2	0.47	0.29
	space_bag1_2	0.77	0.48
	bagc1_3	**1.60**	1.00
	bagc2_3	0.00	0.00
Curb area	signage_curb1_2	**2.60**	1.00
	Weathercover1_2	1.34	0.51
	space_curb1_2	1.54	0.59
	transit_info1_2	1.49	0.57
	ATM1_2	0.84	0.32
Circulation	signage_cir1_2	1.89	0.89
	Ttnod1_2	0.64	0.30
	chnglvl1_2	0.00	0.00
	chnglvl1_3	**2.12**	1.00
	Convey1_2	1.32	0.62
	Eleccrt1_2	0.67	0.32
Common amenities	cofres1_4	1.54	0.47
	cofres2_4	0.94	0.28
	cofres3_4	0.00	0.00
	info_com1_2	0.83	0.25
	wsh1_4	**3.32**	1.00
	wsh2_4	1.78	0.54
	wsh3_4	1.82	0.55
	Water1_2	1.09	0.33
	intnt1_3	0.88	0.26
	intnt2_3	0.00	0.00

Table 6-41: Relative importance weights-departure flow path-choice analysis

Functional area	Attribute label	Estimated coefficient - absolute value $\|\beta\|$	Relative weight (w_dc)
Common amenities	Automated services1_2	0.78	0.24
	fltinfo1_4	2.05	0.62
	fltinfo2_4	0.84	0.25
	fltinfo3_4	1.47	0.44
	Info_com1_3	1.05	0.32
	Info_com2_3	0.41	0.12
	wsh1_4	**3.31**	1.00
	wsh2_4	1.96	0.59
	wsh3_4	1.50	0.45
	water1_2	0.74	0.22
Check-in hall	Chkin1_2	1.03	0.70
	Chkin3_2	**1.48**	1.00
	info_check-in1_3	1.08	0.73
	info_check-in2_3	0.66	0.45
	Check in Kiosk1_2	1.18	0.80
	Signage_check-in1_2	0.26	0.17
	Sec_screening1_2	0.90	0.61
Lounge area	seat1_2	0.56	0.31
	seat3_2	1.31	0.72
	retail shops1_2	0.54	0.30
	restaurants1_2	1.21	0.66
	charging stations1_2	0.53	0.29
	intent1_3	**1.83**	1.00
	intent2_3	0.00	0.00
Curb area	space_curb1_2	1.63	0.84
	Distckn1_2	1.08	0.56
	Distckn3_2	0.00	0.00
	weathercover1_2	1.22	0.63
	bagc1_2	**1.93**	1.00
	porter1_2	0.00	0.00
Circulation	signage_cir1_2	2.25	0.98
	Ttnod1_2	1.11	0.48
	chnglvl1_2	0.67	0.29
	chnglvl1_3	**2.30**	1.00
	walking1_2	1.38	0.60
	eleccrt1_2	0.41	0.18

6.4.2 Identification of attribute categories using the value of relative importance

The calculated values of relative importance can be used classify the attribute service levels based on the importance for overall service quality of the passenger terminal service environment. Methodology given in Chapter 3 under section 3.12.4.1 is used.

Calculations for arriving passenger flow path:

$$\overline{w\_dc}_{\,Arrival} = \frac{\sum_{i=1}^{n} w\_dc_i}{n} = \frac{13.83}{29} = 0.48$$

$$\sigma_{wdc} = \sqrt{\frac{\left(w\_dc_i - \overline{w\_dc}\right)^2}{n}} = 0.32$$

The categories of attribute relative importance for arrival passenger flow path can be defined as follows:

Low importance:$(Value\ of\ relative\ importance <\ 0.16)$,

Moderate to low importance:$(\ 0.16 < Value\ of\ relative\ importance < 0.48)$,

Moderate to high importance:$(\ 0.48 < Value\ of\ relative\ importance < 0.8)$,

High importance:$(\ Value\ of\ relative\ importance >\ 0.8)$.

Calculations for departing passenger flow path:

$$\overline{w\_dc}_{\,departing} = \frac{\sum_{i=1}^{n} w\_dc_i}{n} = \frac{18.55}{36} = 0.52$$

$$\sigma_{wdc} = \sqrt{\frac{\left(w\_dc_i - \overline{w\_dc}\right)^2}{n}} = 0.31$$

The categories of attribute relative importance for departing passenger flow path can be defined as follows:

Low importance:($Value\ of\ relative\ importance <\ 0.2$),

Moderate to low importance:($0.2 < Value\ of\ relative\ importance < 0.52$),

Moderate to high importance:($0.52 < Value\ of\ relative\ importance < 0.83$),

High importance:($Value\ of\ relative\ importance >\ 0.83$).

6.4.3 Identification of attribute categories using the variation in attribute importance

Average change in coefficients was calculated in order to determine the direction and the amount of change in coefficients of split-2 and 3 with respect to split-1. Average change in coefficients is given by:

$$\text{Average change in coefficients} = {\{(\beta_{ji3}-\beta_{ji1}) + (\beta_{ji2} - \beta_{ji1})\}}/{2} \quad (42)$$

Table 6-42 and Table 6-43 shows the results obtained from the ordinal regression analysis for arriving and departing flow paths respectively.

Table 6-42: Relative importance weights-arrival flow path-ordinal regression

Functional area	Attribute label	Split-1 $\lvert\beta_{ji1}\rvert$	Split-2 $\lvert\beta_{ji2}\rvert$	Split-3 $\lvert\beta_{ji3}\rvert$	Average weight w_or_{ji}	Average Coef-change
Baggage claim	signage_bag1_2	0.70	0.85	1.08	1.00	0.27
	delt1_2	0.38	0.55	0.70	0.62	0.24
	delt3_2	0.79	0.59	0.79	0.82	-0.11
	bbltl1_2	0.00	0.21	0.30	0.19	0.25
	bbltl3_2	0.00	0.00	0.00	0.00	0.00
	space_bag1_2	0.55	0.58	0.79	0.73	0.13
	bagc1_3	0.77	0.57	0.96	0.87	0.00
	bagc2_3	0.52	0.49	0.50	0.57	-0.02
Curb area	signage_curb1_2	0.94	0.91	1.02	0.94	0.03
	Weathercover1_2	0.54	0.72	1.10	0.77	0.37
	space_curb1_2	0.57	0.89	1.09	0.84	0.41
	transit_info1_2	0.72	0.92	1.41	1.00	0.45
	ATM1_2	0.76	0.72	0.63	0.69	-0.09
Circulation	signage_cir1_2	1.07	1.18	1.25	1.00	0.14
	Ttnod1_2	0.65	0.79	0.64	0.59	0.07
	chnglvl1_2	0.50	0.55	0.00	0.30	-0.22
	chnglvl1_3	0.59	0.50	0.73	0.52	0.03
	Convey1_2	0.79	0.91	0.92	0.75	0.13
	Eleccrt1_2	0.39	0.41	0.56	0.39	0.10
Common amenities	cofres1_4	1.15	0.59	0.64	0.50	-0.54
	cofres2_4	0.45	0.32	0.00	0.16	-0.29
	cofres3_4	0.00	0.00	0.00	0.00	0.00
	info_com1_2	0.33	0.00	0.61	0.20	-0.03
	wsh1_4	1.51	1.59	1.68	1.00	0.12
	wsh2_4	0.00	0.00	0.00	0.00	0.00
	wsh3_4	0.59	0.50	0.59	0.35	-0.05
	Water1_2	0.72	0.86	0.86	0.51	0.14
	intnt1_3	0.68	0.55	0.39	0.34	-0.21
	intnt2_3	0.00	0.00	0.00	0.00	0.00

Table 6-43: Relative importance weights-departure flow path-ordinal regression

Functional area	Attribute label	Split-1 $\|\beta_{ji1}\|$	Split-2 $\|\beta_{ji2}\|$	Split-3 $\|\beta_{ji3}\|$	Average weight w_or_{ji}	Average Coef-change
Common amenities	Automated services	0.48	0.31	0.76	0.32	0.06
	fltinfo1_4	0.86	0.78	0.73	0.50	-0.11
	fltinfo2_4	0.00	0.00	0.68	0.14	0.34
	fltinfo3_4	0.00	0.38	0.73	0.24	0.56
	info1_3_com	1.20	1.00	1.21	0.72	-0.09
	info2_3_com	0.53	0.44	0.63	0.34	0.00
	wsh1_4	1.30	1.29	2.13	1.00	0.41
	wsh2_4	0.80	0.57	0.76	0.45	-0.14
	wsh3_4	0.58	0.41	0.96	0.41	0.10
	water1_2	0.49	0.51	0.60	0.34	0.07
Check-in hall	Chkin1_2	0.62	0.50	0.46	0.65	-0.14
	Chkin3_2	0.53	0.70	0.71	0.80	0.18
	info1_3_check-in	0.84	0.85	0.72	1.00	-0.05
	info2_3_check-in	0.00	0.00	0.00	0.00	0.00
	Check in Kiosk1_2	0.45	0.56	0.59	0.66	0.12
	Signage_check-in1_2	0.00	0.17	0.37	0.25	0.27
	Sec_screening1_2	0.45	0.47	0.67	0.66	0.13
Lounge area	seat1_2	0.13	0.26	0.29	0.23	0.15
	seat3_2	0.57	0.73	0.62	0.66	0.11
	retail shops1_2	0.49	0.55	0.68	0.60	0.13
	restaurants1_2	0.67	0.84	1.03	0.87	0.27
	charging stations1_2	0.24	0.44	0.48	0.40	0.22
	intent1_3	0.86	1.00	1.04	1.00	0.16
	intent2_3	0.00	0.00	0.00	0.00	0.00
Curb area	space_curb	0.68	0.53	0.35	0.67	-0.24
	Distckn1_2	0.84	0.81	0.68	1.00	-0.09
	Distckn3_2	0.00	0.00	0.86	0.37	0.23
	weathercover1_2	0.75	0.52	0.61	0.81	-0.18
	bagc1_2	0.56	0.48	0.54	0.68	-0.06
	porter1_2	0.00	0.00	0.51	0.22	0.25
Circulation	signage_cir1_2	1.18	1.34	1.30	1.00	0.14
	Ttnod1_2	0.55	0.49	0.66	0.44	0.03
	chnglvl1_2	0.45	0.67	0.62	0.46	0.20
	chnglvl1_3	0.64	0.93	1.19	0.72	0.42
	walking1_2	0.81	0.94	0.96	0.71	0.14
	eleccrt1_2	0.32	0.20	0.46	0.26	0.01

Figure 6-5 and Figure 6-6 show the plots of average change in coefficient against relative importance for the arriving and departing flow paths respectively. The relative importance axis is divided into four areas based on the importance categories identified in section 6.4.2. In Figure 6-5 and Figure 6-6 different data series indicate the level of significance obtained in the hypothesis test for proportional odds assumption performed using the *brant* test. Attribute importance that vary significantly with different cumulative splits will be shown significant in the *brant* test of proportional odds assumption. According to the results most of the attributes satisfy the proportional odds assumption, thus the marginal effects are constant. Nevertheless attributes show both increasing and decreasing trends in the marginal effects according to the average variation in coefficients. For increasing marginal effects, there is evidence to support the hypothesized variation with high level of statistical significance. However for decreasing marginal effects, available evidence have low level of significance. However the observed trends of the marginal effects can be used with reasonable confidence for developing the service quality grading scheme.

Figure 6-7 and Figure 6-8 shows the plot of relative importance weights from the two analysis. Both flow paths indicate a significant correlation between choice response and preference rating response. Thus there is consistency between the two forms of importance weights.

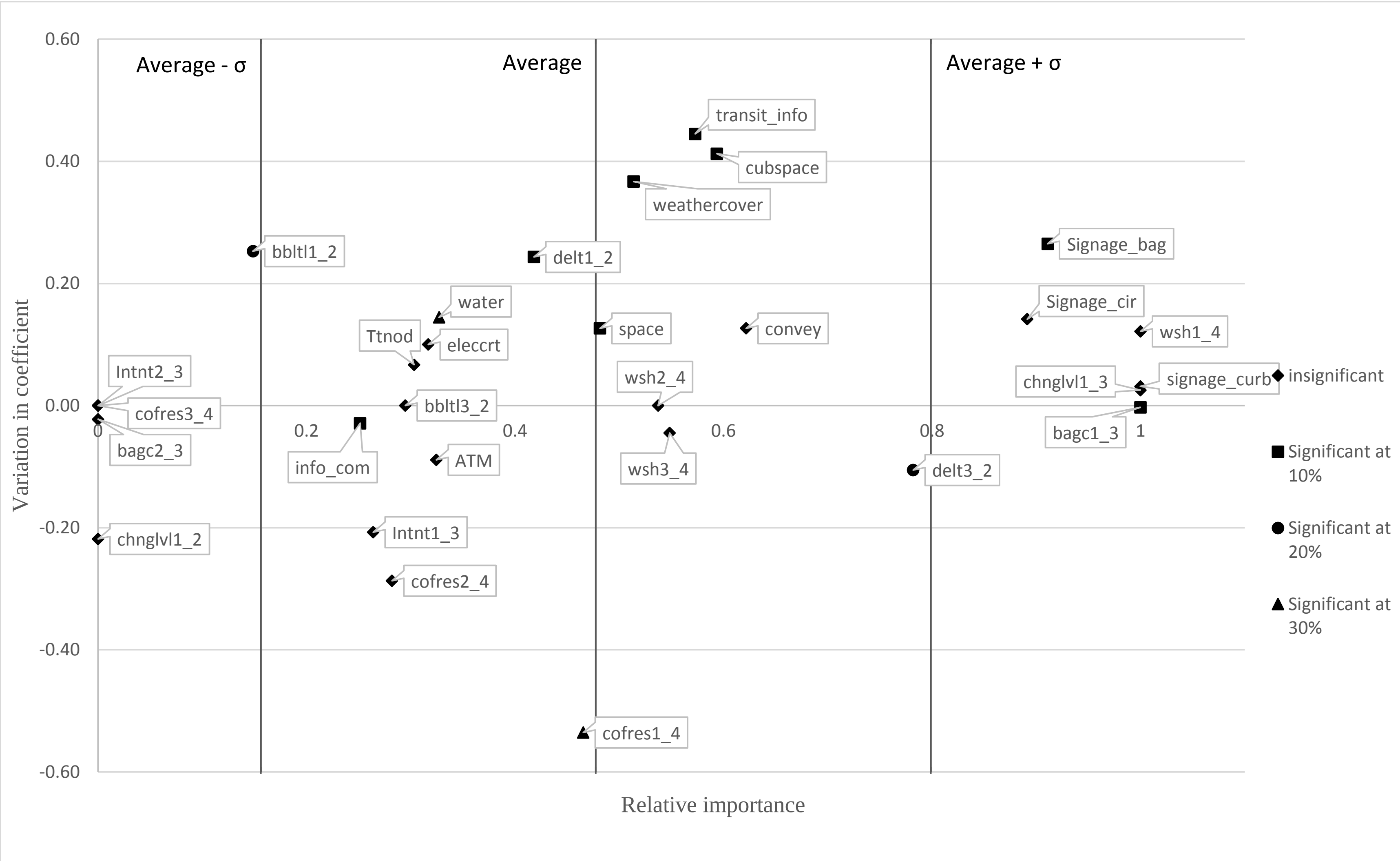


Figure 6-5: Variation of attribute relative importance -arrival flow path

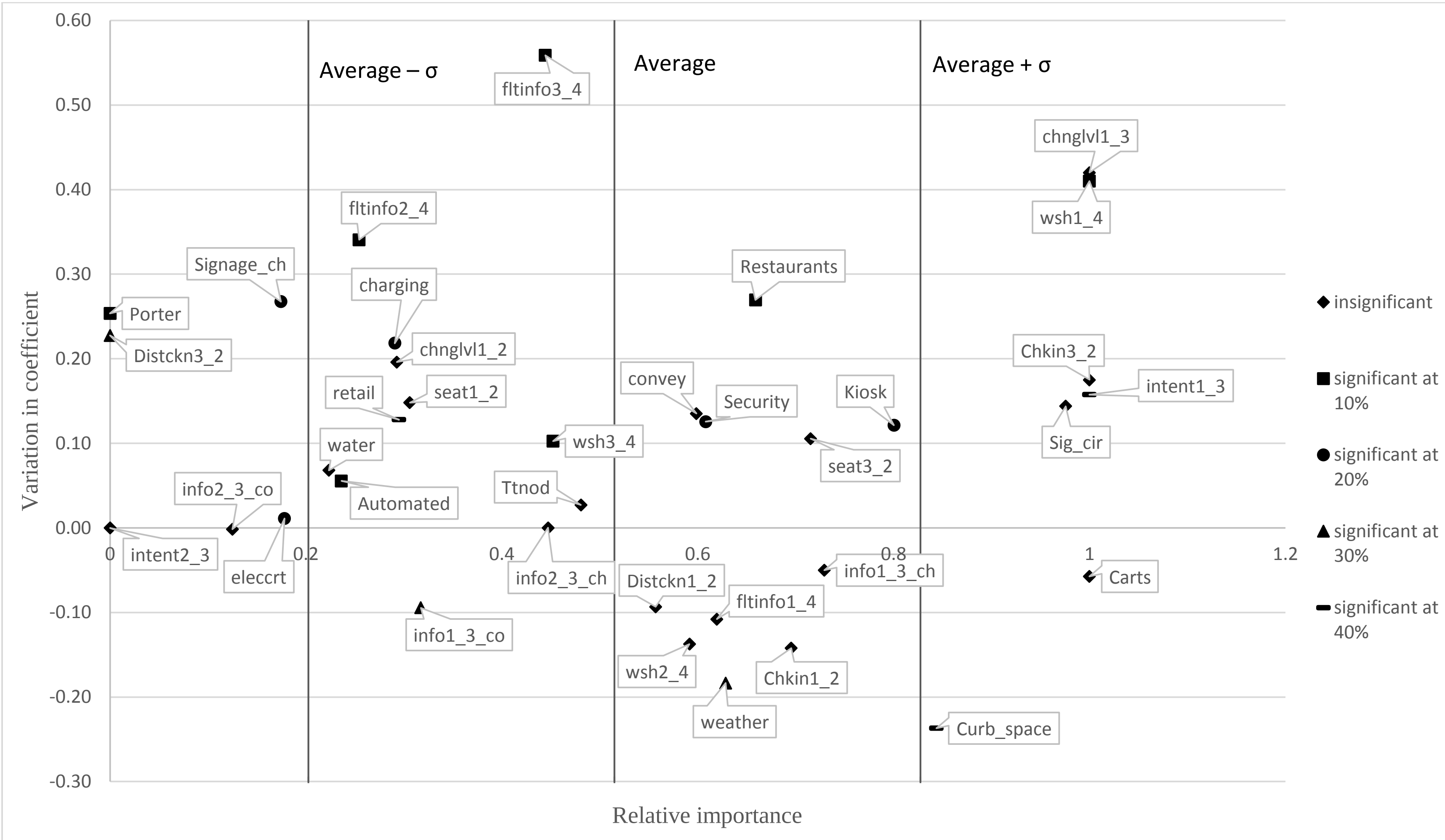


Figure 6-6: Variation of attribute relative importance -departure flow path

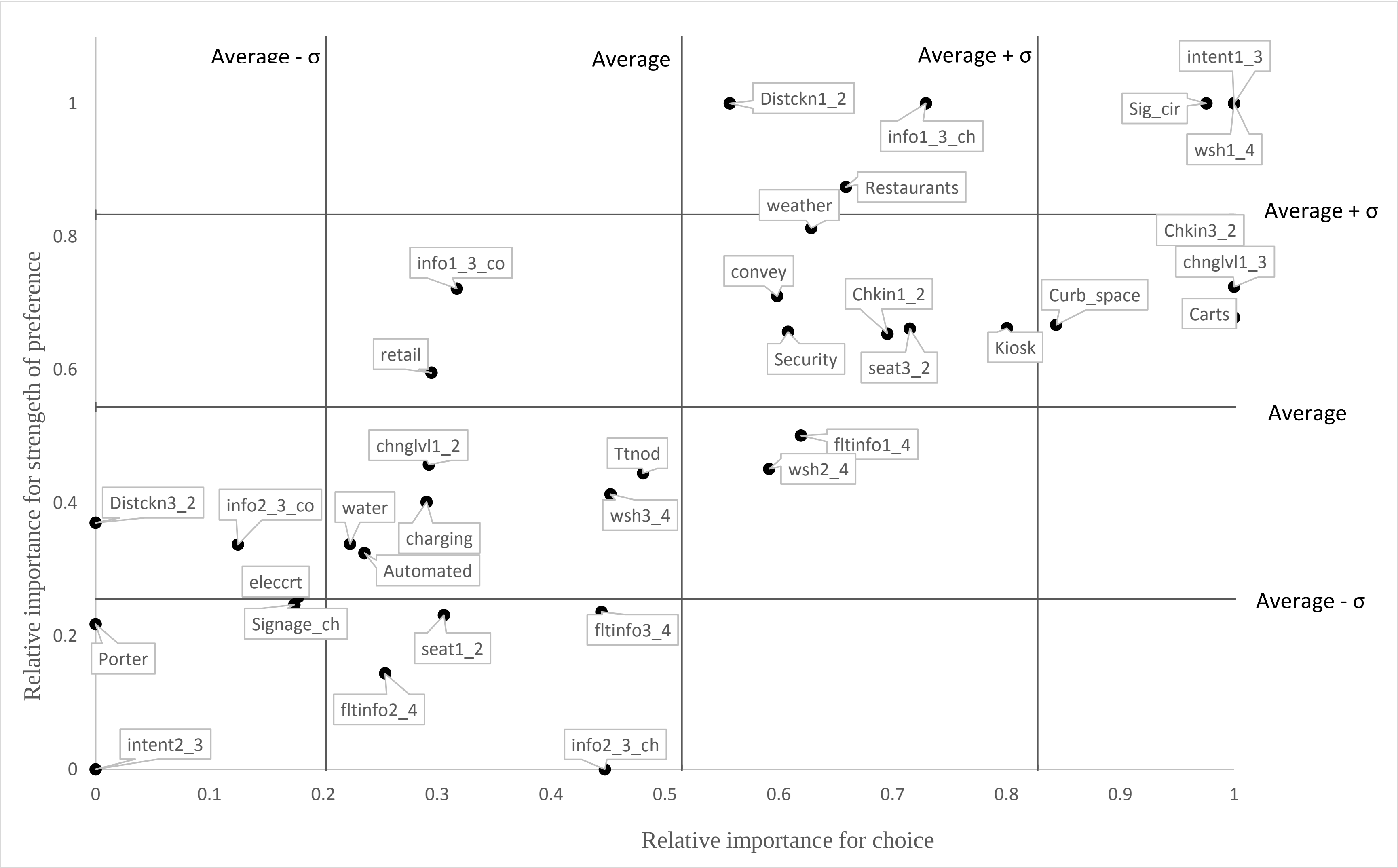


Figure 6-7: Choice Vs preference-rating importance weights - departure flow path

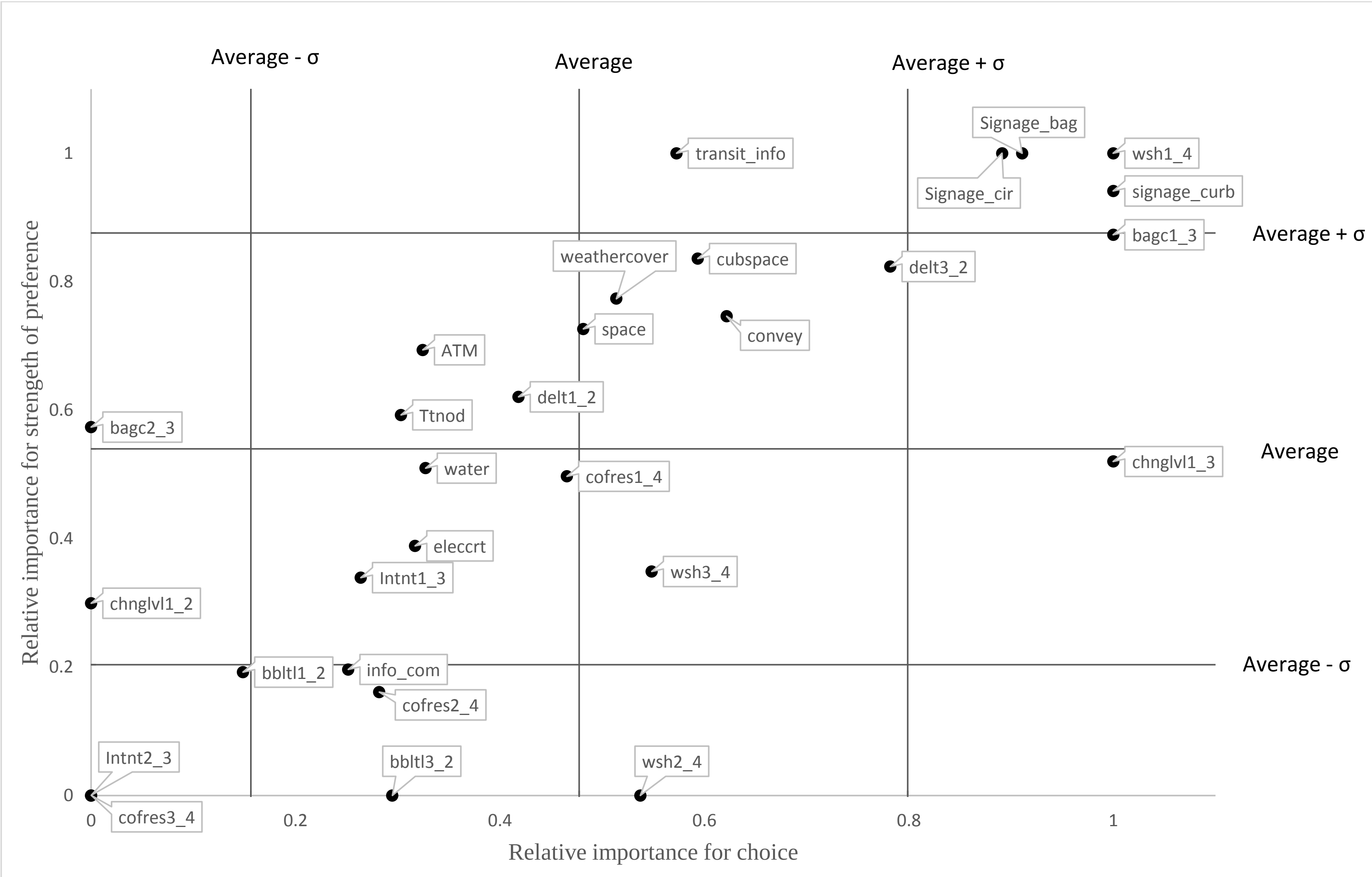


Figure 6-8: Choice Vs preference-rating importance weights - arrival flow path

6.5 Definition of the overall service quality standards

Minimum service quality criteria identification model given in Table 3-8 under section 3.10 of Chapter 3 can be used to define the overall service quality standards for the set of ordered overall service quality grades defined. Methodology section 3.12.4 identified four categories based on overall importance. It can be seen that categories of moderate-high and high importance contain most of the essential attributes. It was observed in the results of the ordinal regression analysis that increasing variations are observed with higher level of significance. However the observed level of significance for decreasing variation in attribute effect sizes is very low. This may have been caused by the limitations in the survey design. Limited number of attributes (five) being included within each choice set (treatment) used for the survey can be identified as a possible reason. Limited number of attributes, may attract too much attention to attributes that would otherwise receive lesser attention in reality. Furthermore, insufficient number of response categories provided for indicating the level of preference for the chosen alternative also may have affected this outcome. Therefore in order to compensate for the effects caused by the above limitations of the survey design a lower level of significance was selected. The significance level used for the identification of increasing or decreasing marginal effects was lowered down to 40%. This is a significant departure from the conventional practice of 5% significance level. The classification rule established in Table 3-8 under section 3.10 of the methodology chapter was applied to the data presented in Figure 6-7 and Figure 6-8 in order to obtain minimum service criteria for overall service quality grading.

Appendix Table G-1 and Appendix Table G-2 shows the assignment of attribute service levels as minimum service criteria for overall service quality standards. The state of attribute service availability is defined based on the "range of service availability" defined under the section

3.9.3 of the methodology chapter. Level of service standards (LOS) are used as the range of service availability for attributes such as processing time, space availability, seating availability, walking distance and signage. The attribute service levels are considered to be ordinal. Attribute service levels that are assigned as minimum service criteria for a certain level of overall grading is indicated with "1". "0" represents attributes service levels not considered for minimum criteria. Attributes are further categorised as "essential" and "non-essential". Essential attributes are defined as attributes that must be provided for the basic processing and holding of passengers at the terminal. Attributes identified as essential for service is shown in Table 6-44. Results show that most of the essential service attributes belong to high and moderate to high importance categories.

Table 6-44: Essential service attributes

Departing	
Attribute name	**Importance**
Curb space	High
Baggage carts	High
Signage for circulation	High
Level changing	High
Walking distance	Moderate to high
Electric carts	Low
Check-in process	High
Signage in the check-in area	Low
Security screening	Moderate to high
Flight information	Moderate to high
Seating availability	Moderate to high
Restaurant options	Moderate to high

Arrival	
Attribute name	**Importance**
Signage at baggage claim	High
Baggage delivery time	Moderate to high
Baggage carts	High
Signage for circulation	High
Curb space	Moderate to high
Level changing	High
Washrooms	High
Walking distance	Moderate to high
Electric carts	Moderate to Low
Restaurant options	Moderate to Low
Space at baggage claim area	Moderate to high

6.5.1 Definition of the grading thresholds

According to methodology section 3.9.5 an overall service grade is resented by the corresponding minimum service quality criteria. Minimum service quality criteria is defined as a specific state of overall service quality denoted by S_{omr} and given by:

$$S_{omr} = \{S_{1mr}, S_{2mr}, \dots, S_{(n-1)mr}, S_{nmr}\} \quad (43)$$

Where:

$$v_{kmr} = \begin{cases} 0, & for\ k \notin B_r \\ > 0, & for\ k \in B_r \end{cases}$$

S_{kmr} is the attribute minimum state of service availability of the k^{th} attribute for the r^{th} service grade, v_{kmr} is the value of S_{kmr} given by the service level.

Appendix Table G-1 and G-2 shows the minimum service criteria defined using the attributes considered for analysis. “1” represents the attribute service states included for minimum service criteria of a certain overall service grade. “0” indicates the attribute service states not included for minimum service criteria. Therefore identification of thresholds of successive overall service grades using objective criteria is shown.

6.5.2 Definition of the minimum score

In the overall grading scheme defined, thresholds of grades are defined using minimum service criteria and a minimum score. In other words minimum score is a resultant of providing the minimum service criteria for a certain grade. A score for attribute state of service availability is obtained by multiplying the attribute value of relative importance w_dc_k with the value of attribute state of service availability Y_{ki}. Where Y_{ki} is defined as the value of k^{th} attribute state of service availability at i^{th} service level (Chapter-3, section3.9.3).

$$s_{ki} = w\_dc_k \times Y_{ki} \tag{44}$$

Where:

s_{ki} is the score for attribute state of availability at i^{th} service level,

w_dc_k is the value of relative importance obtained from Table 6-40 and Table 6-41.

According to the above equation, the attribute score linearly increase with the state of attribute service availability. This linear relationship was used for simplicity. Determinates of the functional relationship between service level increments and score can include marginal importance of service quality increments perceived by users, marginal increase in cost of service provision or combination of both in terms of total cost (benefit to users + cost to the operator).

Then the total score T for a given overall service quality state is given by:

$$T = \sum_{k=1}^{n} s_{ki} \tag{45}$$

Where n is the total number of attributes considered for evaluation of the flow path.

Equation-43 above defines the overall service state of the minimum service criteria of r^{th} grading level.

Let s_{kmr} denote the score of k^{th} attribute state of availability for the minimum service criteria for r^{th} overall service grading level.

Let T_r denote the total minimum score at the threshold of the r^{th} overall grading level.

Where r = 1, 2, 3

Then T_r is given by:

$$T_r = \sum_{k=1}^{n} s_{kmr} \tag{46}$$

Table 6-45 shows the minimum score obtained for the minimum service criteria defined in Appendix Table G-1 and G-2.

Table 6-45: Total score for grading thresholds

	Total minimum score (T_r)	
Overall grading	Departing flow path	Arriving flow path
Basic	6.2	7.64
Average	20.7	20.12
Above average	36.56	31.73

A scoring system provides flexibility for defining overall service quality standards compared to using only the minimum service quality criteria. Minimum service quality criteria will only encompass the most important set of attributes and it is intended to ensure a minimum standard of overall service provision with respect to a certain level of grading. However one need to be careful to leave room for service differentiation for the industry to be competitive. Modern airport terminals have a wide range of services that are differentiated to focus various customer segments based on types of passenger and airlines. Minimum service quality criteria alone cannot adequately account for such service differentiations specific to airport markets. Flexibility of the overall grading scheme can be improved by including a scoring system in addition to the minimum service quality criteria. This can be achieved by defining the overall service standard as a combination of minimum service quality criteria and a minimum total score T_r^* such that:

$T_r^* > T_r$

Let δ denote the difference between T_r^* and T_r , then it shows:

$$T_r^* = T_r + \delta \tag{47}$$

The value of δ may represent service quality added using optional criteria that is not specified under minimum service criteria. Therefore this margin can be defined in order to allow for market or airport specific service quality differentiations in addition to satisfying minimum service criteria. This additional margin allows the threshold to be further regulated beyond the minimum service requirement in order to allow for a wider range of service attributes.

6.6 Conclusion

Methodology proposed in Chapter 3 of thesis was applied to determine a set of overall service quality standards for an airport passenger terminal. Data collected using the stated preference survey methodology explained Chapter 5 of this thesis was used. Overall service quality standards were defined for arriving passenger flow path and departing passenger flow path separately. Some specific conclusions drawn from the analysis are as follows:

Proof of hypothesis: The methodology proposed in this thesis used the observed variation in the attribute value of relative importance as the basis for determine the criteria for defining the set of overall service quality standards. In this study the value of attribute relative importance is defined as the relative magnitude of the effect (coefficient) of the service availability of an individual attribute for determining the level of preference for overall service quality of passengers. Attributes are categorised based on the overall value of relative importance as low, moderate-low, moderate-high and high importance. A further categorization of attributes is defined using the type of variation in the value of relative importance against the level of preference for overall service quality. Three types of variations are defined. They are decreasing, constant and increasing. Based on the above categorization of attributes, the model shown in Table 3-8 was used to assign attribute states of service viability as criteria for the overall service quality standards.

Coefficients estimated for the attribute service levels in the discrete choice analysis was used to determine the value of attribute relative importance. Attributes were categorised based on the value of relative importance using the method given in section 3.12.4.1 in Chapter 3. Table 6-44 shows that most of the attributes that are identified as essential were categorised into high and moderate-high categories based on the value of relative importance derived using the above analysis. Coefficients estimated using the generalised ordinal regression analysis was used to determine the type of variation in the attribute effect size with respect to the level of preference. The methodology given in section 3.12.2.1 in Chapter 3 was used. It was observed in the results of the ordinal regression analysis that increasing variations are observed with higher level of significance. However the observed level of significance for decreasing variation in attribute effect sizes is very low. This may have been caused by the limitations in the stated preference survey design used for the collection of data.

Goodness of fit of regression equations: The goodness of fit of all the discrete choice models was good according to the resulting pseudo r^2 value and the percentage of correctly predicted observations. Therefore according to the discrete choice model, the assumed model specification has been able to explain the relationship between the utility for overall service quality and the availability of service attributes quite well. However the goodness of fit in most of the ordinal regression models was found to be low based on the pseudo r^2 and the percentage of correctly predicted observations. This is an indication that the model specification used to explain the level of preference using the utility difference of the availability of service attribute needs further improvements. Improvements can be made to the model specification by considering additional factors such as interactions among attributes and interactions among attributes and sociodemographic variables. However the all the resulted models was statistically significant and most of the attributes were found to be significant determinants of the level of preference.

Survey methodology: A stated preference technique was used. The hypothetical decision context allowed the analyst to control the number and the variation of their service levels. Also it enabled the surveyors to gather responses outside of the airport environment as well. Furthermore this technique allows the respondent to evaluate multiple service attributes as a bundle similar to a real service environment. Despite these advantages some of the limitations associated with this technique may have had an effect on the results. Respondent behaviour in reality being different to what is displayed in a hypothetical context presented in the survey is a major criticism against stated preference technique. In order to minimize this effect, respondents were presented with a detailed description of the hypothetical context within which they made their decision. Also the hypothetical context used in the survey referred to an ordinary airport environment where the respondent is quite familiar in their travel. Hence their response behaviour could be very much similar to their real behaviour. Respondent's information burden is another limiting factor of stated preference survey methods. Unlike direct questioning respondents have to make trade-offs among multiple attribute levels in one question. This limits the number of attributes that can be included in one question. The size of the overall survey design also puts a cap on the total number of attributes that can be included in the survey. Airport service environment was classified based on physical layout and functional area.

Survey design: Since the data needed for the study is collected using an experimental design, the specific design of the SP experiment has a very strong effect on the data collected. Classification of the attribute into functional groups, number of categories in the ordinal rating scale and number and type of attribute service levels are the most critical experimental design related decisions that can effect analysis results. The sensitivity of results with regard to the above design related decisions is difficult to be tested. However extensive attentions was given to minimize such biasness affecting the results during the experiment design process as explained in chapter 5 of this thesis. When attributes are categorized into functional groups, the analyst assumes there is negligible trade-off among attributes across groups. However this assumption cannot be tested without sacrificing the questionnaire design complexity or respondent burden. Careful attention was given to grouping of attributes according to relationship to a similar function area. This way it is more valid to assume the trade-offs within a group is more relevant than the trade-offs across groups. The number and the description of service levels used also affect the trade-offs observed in results.

In order to keep the survey design size from getting unwieldy it is necessary to keep attribute service levels to a minimum. At the same time a proper representation of the range of service availability is also required to draw informative conclusions from results. At the same time respondents must be able to easily apprehend the scenario described by the description. It was challenging to manage all the above criteria within the survey design. All the attributes except few required service levels to be descriptive. Thus the service levels needed to be described clearly but in a concise manner. Number of service levels to be used depends on the available information regarding attribute range of service availability. This information was obtained from various literature pertaining to passenger terminal design and operations. However more realistic and current information could be obtained using a survey of a representative group of passenger terminals. Existence of such a data base would be beneficial for the airports industry as a source of information on airport facilities for facility designing and benchmarking practices.

Sources of data collection: Data was collected mainly from two sources. Personal interviews were carried out at the Calgary International Airport (YYC). Additionally the survey was posted online and was circulated among two prominent professional bodies related to engineering. This one of the main advantages offered by using SP survey design, that it allowed recruitment of respondents outside the real airport environment. Data samples from two sources were compared based on multiple socio-demographic characteristics. It is interesting to find out that most of the characteristics did not show a significant difference (Table 6-1). Therefore it was decided to combine the data from both sources for further analysis.

Generalisability of results: The generalizability of survey results is dependent on the representativeness of the respondent sample recruited and the overall context within which the survey was conducted. The scope of an overall service quality grading scheme must be limited to a comparative group of airports in terms of factors such as overall magnitude and type of operations, primary airline markets served and country or region of location. 42% of the 756 respondents was recruited at the Calgary International airport. Remaining 58% of the respondents were recruited online. 80% of the online respondents are from Canada, remaining 20% were located in 10 different countries. Out of the 80% respondents within Canada 85% were located in the province of Alberta. Therefore majority of the respondents represent airport users in Alberta, Canada. Thus the generalisability of the results is limited to the preferences of airport users in the province of Alberta, Canada. This is a limitation in terms of the findings made in this study. Data analysis revealed that sociodemographic variables such as age, gender, income level, trip purpose affect the user's preference for service quality. In order to improve the generalizability of the results, data need to be collected from a wider population of airport users. The ability to disseminate the survey online has the advantage of recruiting respondents spread geographically with minimum cost.

The online survey was mainly disseminated among the members of two prominent engineering professional bodies. Therefore the sample of respondents taking the online survey is biased in terms of variables such as income level and gender. This is also a limitation in terms of the recruited sample of respondents for the survey. It is ideal to recruit the entire sample of respondents at airports representing different geographical regions in order to maximize the generalizability of the findings. However, restrictions in terms of resources and access to airports greatly limit the ability to collect data from a wider population of users.

The context within which the data was collected is another factor that affects generalizability. In this research a hypothetical context was used with a stated preference experiment design. All the attributes and their service level were described in a generic fashion to avoid any implicit or explicit relevance to a particular airport terminal. Therefore, data collected from a stated preference experiments are considerably higher compared to survey data collected with respect to a specific airport context. It is important to give careful attention when choosing type of attributes and attribute range of service availability for the experiment design, to adequately represent the service availability of the group of airports considered for the study.

Including additional attributes: The overall service quality standards developed will only be valid for the attributes and their range of service availability considered in the study. It is expected that provision of service at airport passenger terminals are evolving very fast and new developments are regularly introduced to the industry. Thus the flexibility of the methodology to cope with the changes in the industry is very important. Based on the analysis technique used, estimation of relative importance for a completely new attribute or a new service level of an existing attribute cannot be performed individually. Nevertheless future developments that are foreseen at the development stage of the methodology can be considered to be included in the stated preference questionnaire design. The hypothetical context of the stated preference technique is advantageous in this particular case as the respondent can be made to evaluate an attributes or a service level that does not exist in reality.

Data validation: No analysis was performed in order to test the validity and the reliability of the data used in this study. This is a limitation found in the analysis process used for this study. Therefore the result and the conclusions derived based on them are subjective to possible inconstancies found in data.

Chapter Seven: Conclusions and Recommendations

7.1 Conclusions

The beginning and throughout this work, the important need for a set of objectively defined overall service quality standards for airport passenger terminals was mentioned. It was pointed out that despite a lot of attention being focused on evaluation and standardising of individual service attributes, the concept of objective standards for overall service quality was not taken up by the research fraternity. Airports industry has shown keen interest in using overall service grading mainly for service quality benchmarking and marketing purposes. Currently this is carried out by third party organizations such as Skytrax and the airports council international (ACI). However there is no methodology developed in order to define overall service quality standards using objectively defined service performance criteria. In order to fill this knowledge gap and industry requirement, this research has proposed a methodology for determining a set of objectively defined overall service quality standards.

A minimum service quality criteria was used to define the overall standards. The minimum service quality criteria was defined using a combination of objectively defined service levels of multiple key service attributes. Variation in the attribute value of relative importance was used as the basis for assigning each attribute service level to minimum service quality criteria of each standard. A stated preference survey technique was used to establish a functional relationship between attribute service levels and the level of preference. The coefficients estimated for the utility functions were used to calculate the relative importance of each attribute. This study took into consideration 35 different service attributes and it was able to evaluate both departing and arriving passenger flow paths.

The objective of the data collection and analysis was to identify different types of service attributes based on the variation in the value of attribute relative importance. Statistical significance of increasing and decreasing variation was tested against the null hypothesis of them being constant. Both variation types obtained significant results, however increasing attribute effects showed slightly more significance than decreasing effects. Nevertheless results of the data analysis presented in Chapter-6 shows reasonable evidence to support the existence of the hypothesized variations in attribute value of relative importance for determining overall service quality preference. Thus, there is potential for refining the survey methodology and analysis technique in future work in order to improve the accuracy of the methodology.

A key component of the research methodology was the identification of comparable airport groups in terms key passenger characteristics. Identification of comparable groups of airports is an important requirement for the establishment overall service quality standards. It was shown in Chapter 4 of the thesis that available classification criteria such as annual total passenger volume is too broad and does not properly address the specific needs of overall service quality evaluation and standardization. It was shown in the same chapter that more disaggregate variables such as annual volume of international passengers, domestic passengers and transfer passengers as multiple classification criteria can be used in order to improve the state of the art.

Considering overall outcome of this thesis, it is suggested that the methodology developed under this research can be used to establish a set of objectively defined overall service quality standards for airport passenger terminals. Previous work stressed the importance of overall service quality evaluation, however a methodology to define an objective criteria for a set of overall service quality standards is proposed for the first time as a result of this research. Another important advancement achieved by the proposed methodology is that it is capable of combining continuous and categorical measures of service availability to a common evaluation framework.

7.2 Limitations and recommendations for future work

7.2.1 Limitations

Majority of the respondents represent airport users in Alberta, Canada. Thus the generalisability of the results is limited. This is a limitation in the findings made in this study. Data analysis revealed that sociodemographic variables such as age, gender, income level, trip purpose affect the user's preference for service quality. In order to improve the generalizability of the results, data need to be collected from a wider population of airport users. The ability to disseminate the survey online has the advantage of recruiting respondents spread geographically with minimum cost.

No analysis was performed in order to test the validity and the reliability of the data used in this study. This is a limitation in the analysis process used for this study. Therefore the result and the conclusions derived based on them are subjective to possible inconstancies in data.

The online survey was mainly disseminated among the members of two prominent engineering professional bodies. Therefore the sample of respondents taking the online survey is biased in terms of variables such as income level and gender. This is also a limitation in terms of the recruited sample of respondents for the survey. It is ideal to recruit the entire sample of respondents at airports representing different geographical regions in order to maximize the generalizability of the findings. However, restrictions in terms of resources and access to airports greatly limit the ability to collect data from a wider population of users.

Respondent behaviour in reality being different to their stated response to a hypothetical context presented in the survey is a limitation in this study. This limitation is difficult to be completely avoided when a stated preference survey technique is used. However careful attention was given in the questionnaire design process in order to improve the realism, clarity and understandability of the hypothetical scenarios presented to the respondents.

The overall service quality standards developed in this study is limited in terms of the attributes and their range of service availability considered for data collection. Restrictions imposed by the stated preference survey design process is a major factor contributing to this limitation. Therefore the data collection was limited to a set of most important service attributes. There are other important service attributes such as airport access road way facilities, parking facilities and facilities passengers needing assistance that were left out of this study. Future research need to be performed in order to determine the necessary parameters associated with the above attributes and integrate them into the framework of overall service quality standards developed in this study.

Attribute range of service availability used for the survey represents generic service conditions based on data obtained from literature sources. This could have been further improved if actual data on the range of service availability was obtained in a sample of passenger terminals. Currently such data is not publically available in sufficient detail required for the study. However data can be collected using a field survey or a questionnaire survey of airport operators. Attempt was made by this research to obtain the necessary data using a questionnaire survey circulated among multiple airport operators of Canada. Unfortunately sufficient data was unable to be collected.

In the process of determining the relative importance weights it was assumed that there is minimum trade-offs across functional categories compared to trade-offs within functional areas. However the data collected did not allowed to test this assumption. The particular survey design used for this study did not allow the collection of responses in order to determine relative importance between functional areas. The stated preference survey design can be extended to obtain this data, but at the expense of increasing the complexity of the survey design. Nevertheless as each functional category is considered primary for the overall service provision, any loss of information from the above assumption is minimal.

7.2.2 Recommendations for future work

The concept of objectively defined overall service standards is proposed for the first time for airport service environments. Therefore further improvement of the methodology is required for successful implementation of the concept in the industry. As highlighted in the previous section, it is necessary to collect data on attribute range of service availability for a wider range of airport conditions. Industry-wide corporation is required for effective collection and management of such a data base that is regularly updated based on new developments in the industry. Such a data base has lot of value for industry applications and research related to service quality in general.

Provided the above information is made available, it necessary to define service level standards for objective attributes with categorical service measures. This is similar to the level of service (LOS) standards defined for attributes with continuous measures such as distance, time and space availability. Availability of such standards for key service attributes such as flight information display, availability of washrooms and passenger conveyance methods is valuable in terms of terminal design and management of services.

This study defined overall service quality grading separately for departing and arriving flow paths. Further research is needed to determine the relevance and validity of combining the two measures to produce a single overall service quality grading to the whole terminal.

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Appendix A: Airport classification methods

Appendix Table A 1: Airport classification used by Transport Canada

Airports	NAS	**National Airport System:** One of the two categories of airports covered by the Canada's National Airport Policy. The NAS includes airports in all national, provincial and territorial capitals, as well as airports with annual traffic of 200,000 passengers or more.
	Regional/local	This is the second category of airports that's covered from the National Airport Policy. • whose scheduled passenger traffic is less than 200,000 a year for three consecutive years • Not the national capital or a provincial or territorial capital • Not classified as Arctic or remote airports • Where there is currently some form of ongoing federal financial involvement relating to the ownership or operation of the airport
	Small Airports	A group of 31 small, federally-supported airports which have no regularly-scheduled air service. They serve local interests only, such as general aviation and recreational flying. In many instances, these airports are operated on behalf of the federal government by municipalities or other local entities.
	Satellite Airports	• **This belongs to Small Airport category** • Several of the larger international airports within the NAS group are complemented by "satellite" airports. These airports help ensure the safe and efficient operation of the larger international airports they serve by diverting small, general aviation (recreational and training aircraft) away from the larger airport. • Initially, these satellites will be included as part of the NAS and will be offered to those airport authorities wishing to assume the operational responsibility of the corresponding satellite airports.

Appendix Table A 2: Airport classification used by Federal Aviation Authority, USA

<table>
<tr><th colspan="3">Airport classification</th><th>Common Name</th></tr>
<tr><td rowspan="8">Commercial service:
Publicly owned airports that have at least 2,500 passenger boarding each calendar year and receive scheduled passenger service</td><td>Primary:</td><td>Hub Type: Percentage of Total US Annual Passenger Boarding</td><td></td></tr>
<tr><td rowspan="4">Commercial Service Airports that have more than 10,000 passengers boarding each year.</td><td>Large:
1% or more</td><td>Large hub</td></tr>
<tr><td>Medium:
At least 0.25%, but less than 1%</td><td>Medium hub</td></tr>
<tr><td>Small:
At least 0.05%, but less than 0.25%</td><td>Small hub</td></tr>
<tr><td>Non-hub primary:
More than 10,000 but less than 0.05%</td><td>Non-hub primary</td></tr>
<tr><td>Non-Primary:
At least 2,500 and no more than 10,000</td><td>Non-hub</td><td>No primary Commercial Service</td></tr>
<tr><td colspan="2">Cargo service:
Airports that, in addition to any other air transportation services that may be available, are served by aircraft providing air transportation of only cargo with a total annual landed weight of more than 100 million pounds. "Landed weight" means the weight of aircraft transporting only cargo in intrastate, interstate, and foreign air transportation. An airport may be both a commercial service and a cargo service airport.</td><td>Cargo service</td></tr>
<tr style="display:none"></tr>
<tr><td colspan="3">Reliever:
Airports designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access to the overall community. These may be publicly or privately-owned.</td><td>Reliever</td></tr>
<tr><td colspan="2" rowspan="2">General Aviation (Non Primary) :
The remaining airports, while not specifically defined in Title 49 USC, are commonly described as General Aviation Airports.
This airport type is the largest single group of airports in the U.S. system. The category also includes privately owned, public use airports that enplane 2500 or more passengers annually and receive scheduled airline service.</td><td>General aviation</td><td></td></tr>
<tr><td>Cargo service</td><td></td></tr>
</table>

Appendix B: Stated preference questionnaire design

Appendix Table B 1: Attribute service levels for arrival circulation

Attribute name (coefficient label)	1	2	3
Signage for circulation (Signage)	Clear directions • Available to important areas (Check-in, security, gates, food court, washrooms)	Clear directions[29] • Not available	
Walking distance and time information (Ttnod)	Walking time to important areas • Displayed	• Not displayed[29]	
Changing levels(Chnglvl)	• No level changes needed (same level)[29]	Level changes required • Escalators & elevators available	Level changes required • Only elevators available (No escalators)
People conveyance within the terminal (conv)	Moving walk ways, shuttles • Available (Walking minimized)	Moving walk ways, shuttles[29] • Not available (Longer walking)	
Electric carts (Eleccrt)	• Electric carts available	• Electric carts not available[29]	

[29] Considered as reference level for dummy coding

Appendix Table B 2: Attribute service levels for arrival baggage claim

Attribute name(coefficient label)	1	2	3
Signage (Signage)	Baggage belt Signage • Good signage-easy to find baggage belt	• Poor signage-difficult to find[30]	
Delivery time (delt)	Waiting time at the claim area • Less than 1minutes	• Between 5 to10 minutes[30]	• Between 15 to 20 minutes
Distance to (bbltl) curb/transit access	• less than 1minute walk	• 5minute walk[30]	• 10minute walk
Space availability(Space)	Baggage claim area • Lot of space available (spacious)	Baggage claim area[30] • Insufficient space available (congested)	
Carts and porters (bagc)	Baggage carts at the claim area • Adequate number available- Free of charge	• Adequate number available- paid carts	• Number of carts inadequate[30]

[30] Considered as reference level for dummy coding

Appendix Table B 3: Attribute service levels for arrival common amenities

Attribute name (coefficient label)	**1**	**2**	**3**	**4**
Coffee shop/restaurants (cofres)	Coffee shop/restaurants • Available at arrival gates • Available after baggage claim	Coffee shop/restaurants • Not available at arrival gates • Available after baggage claim	Coffee shop/restaurants • Available at arrival gates • Not available after baggage claim	Coffee shop/restaurants[31] • Not available at arrival gates • Not available after baggage claim
Information booths/desks (info)	Information desks/staff available	Information desks/staff not[31] available		
Availability of washrooms (wsh)	Number of washrooms • Adequate at arrival gates • Adequate after baggage claim	Number of washrooms • Inadequate at arrival gates • Adequate after baggage claim	Number of washrooms • Adequate at arrival gates • Inadequate after baggage claim	Number of washrooms[31] • Inadequate after baggage claim • Inadequate at arrival gates
Hydration stations (water)	Drinking Water fountains • Available	• Not available[31]		
Internet connectivity (Intnt)	Internet • Free Wi-FI	• Paid Wi-FI	• Internet access not available[31]	

[31] Considered as reference level for dummy coding

Appendix Table B 4: Attribute service levels for arrival curb area

Attribute name (coefficient label)	**1**	**2**
Signage (Signage_curb)	Clear signage to important curb areas • Available (Taxi, Pick up areas, public transit stop)	Clear signage to important curb areas[32] • Not available
weather protection (weather)	• Curb front/Parking-access weather protected	• Curb front/Parking-access not weather protected[32]
Curb front space for passenger pick-up (Curbspace)	Space availability at curb front area • Sufficient space available	Curb front area[32] • Space insufficient (crowded)
Transit information desk (TransInfo)	Transit/taxi/car rental information desk • Avalable on site	Transit/taxi/car rental information desk[32] • Not available
ATM (ATM)	• Banking machine (ATM) available	• Banking machine (ATM) not available[32]

[32] Considered as reference level for dummy coding

Appendix Table B 5: Attribute service levels for departing lounge areas

Attribute name (coefficient label)	1	2	3
Availability of seating (seating)	• Adequate number of seats available • Basic lounge chairs, resting chairs, sofas	• Adequate number of seats available[33] • Basic lounge chairs only	• Number of seats inadequate (seating congested)
Retail shopping (retail shops)	• Good_choice of Shopping options (Duty-free, retail, book store, souvenirs etc.)	• Poor choice of Shopping options[33]	
Restaurants (restaurants)	• Good choice of food/beverage options (Popular fast food and casual Restaurants, bar etc.)	• Poor choice of food/beverage options[33] (Fast-food/snacks only)	
Power/charging for mobile devices (charging stations)	• Mobile device charging points available	• Mobile device charging points not Available[33]	
Internet connectivity (intent)	• Free Wi-FI internet available	• Free Wi-FI internet not available (paid access)	• Internet access not available[33]

[33] Considered as reference level for dummy coding

Appendix Table B 6: Attribute service levels for departing common amenities

Attribute name (coefficient label)	**1**	**2**	**3**	**4**
Automated services (automated)	Information kiosks (maps, search amenities) • Available at all important nodes	Information, kiosks[34] • Not Available		
Flight information display (fltinfo)	Number of flight information display • Adequate before and after	Number of flight information display • Adequate before security	Number of flight information display • Inadequate before security	Flight information display • Inadequate before and after security[34]
Information booths/desks (info_com)	• Airport ambassadors available	• Information desks available	• No information available[34]	
Availability of washrooms (wsh)	Number of washrooms • Adequate before and after security	Number of washrooms • Inadequate before security • Adequate after security	Number of washrooms • Adequate before security • Inadequate after security	Number of washrooms • Overall inadequate[34]
Hydration stations (water)	• Hydration stations available	• Hydration stations not available[34]		

[34] Considered as reference level for dummy coding

Appendix Table B 7: Attribute service levels for departing circulation

Attribute name (coefficient label)	1	2	3
Signage for circulation (Signage)	Clear directions • Available to important areas (Check-in, security, gates, food court, washrooms)	Clear directions[35] • Not available	
Walking distance and time information (Ttnod)	Walking time to important areas • Displayed	• Not displayed[35]	
Changing levels(Chnglvl)	• No level changes needed (same level)[35]	Level changes required • Escalators & elevators available	Level changes required • Only elevators available (No escalators)
People conveyance within the terminal (conv)	Moving walk ways, shuttles • Available (Walking minimized)	Moving walk ways, shuttles[35] • Not available (Longer walking)	
Electric carts (Eleccrt)	• Electric carts available	• Electric carts not available[35]	

[35] Considered as reference level for dummy coding

Appendix Table B 8: Attribute service levels for check-in area

Attribute name (coefficient label)	1	2	3
Check-in process (chkin)	• Wait less than 1 minute in queue[36]	• Wait between 5 to 10 minutes	• Wait between 15 to 20 minutes
Staff assistance (info_check-in)	• Airport ambassadors available	• Information desks available	• No Information desks available[36] • No airport ambassadors available
Automated kiosks (Check in Kiosk)	• Automated check-in kiosks available	• Automated check-in kiosks not available[36]	
Check-in counter signage (Signage_check-in)	• Dynamic signage at check-in and security (Display expected wait time in queues, flights boarding)	• Static signage[36] (No display of expected wait time in queue)	
Security screening (Sec_screening)	• Preparation before security check not required Walk through with carryon luggage	• Preparation before security check required[36] Passenger and luggage separated	

[36] Considered as reference level for dummy coding

Appendix Table B 9: Attribute service levels for departure curb area

Attribute name (coefficient label)	**1**	**2**	**3**
Curb front space (Curb_space)	Curb front area • Not congested (spacious)	Curb front area[37] • Congested (crowded)	
Location of check-in (Distckn)	Distance from curb front/parking to check-in • less than 1 minute walk	Distance from curb front/parking to check-in • Between 5-10 minute walk[37]	Distance from curb front to check-in • Between 15 - 20 minute walk
Weather protection (weather)	• Weather protection available	• Weather protection not available[37]	
Baggage carts (carts)	Baggage carts • Availability at curb front is good	Baggage carts[37] • Availability at curb front is poor	
Porters (porter)	• Porters available for baggage handling	• Porters not available for baggage handling[37]	

[37] Considered as reference level for dummy coding

Appendix Table B 10: Experiment design – lounge facilities -Departing

Treatment code	Availability of seating	Retail shopping	restaurants	Charging for mobile devices	Internet		Availability of seating	Retail shopping	restaurants	Charging for mobile devices	Internet
#	Alternative A						Alternative B				
DLNG1	2	1	2	1	2		1	1	1	2	1
DLNG2	1	2	2	1	3		3	2	2	2	1
DLNG3	1	2	1	2	2		2	1	2	1	2
DLNG4	1	1	2	1	1		1	2	1	1	3
DLNG5	1	2	1	1	3		1	1	2	1	1
DLNG6	3	2	2	2	1		1	1	1	1	1
DLNG7	2	1	2	2	3		3	1	1	1	2
DLNG8	1	1	1	1	1		1	2	2	2	2
DLNG9	1	1	1	2	1		2	2	1	1	1
DLNG10	1	1	2	2	1		2	2	1	2	1
DLNG11	3	1	1	2	3		3	2	2	1	1
DLNG12	3	2	2	1	1		1	2	1	2	2
DLNG13	3	1	1	1	2		1	1	2	2	1
DLNG14	2	2	1	2	1		2	1	2	2	3
DLNG15	1	2	2	2	2		3	1	1	2	3
DLNG16	2	2	1	1	1		1	2	2	1	3

Appendix Table B 11: Experiment design – Common amenities -Departing

Treatment code	Automated services	Flight information display	Information booths/desks	Availability of washrooms	Hydration stations		Automated services	Flight information display	Information booths/desks	Availability of washrooms	Hydration stations
	Alternative A						Alternative B				
DCOM1	2	4	3	1	2		1	1	1	1	1
DCOM2	2	1	2	3	1		2	4	3	1	2
DCOM3	2	1	1	2	2		1	3	2	1	2
DCOM4	2	4	1	4	1		1	1	3	4	2
DCOM5	2	3	3	2	1		2	2	2	4	2
DCOM6	2	3	1	3	2		2	4	1	4	1
DCOM7	1	4	1	3	2		2	1	2	3	1
DCOM8	1	2	3	3	1		2	3	3	2	1
DCOM9	2	2	2	4	2		1	3	1	4	1
DCOM10	1	3	1	4	1		1	4	2	2	1
DCOM11	1	2	1	2	2		2	2	1	1	1
DCOM12	2	2	1	1	1		1	4	1	3	2
DCOM13	1	3	2	1	2		1	2	3	3	1
DCOM14	1	1	1	1	1		1	2	1	2	2
DCOM15	1	1	3	4	2		2	3	1	3	2
DCOM16	1	4	2	2	1		2	1	1	2	2

Appendix Table B 12: Experiment design – Check-in area -Departing

Treatment code	Check-in process	Staff assistance	Automated kiosks	Check-in counter signage	Security screening		Check-in process	Staff assistance	Automated kiosks	Check-in counter signage	Security screening
#	Alternative A						Alternative B				
DCHK1	2	2	2	1	1		1	1	1	2	1
DCHK2	1	3	2	1	2		3	1	2	2	2
DCHK3	1	2	1	2	2		2	2	2	1	1
DCHK4	1	1	2	1	1		1	3	1	1	2
DCHK5	1	3	1	1	2		1	1	2	1	1
DCHK6	3	1	2	2	2		1	1	1	1	1
DCHK7	2	3	2	2	1		3	2	1	1	1
DCHK8	1	1	1	1	1		1	2	2	2	2
DCHK9	1	1	1	2	1		2	1	1	1	2
DCHK10	1	1	2	2	1		2	1	1	2	2
DCHK11	3	3	1	2	1		3	1	2	1	2
DCHK12	3	1	2	1	2		1	2	1	2	2
DCHK13	3	2	1	1	1		1	1	2	2	1
DCHK14	2	1	1	2	2		2	3	2	2	1
DCHK15	1	2	2	2	2		3	3	1	2	1
DCHK16	2	1	1	1	2		1	3	2	1	2

Appendix Table B 13: Experiment design – Curb area -Departing

Treatment code	Curb front space	Distance to check-in	Weather protection	Baggage carts	Porters		Curb front space	Distance to check-in	Weather protection	Baggage carts	Porters
	Alternative A						Alternative B				
DCUB1	1	1	1	1	1		2	3	1	1	2
DCUB2	2	1	2	2	2		1	1	1	1	1
DCUB3	2	1	2	1	1		2	2	1	2	1
DCUB4	1	3	2	2	1		1	1	1	2	2
DCUB5	1	2	2	1	2		2	1	2	2	2
DCUB6	2	2	1	2	1		1	2	2	1	2
DCUB7	1	1	1	2	2		2	1	2	1	1
DCUB8	2	3	1	1	2		1	3	2	2	1

Appendix Table B 14: Experiment design – Circulation -Departing

Treatment code	Signage for circulation (Way finding)	Time to nodes	Changing levels (floors)	People conveyance	Electric carts		Signage for circulation (Way finding)	Time to nodes	Changing levels (floors)	People conveyance	Electric carts
#	Alternative A						Alternative B				
DCIR1	1	1	1	1	1		2	1	3	1	2
DCIR2	2	2	1	2	2		1	1	1	1	1
DCIR3	2	2	1	1	1		2	1	2	2	1
DCIR4	1	2	3	2	1		1	1	1	2	2
DCIR5	1	2	2	1	2		2	2	1	2	2
DCIR6	2	1	2	2	1		1	2	2	1	2
DCIR7	1	1	1	2	2		2	2	1	1	1
DCIR8	2	1	3	1	2		1	2	3	2	1

Appendix Table B 15; Experiment design – Baggage claim area -Arriving

Treatment code	Signage	Delivery time	Baggage belt location	Space availability	Baggage Carts		Signage	Delivery time	Baggage belt location	Space availability	carts and porters
	Alternative A						Alternative B				
ABGC1	1	3	3	1	2		2	1	1	2	2
ABGC2	2	3	2	2	1		2	2	3	1	3
ABGC3	2	2	1	1	1		1	1	3	2	1
ABGC4	2	1	1	1	1		1	1	2	1	3
ABGC5	2	1	2	1	2		1	1	1	2	3
ABGC6	2	1	1	2	2		1	2	2	2	1
ABGC7	1	1	3	2	1		2	1	2	1	2
ABGC8	1	1	2	1	3		2	2	1	1	1
ABGC9	2	3	1	2	3		1	1	1	1	1
ABGC10	1	3	1	1	1		2	1	3	2	1
ABGC11	2	1	3	2	1		1	2	1	2	2
ABGC12	1	2	2	2	1		2	1	1	1	1
ABGC13	2	2	3	1	3		2	3	1	2	3
ABGC14	1	1	1	1	1		2	3	2	2	1
ABGC15	1	1	1	2	3		1	3	3	1	2
ABGC16	1	2	1	2	2		1	3	1	1	1

Appendix Table B 16: Experiment design – Common amenities -Arriving

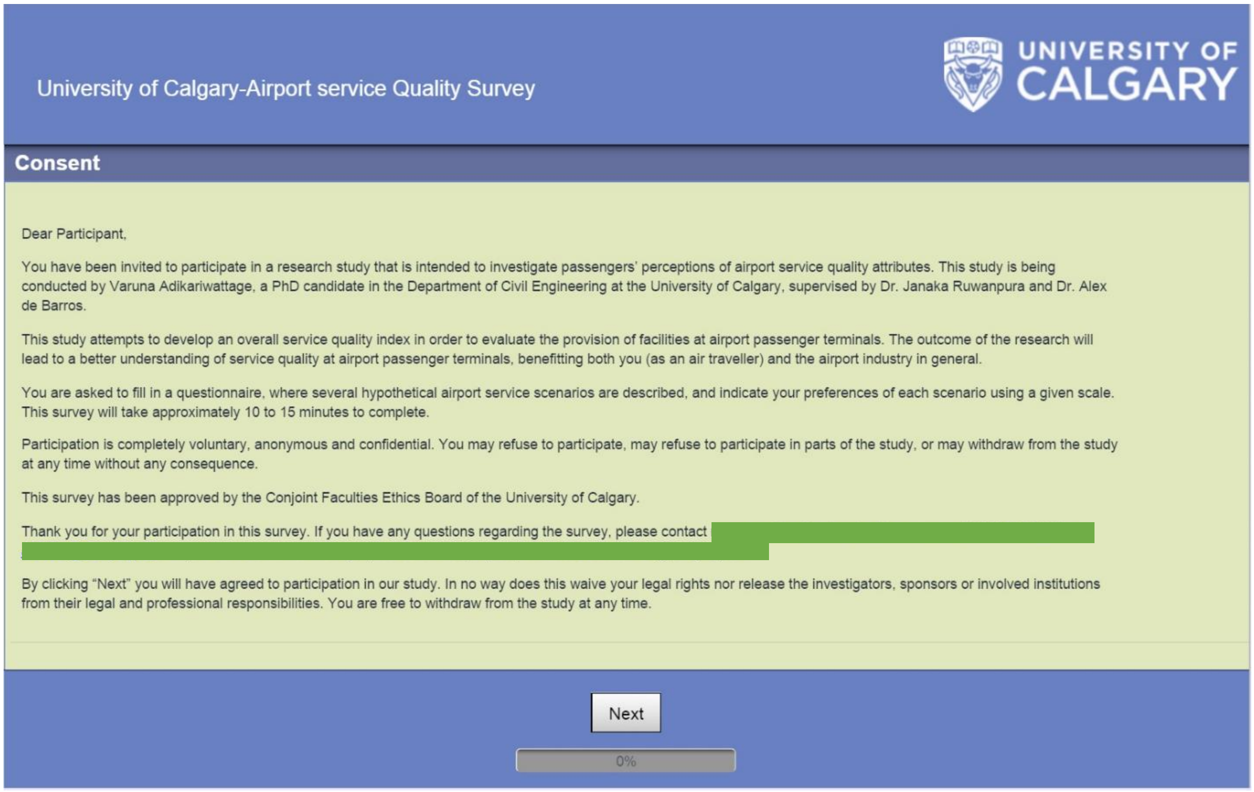
Treatment code	Restaurants	Information	Washrooms	Hydration stations	Internet		Restaurants	Information	Washrooms	Hydration stations	Internet
	Alternative A						Alternative B				
ACOM1	3	1	2	1	3		4	1	3	2	1
ACOM2	3	2	1	2	2		4	2	4	1	1
ACOM3	2	2	1	1	1		4	1	1	2	3
ACOM4	4	2	4	1	1		3	2	1	2	2
ACOM5	4	2	2	1	2		1	1	1	1	1
ACOM6	1	2	2	2	1		3	1	4	1	1
ACOM7	4	1	1	2	3		2	2	3	1	3
ACOM8	1	1	3	1	2		2	2	1	1	1
ACOM9	3	2	3	2	1		2	1	4	2	2
ACOM10	3	1	4	1	1		2	1	2	2	1
ACOM11	1	2	4	2	3		3	2	3	2	1
ACOM12	2	1	4	2	2		3	1	2	1	3
ACOM13	2	2	3	1	3		4	2	2	1	2
ACOM14	1	1	1	1	1		1	2	2	2	1
ACOM15	4	1	3	2	1		1	2	4	2	3
ACOM16	2	1	2	2	1		1	1	3	1	2

Appendix Table B 17: Experiment design – Curb area -Arriving

Treatment code	Signage	weather protection	Curb front Space	Transit information desk	ATM		Signage	weather protection	Curb front Space	Transit information desk	ATM
	Alternative A						Alternative B				
ACUB1	2	2	2	1	2		1	1	1	1	1
ACUB2	1	2	2	2	1		1	2	1	1	2
ACUB3	2	1	1	2	2		2	2	2	1	2
ACUB4	2	2	1	2	1		1	1	2	2	2
ACUB5	1	1	1	1	1		1	2	2	2	1
ACUB6	1	1	2	2	2		2	2	1	2	1
ACUB7	1	2	1	1	2		2	1	2	1	1
ACUB8	2	1	2	1	1		2	1	1	2	2

Appendix Table B 18: Experiment design – Circulation - Arriving

Treatment code	Signage for circulation (Way finding)	Time to nodes	Changing levels (floors)	People conveyance	Electric carts		Signage for circulation (Way finding)	Time to nodes	Changing levels (floors)	People conveyance	Electric carts
#	Alternative A						Alternative B				
ACIR1	1	1	1	1	1		2	1	3	1	2
ACIR2	2	2	1	2	2		1	1	1	1	1
ACIR3	2	2	1	1	1		2	1	2	2	1
ACIR4	1	2	3	2	1		1	1	1	2	2
ACIR5	1	2	2	1	2		2	2	1	2	2
ACIR6	2	1	2	2	1		1	2	2	1	2
ACIR7	1	1	1	2	2		2	2	1	1	1
ACIR8	2	1	3	1	2		1	2	3	2	1



University of Calgary-Airport service Quality Survey

UNIVERSITY OF CALGARY

Consent

Dear Participant,

You have been invited to participate in a research study that is intended to investigate passengers' perceptions of airport service quality attributes. This study is being conducted by Varuna Adikariwattage, a PhD candidate in the Department of Civil Engineering at the University of Calgary, supervised by Dr. Janaka Ruwanpura and Dr. Alex de Barros.

This study attempts to develop an overall service quality index in order to evaluate the provision of facilities at airport passenger terminals. The outcome of the research will lead to a better understanding of service quality at airport passenger terminals, benefitting both you (as an air traveller) and the airport industry in general.

You are asked to fill in a questionnaire, where several hypothetical airport service scenarios are described, and indicate your preferences of each scenario using a given scale. This survey will take approximately 10 to 15 minutes to complete.

Participation is completely voluntary, anonymous and confidential. You may refuse to participate, may refuse to participate in parts of the study, or may withdraw from the study at any time without any consequence.

This survey has been approved by the Conjoint Faculties Ethics Board of the University of Calgary.

Thank you for your participation in this survey. If you have any questions regarding the survey, please contact [redacted]

By clicking "Next" you will have agreed to participation in our study. In no way does this waive your legal rights nor release the investigators, sponsors or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time.

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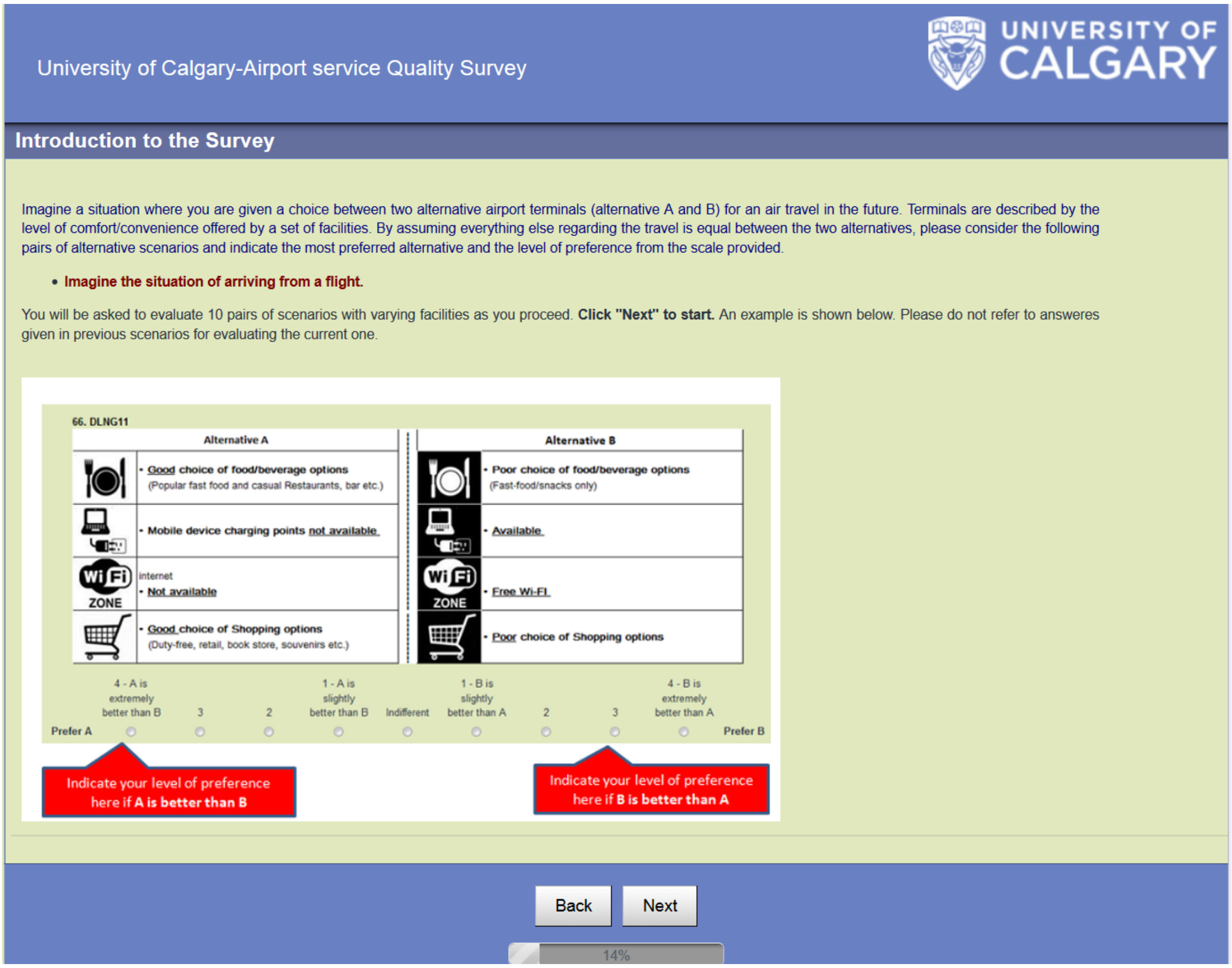
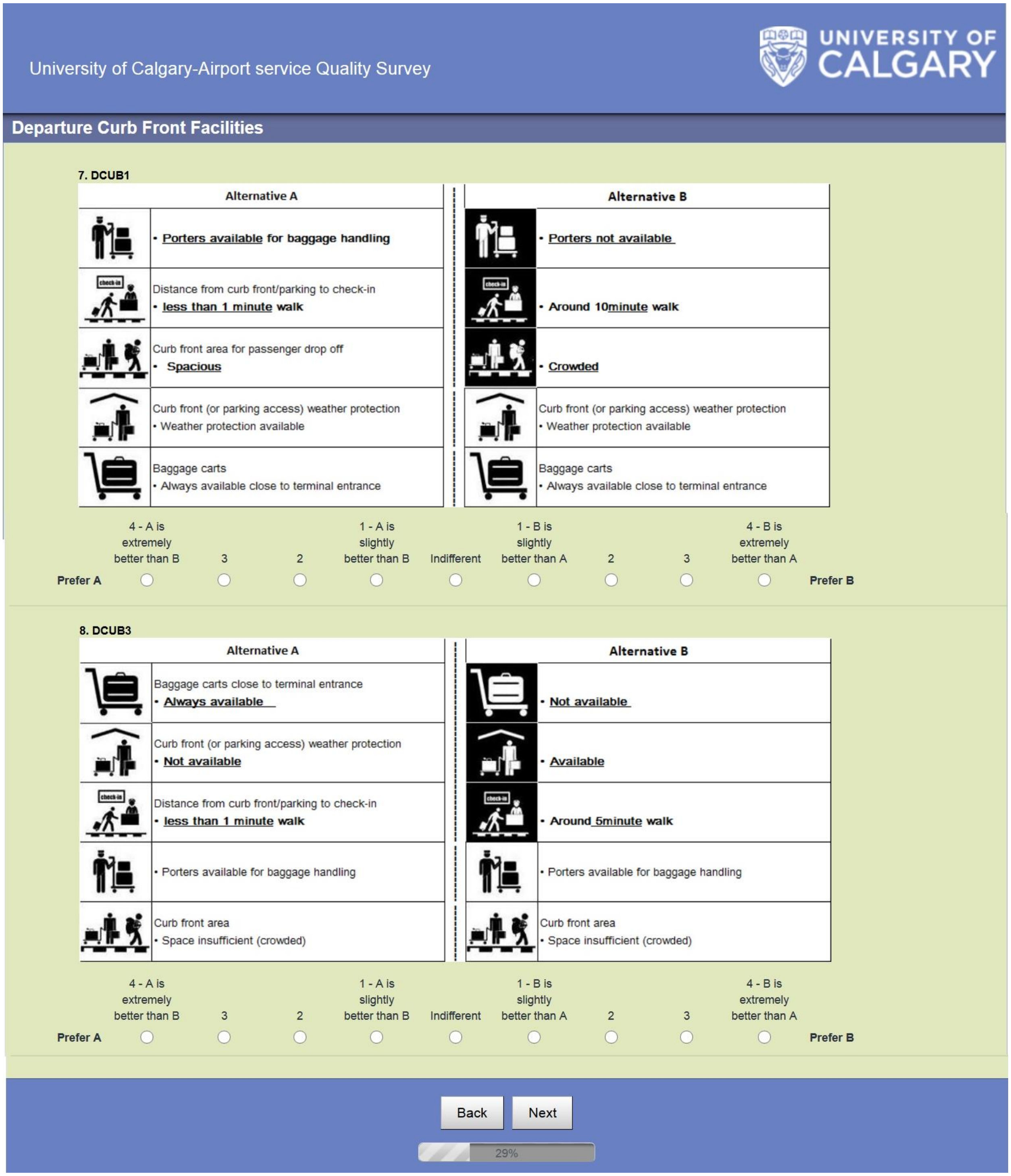
Appendix Figure B 1: Consent form



Appendix Figure B 2: Description of the hypothetical context



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Departure Curb Front Facilities

7. DCUB1

Alternative A	Alternative B
• Porters available for baggage handling	• Porters not available
Distance from curb front/parking to check-in • less than 1 minute walk	• Around 10minute walk
Curb front area for passenger drop off • Spacious	• Crowded
Curb front (or parking access) weather protection • Weather protection available	Curb front (or parking access) weather protection • Weather protection available
Baggage carts • Always available close to terminal entrance	Baggage carts • Always available close to terminal entrance

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

8. DCUB3

Alternative A	Alternative B
Baggage carts close to terminal entrance • Always available	• Not available
Curb front (or parking access) weather protection • Not available	• Available
Distance from curb front/parking to check-in • less than 1 minute walk	• Around 5minute walk
• Porters available for baggage handling	• Porters available for baggage handling
Curb front area • Space insufficient (crowded)	Curb front area • Space insufficient (crowded)

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

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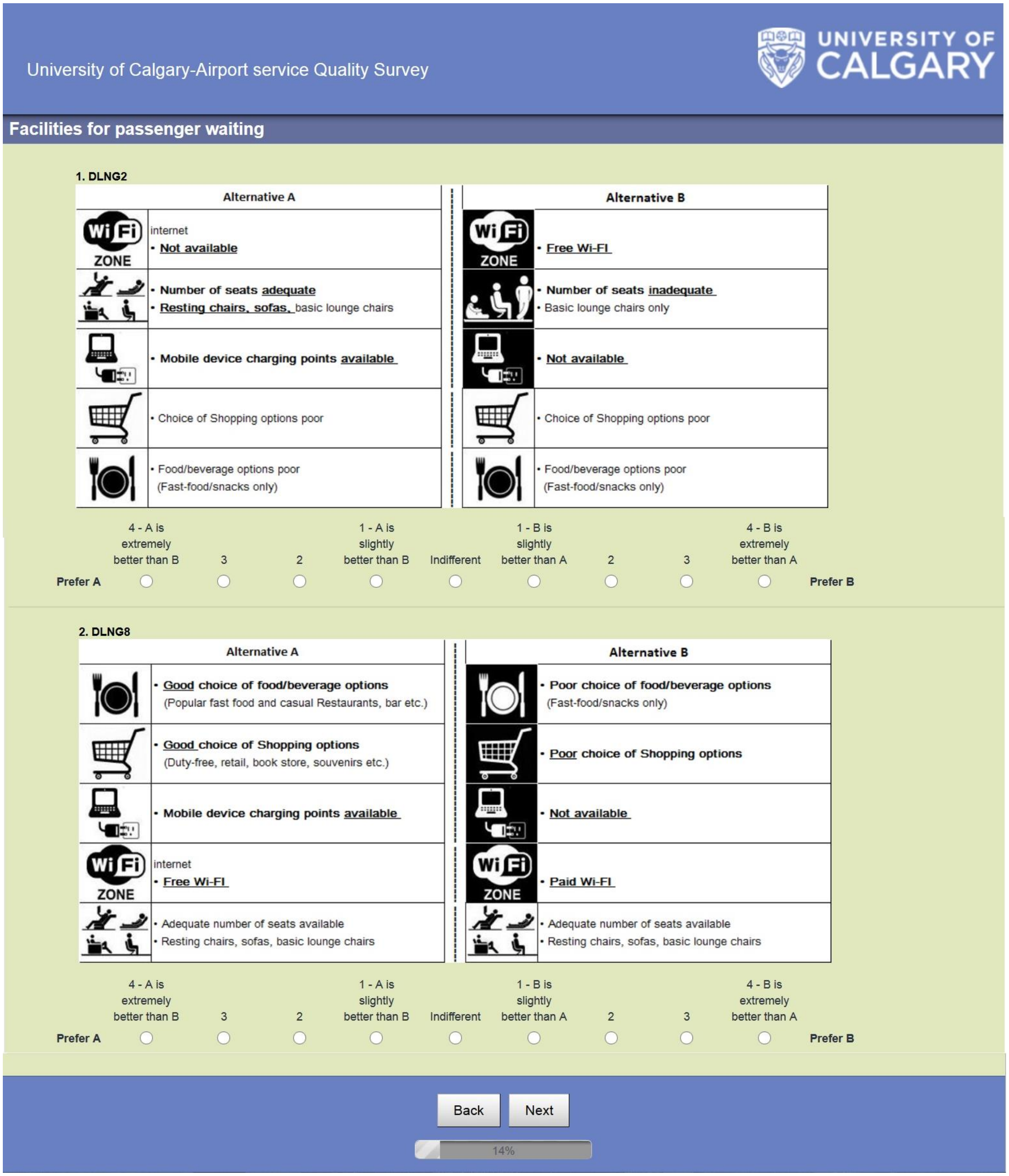
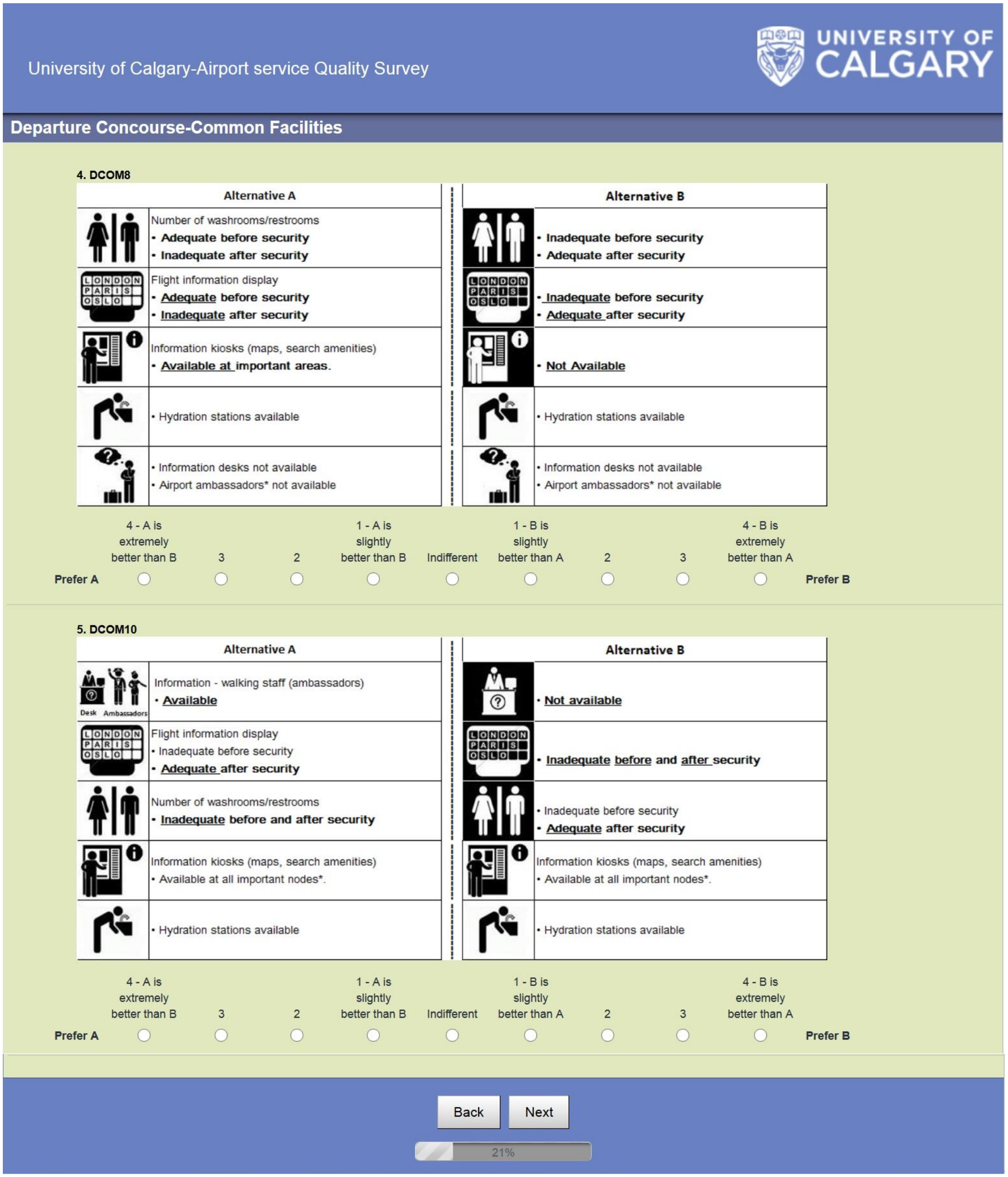
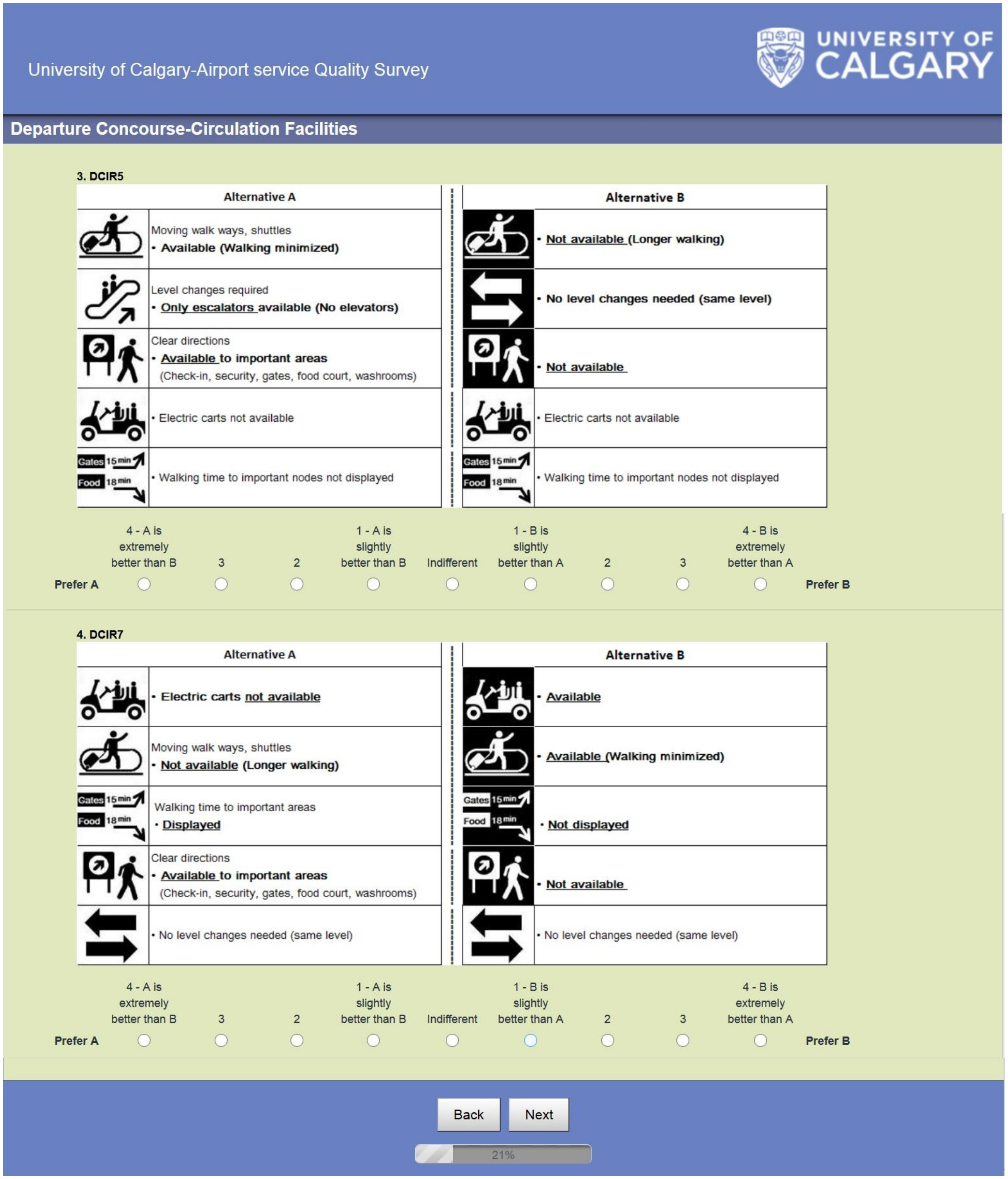
Appendix Figure B 3: Choice sets for departure curb area



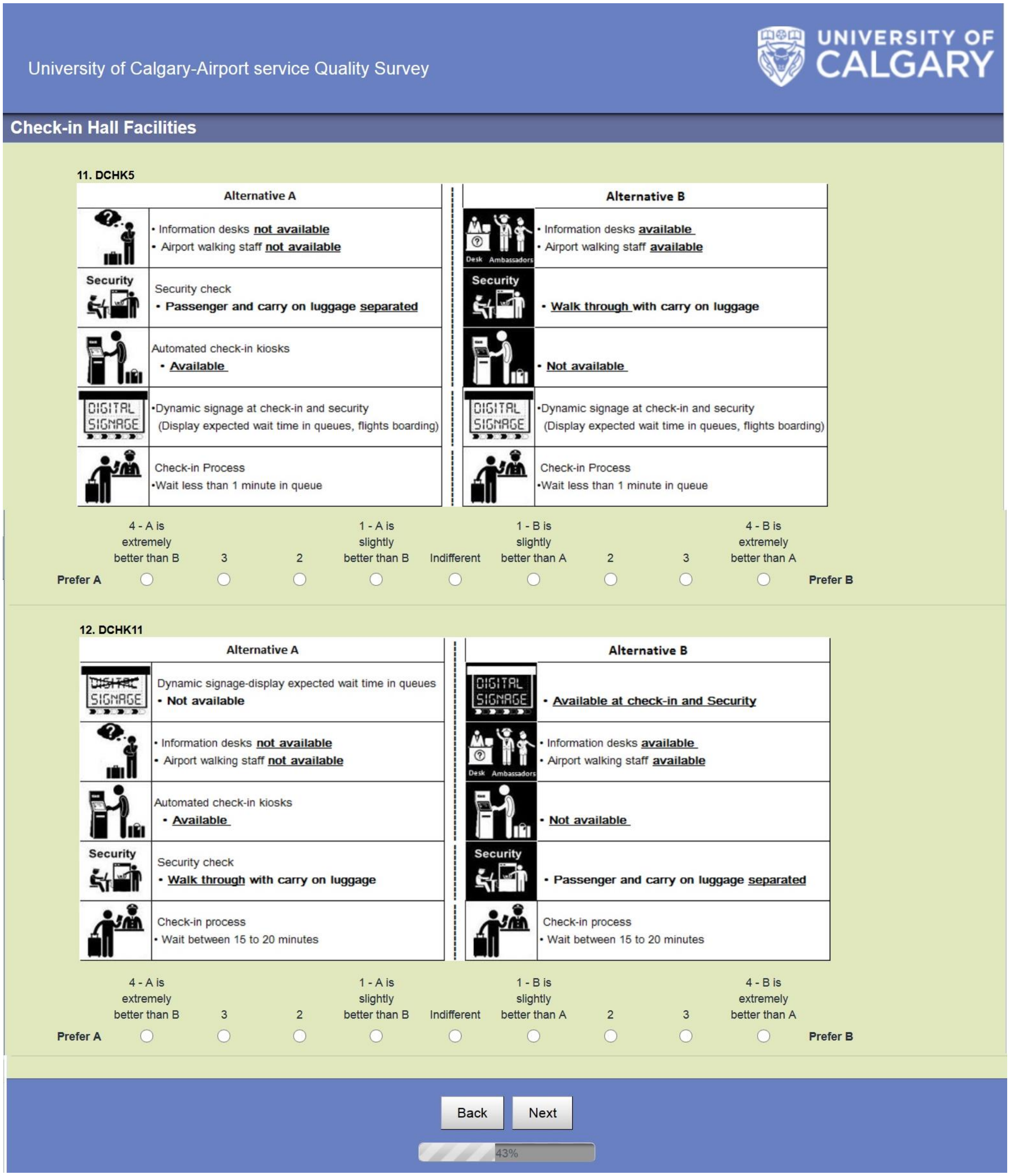
Appendix Figure B 4: Choice sets for departure lounge area



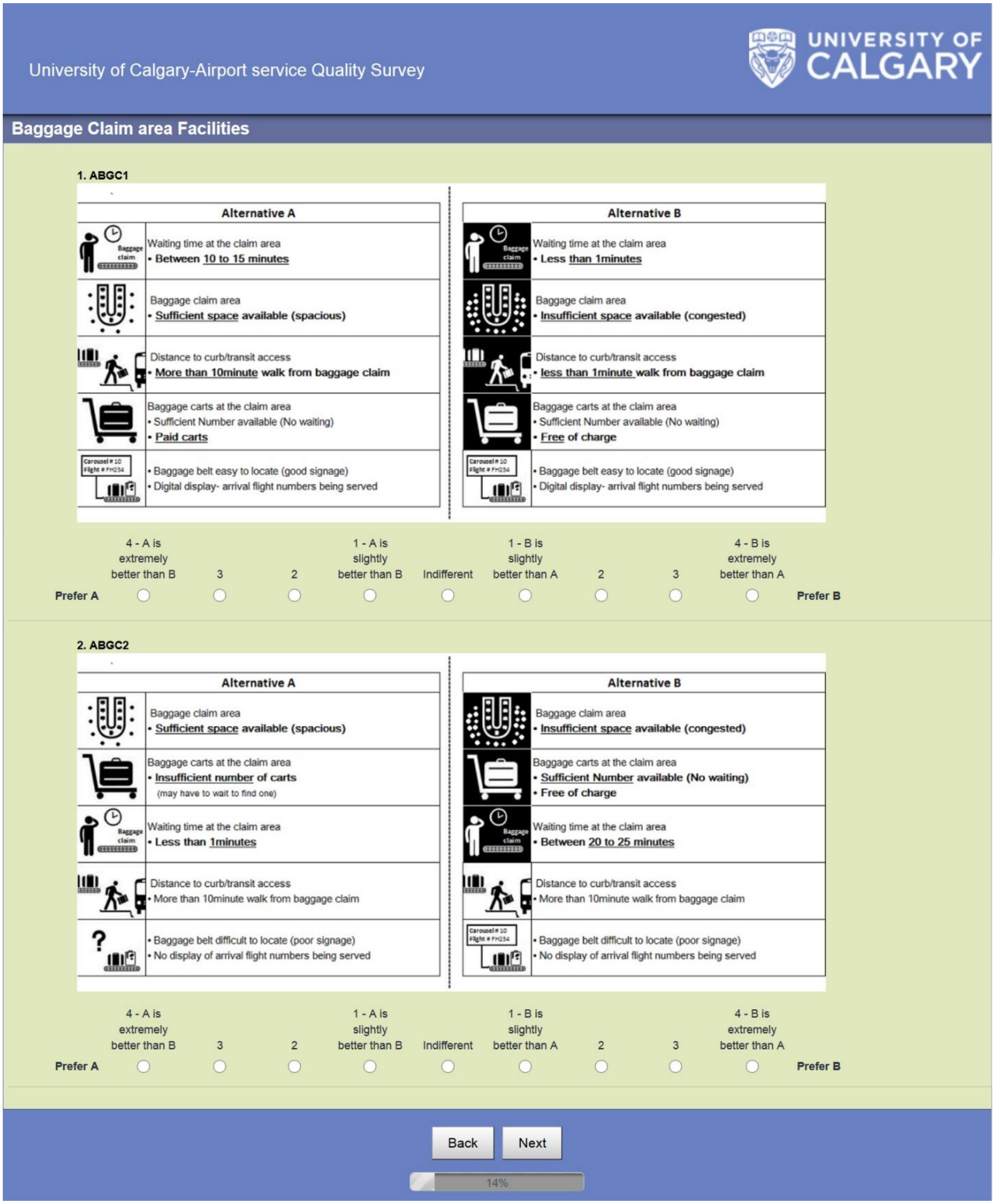
Appendix Figure B 5: Choice sets for departure common amenities



Appendix Figure B 6: Choice sets for departure circulation



Appendix Figure B 7: Choice sets for departure check-in area



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Baggage Claim area Facilities

1. ABGC1

Alternative A	Alternative B
Waiting time at the claim area • Between 10 to 15 minutes	Waiting time at the claim area • Less than 1minutes
Baggage claim area • Sufficient space available (spacious)	Baggage claim area • Insufficient space available (congested)
Distance to curb/transit access • More than 10minute walk from baggage claim	Distance to curb/transit access • less than 1minute walk from baggage claim
Baggage carts at the claim area • Sufficient Number available (No waiting) • Paid carts	Baggage carts at the claim area • Sufficient Number available (No waiting) • Free of charge
• Baggage belt easy to locate (good signage) • Digital display- arrival flight numbers being served	• Baggage belt easy to locate (good signage) • Digital display- arrival flight numbers being served

Prefer A — 4 - A is extremely better than B — 3 — 2 — 1 - A is slightly better than B — Indifferent — 1 - B is slightly better than A — 2 — 3 — 4 - B is extremely better than A — Prefer B

2. ABGC2

Alternative A	Alternative B
Baggage claim area • Sufficient space available (spacious)	Baggage claim area • Insufficient space available (congested)
Baggage carts at the claim area • Insufficient number of carts (may have to wait to find one)	Baggage carts at the claim area • Sufficient Number available (No waiting) • Free of charge
Waiting time at the claim area • Less than 1minutes	Waiting time at the claim area • Between 20 to 25 minutes
Distance to curb/transit access • More than 10minute walk from baggage claim	Distance to curb/transit access • More than 10minute walk from baggage claim
• Baggage belt difficult to locate (poor signage) • No display of arrival flight numbers being served	• Baggage belt difficult to locate (poor signage) • No display of arrival flight numbers being served

Prefer A — 4 - A is extremely better than B — 3 — 2 — 1 - A is slightly better than B — Indifferent — 1 - B is slightly better than A — 2 — 3 — 4 - B is extremely better than A — Prefer B

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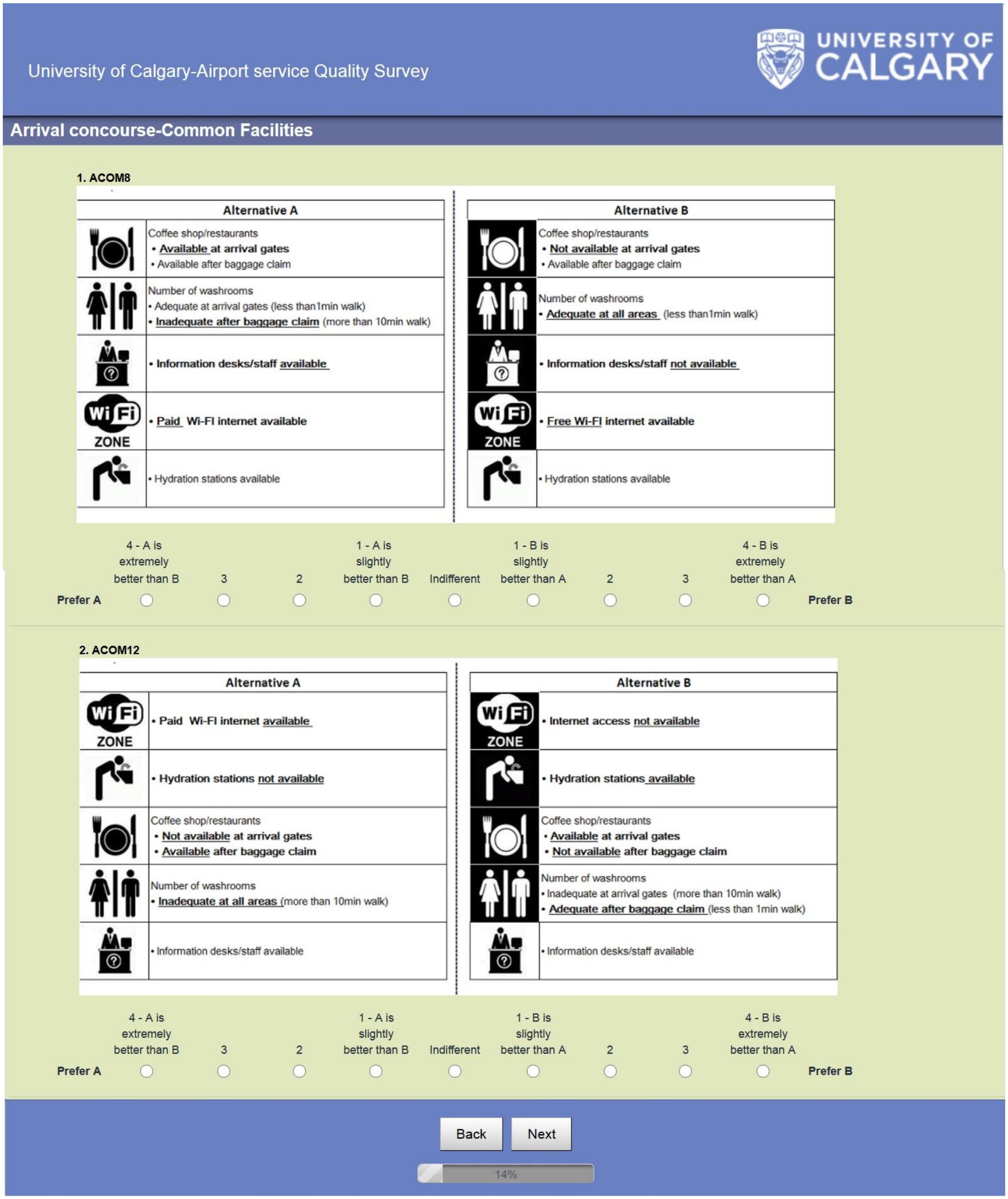
Appendix Figure B 8: Choice sets for arrival baggage claim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Arrival concourse-Common Facilities

1. ACOM8

Alternative A	Alternative B
Coffee shop/restaurants • Available at arrival gates • Available after baggage claim	Coffee shop/restaurants • Not available at arrival gates • Available after baggage claim
Number of washrooms • Adequate at arrival gates (less than1min walk) • Inadequate after baggage claim (more than 10min walk)	Number of washrooms • Adequate at all areas (less than1min walk)
• Information desks/staff available	• Information desks/staff not available
• Paid Wi-FI internet available	• Free Wi-FI internet available
• Hydration stations available	• Hydration stations available

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

2. ACOM12

Alternative A	Alternative B
• Paid Wi-FI internet available	• Internet access not available
• Hydration stations not available	• Hydration stations available
Coffee shop/restaurants • Not available at arrival gates • Available after baggage claim	Coffee shop/restaurants • Available at arrival gates • Not available after baggage claim
Number of washrooms • Inadequate at all areas (more than 10min walk)	Number of washrooms • Inadequate at arrival gates (more than 10min walk) • Adequate after baggage claim (less than 1min walk)
• Information desks/staff available	• Information desks/staff available

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

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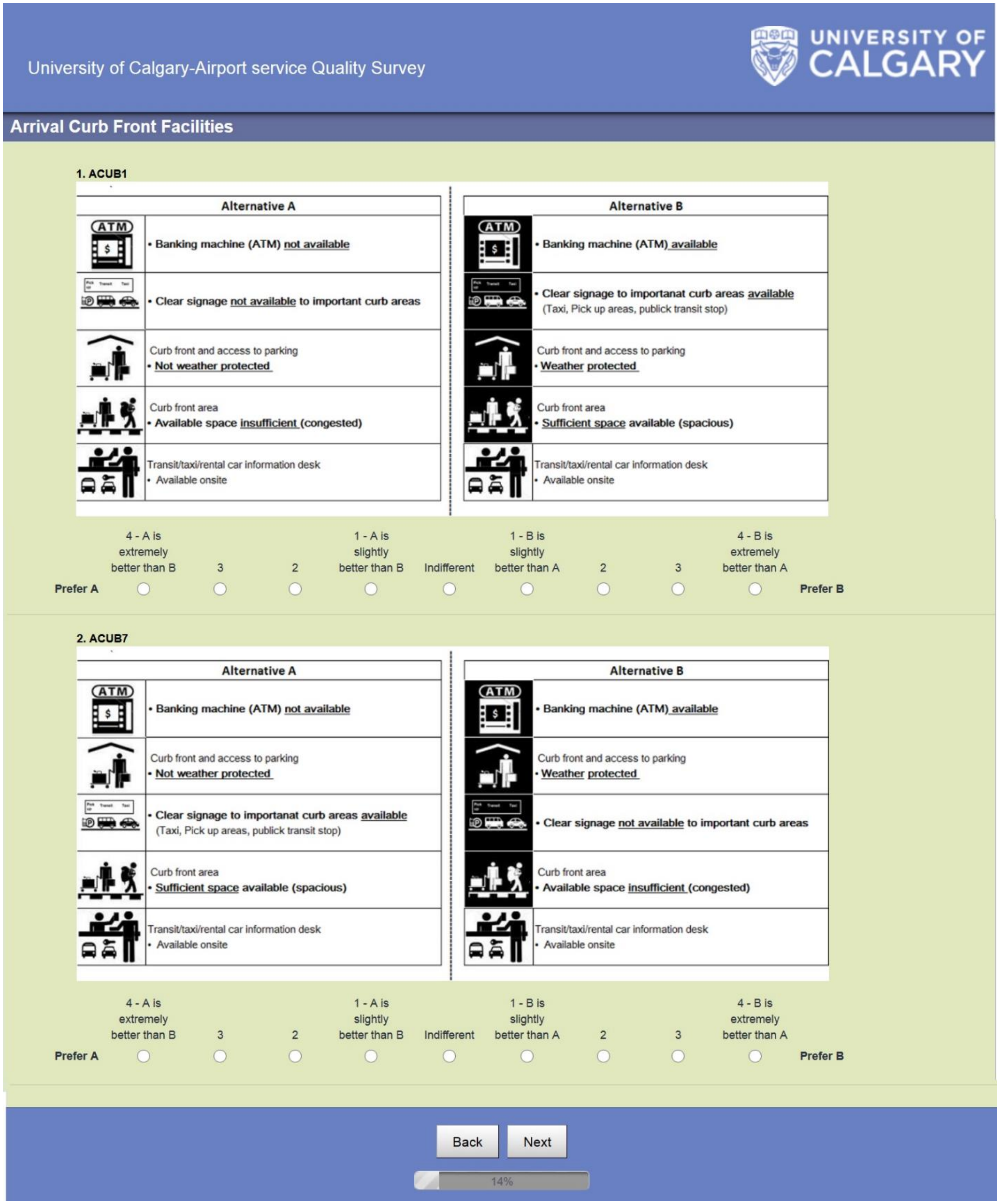
14%

Appendix Figure B 9: Choice sets for arrival common amenities



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Arrival Curb Front Facilities

1. ACUB1

Alternative A	Alternative B
• Banking machine (ATM) not available	• Banking machine (ATM) available
• Clear signage not available to important curb areas	• Clear signage to importanat curb areas available (Taxi, Pick up areas, publick transit stop)
Curb front and access to parking • Not weather protected	Curb front and access to parking • Weather protected
Curb front area • Available space insufficient (congested)	Curb front area • Sufficient space available (spacious)
Transit/taxi/rental car information desk • Available onsite	Transit/taxi/rental car information desk • Available onsite

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

2. ACUB7

Alternative A	Alternative B
• Banking machine (ATM) not available	• Banking machine (ATM) available
Curb front and access to parking • Not weather protected	Curb front and access to parking • Weather protected
• Clear signage to importanat curb areas available (Taxi, Pick up areas, publick transit stop)	• Clear signage not available to important curb areas
Curb front area • Sufficient space available (spacious)	Curb front area • Available space insufficient (congested)
Transit/taxi/rental car information desk • Available onsite	Transit/taxi/rental car information desk • Available onsite

	4 - A is extremely better than B	3	2	1 - A is slightly better than B	Indifferent	1 - B is slightly better than A	2	3	4 - B is extremely better than A	
Prefer A	○	○	○	○	○	○	○	○	○	Prefer B

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14%

Appendix Figure B 10: Choice sets for arrival curb area

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Respondent information

14. Please select the range for the number of trips you have made by air during the past year.

○ 1 to 5 ○ 6 to 10 ○ 11 to 20 ○ More than 20

15. Please select the appropriate option regarding how you travel most often (You may select multiple options if appropriate)

- ☐ Travel alone
- ☐ Travel with family/group (all adults)
- ☐ Travel with family with kids
- ☐ Travel with an infant
- ☐ Travel with an elderly or a person needing assistance

16. Please indicate which type of air travel you do most often (You may select multiple options if appropriate)

☐ Leisure travel ☐ Business travel ☐ Other

17. Please indicate the travel/ticket class most often used in your air travel

☐ Economy class ☐ Business class ☐ First class

18. Please select the age group you belong to

○ 15 to 25 ○ 26 to 35 ○ 36 to 45 ○ 46 to 55 ○ 56 to 65 ○ 66 or above ○ Do not want to disclose

19. Please indicate your gender

○ Male ○ Female

20. Please indicate the income(annual) category you belong to:

○ $20,000 or less ○ $20,000 - $50,000 ○ $50,000 - $100,000 ○ $100,000 - 150,000 ○ $150,000 - $200,000 ○ $200,000 or above

○ Do not want to disclose

Back Submit

93%

Appendix Figure B 11: Respondent socio-demographic information

Appendix C: Correlation analysis between the sociodemographic variables

Appendix Table C 1: Contingency table-Trip frequency Vs Travel group

	Trip_frequency				
Travel_group	3	8	16	30	Total
Family/group	222	143	56	23	444
	50[38]	32.21	12.61	5.18	100
	68.31[39]	60.34	48.28	29.49	58.73
Travel alone	103	94	60	55	312
	33.01	30.13	19.23	17.63	100
	31.69	39.66	51.72	70.51	41.27
Total	325	237	116	78	756
	42.99	31.35	15.34	10.32	100
	100	100	100	100	100
Pearson chi2(3)	45.3				
Pr	0.00				
Cramér's V	0.25				

Appendix Table C 2: Contingency table-Trip frequency Vs Travel purpose

	Trip_frequency				
Travel_purpose	3	8	16	30	Total
Business	82	137	81	66	366
	22.4	37.43	22.13	18.03	100
	25.23	57.81	69.83	84.62	48.41
Leisure	243	100	35	12	390
	62.31	25.64	8.97	3.08	100
	74.77	42.19	30.17	15.38	51.59
Total	325	237	116	78	756
	42.99	31.35	15.34	10.32	100
	100	100	100	100	100
Pearson chi2(3)	140.539				
Pr	0.00				
Cramér's V	0.4312				

[38] Within row relative frequency
[39] Within column relative frequency

Appendix Table C 3: Contingency table-Trip frequency Vs Ticket class

Ticket_class	Trip_frequency				
	3	8	16	30	Total
Business class	19	35	26	17	97
	19.59	36.08	26.8	17.53	100
	5.85	14.77	22.41	21.79	12.83
Economy class	306	202	90	61	659
	46.43	30.65	13.66	9.26	100
	94.15	85.23	77.59	78.21	87.17
Total	325	237	116	78	756
	42.99	31.35	15.34	10.32	100
	100	100	100	100	100
Pearson chi2(3)	30.09				
Pr	0.00				
Cramér's V	0.1995				

Appendix Table C 4: Contingency table-Trip frequency Vs Gender

Gender	Trip_frequency				
	3	8	16	30	Total
Female	142	80	23	14	259
	54.83	30.89	8.88	5.41	100
	43.83	33.76	19.83	17.95	34.3
Male	182	157	93	64	496
	36.69	31.65	18.75	12.9	100
	56.17	66.24	80.17	82.05	65.7
Total	324	237	116	78	755
	42.91	31.39	15.36	10.33	100
	100	100	100	100	100
Pearson chi2(3)	33.11				
Pr	0.00				
Cramér's V	0.21				

Appendix Table C 5: Contingency table-Trip frequency Vs age

	Trip_frequency				
Age	3	8	16	30	Total
20	28	9	5	5	47
	59.57	19.15	10.64	10.64	100
	8.7	3.83	4.31	6.41	6.26
30	93	51	20	17	181
	51.38	28.18	11.05	9.39	100
	28.88	21.7	17.24	21.79	24.1
40	59	68	25	15	167
	35.33	40.72	14.97	8.98	100
	18.32	28.94	21.55	19.23	22.24
50	67	59	24	17	167
	40.12	35.33	14.37	10.18	100
	20.81	25.11	20.69	21.79	22.24
60	52	38	33	21	144
	36.11	26.39	22.92	14.58	100
	16.15	16.17	28.45	26.92	19.17
75	23	10	9	3	45
	51.11	22.22	20	6.67	100
	7.14	4.26	7.76	3.85	5.99
Total	322	235	116	78	751
	42.88	31.29	15.45	10.39	100
	100	100	100	100	100
Pearson chi2(15)	34.0164				
Pr	0.003				
Cramér's V	0.1229				

Appendix Table C 6: Contingency table-Trip frequency Vs income

	Trip_frequency				
Income	3	8	16	30	Total
15000	15	1	0	0	16
	93.75	6.25	0	0	100
	5.77	0.48	0	0	2.57
35000	43	12	2	1	58
	74.14	20.69	3.45	1.72	100
	16.54	5.74	2.3	1.49	9.31
75000	96	66	17	8	187
	51.34	35.29	9.09	4.28	100
	36.92	31.58	19.54	11.94	30.02
125000	67	75	26	16	184
	36.41	40.76	14.13	8.7	100
	25.77	35.89	29.89	23.88	29.53
175000	29	35	19	18	101
	28.71	34.65	18.81	17.82	100
	11.15	16.75	21.84	26.87	16.21
250000	10	20	23	24	77
	12.99	25.97	29.87	31.17	100
	3.85	9.57	26.44	35.82	12.36
Total	260	209	87	67	623
	41.73	33.55	13.96	10.75	100
	100	100	100	100	100
Pearson chi2(15)	134.8132				
Pr	0.00				
Cramér's V	0.2686				

Appendix Table C 7: Contingency table-Gender Vs Travel group

	Gender		
Travel_group	Female	Male	Total
Family/group	160	283	443
	36.12	63.88	100
	61.78	57.06	58.68
Travel alone	99	213	312
	31.73	68.27	100
	38.22	42.94	41.32
Total	259	496	755
	34.3	65.7	100
	100	100	100
Pearson chi2(1)	1.5631		
Pr	0.211		
Cramér's V	0.0455		

Appendix Table C 8: Contingency table-Income Vs Travel group

	income						
Travel_group	15000	35000	75000	125000	175000	250000	Total
Family/group	12	27	113	111	51	43	357
	3.36	7.56	31.65	31.09	14.29	12.04	100
	75	46.55	60.43	60.33	50.5	55.84	57.3
Travel alone	4	31	74	73	50	34	266
	1.5	11.65	27.82	27.44	18.8	12.78	100
	25	53.45	39.57	39.67	49.5	44.16	42.7
Total	16	58	187	184	101	77	623
	2.57	9.31	30.02	29.53	16.21	12.36	100
	100	100	100	100	100	100	100
Pearson chi2(5)	8.2021						
Pr	0.145						
Cramér's V	0.1147						

Appendix D: Correlation analysis between the independent variables

Appendix Table D 1: Correlation for discrete choice analysis - Departure lounge area

		seating 1_2	seating 3_2	shops	Restaurants	Charginggstn	Intnt1_3	Intnt2_3
seating1_2	Correlation Coefficient	1.000	-.569**	-.016	.009	-.017	.010	.004
	Sig. (2-tailed)		.000	.439	.676	.419	.635	.835
seating3_2	Correlation Coefficient	-.569**	1.000	.006	.010	.018	-.002	-.004
	Sig. (2-tailed)	.000		.780	.619	.388	.913	.832
shops	Correlation Coefficient	-.016	.006	1.000	-.003	-.009	-.029	.007
	Sig. (2-tailed)	.439	.780		.867	.653	.161	.744
restaurants	Correlation Coefficient	.009	.010	-.003	1.000	-.019	.004	.005
	Sig. (2-tailed)	.676	.619	.867		.363	.834	.795
chargingstn	Correlation Coefficient	-.017	.018	-.009	-.019	1.000	.003	.021
	Sig. (2-tailed)	.419	.388	.653	.363		.877	.314
intnt1_3	Correlation Coefficient	.010	-.002	-.029	.004	.003	1.000	-.577**
	Sig. (2-tailed)	.635	.913	.161	.834	.877		.000
intnt2_3	Correlation Coefficient	.004	-.004	.007	.005	.021	-.577**	1.000
	Sig. (2-tailed)	.835	.832	.744	.795	.314	.000	

Appendix Table D 2: Correlation for ordinal logistic regression - Departure lounge area

		Seating 1_2	seating 3_2	Shops	Restaurants	charging	Intent 1_3	Intent 2_3
seat1_2	Correlation Coefficient	1.000	-.588**	.045	-.043	-.306**	-.201**	.036
	Sig. (2-tailed)		.000	.090	.111	.000	.000	.181
seat3_2	Correlation Coefficient	-.588**	1.000	.030	.168**	.139**	.220**	-.053
	Sig. (2-tailed)	.000		.265	.000	.000	.000	.052
retail	Correlation Coefficient	.045	.030	1.000	-.107**	.078**	.009	-.195**
	Sig. (2-tailed)	.090	.265		.000	.003	.740	.000
Restaurants	Correlation Coefficient	-.043	.168**	-.107**	1.000	-.019	-.148**	.045
	Sig. (2-tailed)	.111	.000	.000		.464	.000	.098
charging	Correlation Coefficient	-.306**	.139**	.078**	-.019	1.000	-.012	.152**
	Sig. (2-tailed)	.000	.000	.003	.464		.653	.000
intent1_3	Correlation Coefficient	-.201**	.220**	.009	-.148**	-.012	1.000	-.448**
	Sig. (2-tailed)	.000	.000	.740	.000	.653		.000
intent2_3	Correlation Coefficient	.036	-.053	-.195**	.045	.152**	-.448**	1.000
	Sig. (2-tailed)	.181	.052	.000	.098	.000	.000	

Appendix E: Detail results of the analysis on the effects caused by sociodemographic variables on service quality preference

Appendix Table E 1: Departure lounge-choice model comparison-blocked by data source

Online_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
seating1_2[40]	0.616	0.175	3.520	0.000		0.095	0.070	0.264	0.360
seating3_2	-1.297	0.239	-5.430	0.000		0.016	0.135	0.367	0.044
retail shops1_2	0.297	0.143	2.080	0.037		-0.586	0.052	0.228	-2.565
restaurants1_2	1.420	0.145	9.790	0.000		0.481	0.052	0.229	2.100
charging stations1_2	0.643	0.155	4.140	0.000		0.270	0.059	0.243	1.112
intent1_3	1.775	0.170	10.440	0.000		-0.180	0.072	0.268	-0.673
intent2_3	-0.156	0.195	-0.800	0.424		-0.488	0.088	0.297	-1.644
Airport_choice (b_2)									
seating1_2	0.522	0.197	2.640	0.008					
seating3_2	-1.313	0.279	-4.710	0.000					
retail shops1_2	0.883	0.178	4.950	0.000					
restaurants1_2	0.939	0.177	5.300	0.000					
charging stations1_2	0.373	0.187	1.990	0.046					
intent1_3	1.955	0.207	9.470	0.000					
intent2_3	0.332	0.224	1.480	0.138					

[40] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

Appendix Table E 2: Departure lounge-choice model comparison-blocked by gender

male_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
seating1_2[41]	0.756	0.161	4.690	0.000		0.546	0.074	0.272	2.008
seating3_2	-1.347	0.219	-6.160	0.000		-0.043	0.148	0.385	-0.111
retail shops1_2	0.545	0.131	4.150	0.000		-0.033	0.056	0.236	-0.141
restaurants1_2	1.264	0.143	8.830	0.000		0.106	0.055	0.234	0.454
charging stations1_2	0.750	0.152	4.930	0.000		0.568	0.062	0.249	2.279
intent1_3	1.829	0.165	11.110	0.000		-0.018	0.076	0.275	-0.067
intent2_3	-0.073	0.187	-0.390	0.696		-0.315	0.092	0.303	-1.040
female_choice (b_2)									
seating1_2	0.210	0.219	0.960	0.338					
seating3_2	-1.304	0.317	-4.120	0.000					
retail shops1_2	0.578	0.196	2.950	0.003					
restaurants1_2	1.157	0.186	6.230	0.000					
charging stations1_2	0.182	0.197	0.920	0.357					
intent1_3	1.847	0.220	8.390	0.000					
intent2_3	0.242	0.238	1.020	0.310					

[41] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

Appendix Table E 3: Departure lounge-choice model comparison-blocked by trip frequency

trip_low_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
seating1_2[42]	0.526	0.205	2.570	0.010		0.126	0.094	0.306	0.411
seating3_2	-0.979	0.280	-3.500	0.000		0.541	0.178	0.422	1.284
retail shops1_2	0.679	0.174	3.910	0.000		0.247	0.066	0.257	0.960
restaurants1_2	1.050	0.172	6.120	0.000		-0.040	0.065	0.256	-0.157
charging stations1_2	0.337	0.174	1.940	0.052		0.095	0.072	0.268	0.355
intent1_3	1.744	0.203	8.590	0.000		-0.044	0.091	0.302	-0.147
intent2_3	0.134	0.220	0.610	0.542		0.162	0.122	0.350	0.462
trip_mid_choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
seating1_2	0.401	0.227	1.760	0.078		-0.662	0.126	0.355	-1.865
seating3_2	-1.521	0.315	-4.820	0.000		0.239	0.242	0.492	0.486
retail shops1_2	0.432	0.190	2.280	0.023		-0.202	0.080	0.283	-0.716
restaurants1_2	1.090	0.189	5.760	0.000		-0.792	0.101	0.318	-2.493
charging stations1_2	0.242	0.204	1.180	0.236		-1.359	0.133	0.365	-3.724
intent1_3	1.788	0.223	8.010	0.000		-0.414	0.131	0.363	-1.141
intent2_3	-0.027	0.271	-0.100	0.921		0.025	0.175	0.418	0.059
trip_high_choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
seating1_2	1.063	0.273	3.900	0.000		0.536	0.116	0.341	1.573
seating3_2	-1.760	0.378	-4.660	0.000		-0.781	0.221	0.470	-1.661
retail shops1_2	0.634	0.210	3.030	0.002		-0.045	0.074	0.272	-0.164
restaurants1_2	1.883	0.255	7.380	0.000		0.833	0.095	0.308	2.708
charging stations1_2	1.601	0.302	5.290	0.000		1.264	0.122	0.349	3.624
intent1_3	2.202	0.286	7.710	0.000		0.458	0.123	0.350	1.307
intent2_3	-0.052	0.318	-0.160	0.870		-0.186	0.150	0.387	-0.482

[42] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

Appendix Table E 4: Departure lounge-choice model comparison-blocked by age

age_low_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
seating1_2[43]	0.439	0.223	1.970	0.049		-0.254	0.088	0.297	-0.855
seating3_2	-1.321	0.344	-3.830	0.000		-0.225	0.191	0.437	-0.514
retail shops1_2	0.695	0.217	3.200	0.001		0.070	0.075	0.274	0.254
restaurants1_2	1.036	0.212	4.890	0.000		-0.154	0.076	0.275	-0.561
charging stations1_2	0.453	0.208	1.900	0.057		-0.328	0.074	0.273	-1.203
intent1_3	1.884	0.232	8.110	0.000		0.012	0.098	0.313	0.038
intent2_3	0.332	0.259	1.280	0.200		0.487	0.115	0.338	1.440
age_mid_choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
seating3_2	0.693	0.196	3.540	0.000		0.247	0.114	0.338	0.732
Shops1_2	-1.096	0.269	-4.070	0.000		0.785	0.211	0.459	1.709
retail shops1_2	0.625	0.168	3.720	0.000		0.284	0.069	0.263	1.079
restaurants1_2	1.190	0.176	6.780	0.000		-0.335	0.082	0.286	-1.173
charging stations1_2	0.781	0.176	4.430	0.000		0.602	0.072	0.268	2.248
intent1_3	1.872	0.210	8.930	0.000		0.061	0.114	0.338	0.181
intent2_3	-0.155	0.218	-0.710	0.475		-0.386	0.155	0.394	-0.980
age_high_choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
seating3_2	0.446	0.275	1.620	0.105		0.007	0.126	0.354	0.020
Shops1_2	-1.881	0.372	-5.060	0.000		-0.560	0.257	0.507	-1.105
retail shops1_2	0.341	0.203	1.680	0.093		-0.354	0.088	0.297	-1.191
restaurants1_2	1.525	0.225	6.770	0.000		0.490	0.096	0.309	1.583
charging stations1_2	0.178	0.202	0.800	0.422		-0.275	0.084	0.290	-0.946
intent1_3	1.811	0.265	6.840	0.000		-0.073	0.124	0.352	-0.207
intent2_3	0.231	0.329	0.700	0.483		-0.101	0.175	0.418	-0.242

[43] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:-coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

Appendix Table E 5: Departure lounge-choice model comparison-blocked by income

income_low (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
seating1_2[44]	0.267	0.218	1.230	0.221		-0.337	0.106	0.325	-1.036
seating3_2	-1.314	0.313	-	0.000		-0.329	0.209	0.457	-0.720
retail shops1_2	0.567	0.198	2.870	0.004		0.081	0.079	0.281	0.287
restaurants1_2	0.869	0.196	4.430	0.000		-0.376	0.085	0.292	-1.288
charging	0.203	0.201	1.010	0.313		-0.370	0.092	0.304	-1.219
intent1_3	2.037	0.250	8.150	0.000		0.485	0.120	0.346	1.399
intent2_3	0.468	0.249	1.880	0.060		0.684	0.140	0.375	1.826
income_mid (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
seating1_2	0.603	0.241	2.500	0.012		-0.337	0.147	0.384	-0.877
seating3_2	-0.985	0.334	-	0.003		0.331	0.252	0.502	0.659
retail shops1_2	0.486	0.200	2.430	0.015		-0.292	0.092	0.303	-0.964
restaurants1_2	1.245	0.217	5.750	0.000		-0.240	0.098	0.313	-0.765
charging	0.573	0.227	2.520	0.012		-0.324	0.125	0.354	-0.917
intent1_3	1.552	0.240	6.470	0.000		-0.252	0.122	0.350	-0.719
intent2_3	-0.216	0.280	-	0.440		-0.104	0.185	0.430	-0.242
income_high (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
seating1_2	0.940	0.299	3.150	0.002		0.673	0.137	0.370	1.822
seating3_2	-1.316	0.375	-	0.000		-0.002	0.239	0.488	-0.004
retail shops1_2	0.778	0.227	3.430	0.001		0.211	0.091	0.301	0.702
restaurants1_2	1.485	0.226	6.560	0.000		0.616	0.090	0.299	2.058
charging	0.898	0.271	3.310	0.001		0.694	0.114	0.338	2.056
intent1_3	1.804	0.255	7.080	0.000		-0.233	0.127	0.357	-0.652
intent2_3	-0.112	0.327	-	0.733		-0.580	0.169	0.411	-1.409

[44] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

E.1 Departure common amenities

E.1.1 Effect of income class

Appendix Table E 7 shows the choice models estimated using data blocked based on income level. According to the comparison shown in the table, Importance of flight information and availability of information desks and staff have increased with income level. A statistically significant increase is shown in the importance in availability of flight information display overall and after security. Also a statistically significant increase is shown in the importance of availability of information desks. This effect can be attributed to higher income travelers being frequent travellers. Though not significant, travel frequency has also effected the average importance of flight information to increase (Appendix Table E 6). Same explanation can be given to the increasing effect of importance on information desks with respect to income.

Results for remaining socio demographic characteristics such as data source, gender, trip frequency and age group did not show statistically significant variation in attribute coefficients.

Appendix Table E 6: Departure common amenities-choice model comparison-blocked by trip frequency

Trip_low_Choice (b_1)	Coef.	Std. Err.	z	$P>\lvert z\rvert$		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Automated1_2[45]	0.582	0.242	2.400	0.016		-0.331	0.127	0.356	-0.931
fltinfo1_4	2.163	0.246	8.810	0.000		0.271	0.135	0.368	0.737
fltinfo2_4	0.727	0.381	1.910	0.056		-0.269	0.356	0.596	-0.450
fltinfo3_4	1.364	0.269	5.070	0.000		-0.176	0.165	0.406	-0.435
info1_3	0.945	0.341	2.770	0.006		-0.062	0.256	0.506	-0.122
info2_3	0.320	0.290	1.100	0.270		-0.183	0.192	0.439	-0.417
wsh1_4	3.377	0.436	7.750	0.000		0.101	0.426	0.653	0.155
wsh2_4	1.933	0.376	5.140	0.000		-0.224	0.326	0.571	-0.393
wsh3_4	1.854	0.317	5.840	0.000		0.457	0.212	0.461	0.993
Water1_2	0.694	0.194	3.570	0.000		-0.127	0.086	0.293	-0.434
Trip_mid_Choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Automated1_2	0.913	0.261	3.500	0.000		0.009	0.159	0.398	0.023
fltinfo1_4	1.892	0.274	6.910	0.000		-0.236	0.167	0.408	-0.578
fltinfo2_4	0.996	0.459	2.170	0.030		0.221	0.459	0.678	0.326
fltinfo3_4	1.540	0.304	5.060	0.000		-0.076	0.200	0.448	-0.170
info1_3	1.007	0.374	2.690	0.007		-0.311	0.360	0.600	-0.519
info2_3	0.503	0.329	1.530	0.127		-0.011	0.281	0.531	-0.021
wsh1_4	3.276	0.486	6.740	0.000		-0.054	0.561	0.749	-0.071
wsh2_4	2.157	0.430	5.020	0.000		0.419	0.415	0.644	0.651
wsh3_4	1.397	0.334	4.180	0.000		0.296	0.244	0.494	0.600
Water1_2	0.822	0.219	3.740	0.000		0.128	0.113	0.336	0.382
Trip_high_Choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Automated1_2	0.904	0.301	3.000	0.003		0.322	0.149	0.386	0.834
fltinfo1_4	2.128	0.303	7.030	0.000		-0.035	0.152	0.390	-0.089
fltinfo2_4	0.775	0.499	1.550	0.120		0.048	0.394	0.628	0.076
fltinfo3_4	1.617	0.329	4.920	0.000		0.253	0.180	0.425	0.595
info1_3	1.318	0.469	2.810	0.005		0.373	0.337	0.580	0.642
info2_3	0.514	0.416	1.240	0.217		0.194	0.257	0.507	0.383
wsh1_4	3.329	0.570	5.840	0.000		-0.048	0.515	0.718	-0.066
wsh2_4	1.738	0.479	3.630	0.000		-0.195	0.371	0.609	-0.320
wsh3_4	1.100	0.363	3.030	0.002		-0.754	0.233	0.483	-1.562
Water1_2	0.693	0.255	2.720	0.007		-0.001	0.103	0.321	-0.004

[45] The coefficient label has three parts, the attribute name (e.g. Automated: - automated services) and the attribute level and reference level (e.g. automated1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C6 for details on attribute service levels

Appendix Table E 7: Departure common amenities-choice model comparison-blocked by income group

income_low (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Automated1_2[46]	0.794	0.262	3.040	0.002		0.224	0.146	0.382	0.587
fltinfo1_4	1.943	0.262	7.410	0.000		0.127	0.159	0.398	0.319
fltinfo2_4	0.673	0.377	1.790	0.074		0.078	0.663	0.814	0.095
fltinfo3_4	1.513	0.311	4.860	0.000		0.607	0.256	0.506	1.200
info1_3	1.208	0.379	3.180	0.001		0.036	0.272	0.521	0.069
info2_3	0.275	0.383	0.720	0.472		-0.244	0.203	0.451	-0.542
wsh1_4	3.377	0.505	6.690	0.000		-0.519	0.605	0.778	-0.668
wsh2_4	2.068	0.477	4.330	0.000		-0.210	0.487	0.698	-0.301
wsh3_4	1.867	0.404	4.620	0.000		0.359	0.315	0.561	0.639
Water1_2	0.752	0.241	3.120	0.002		0.089	0.110	0.331	0.269
income_mid (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Automated1_2	0.570	0.278	2.050	0.040		-0.589	0.293	0.541	-1.088
fltinfo1_4	1.816	0.300	6.060	0.000		-1.008	0.358	0.599	-1.684
fltinfo2_4	0.596	0.721	0.830	0.409		-0.744	0.749	0.865	-0.860
fltinfo3_4	0.906	0.399	2.270	0.023		-1.474	0.341	0.584	-2.523
info1_3	1.172	0.357	3.280	0.001		-0.720	0.575	0.758	-0.950
info2_3	0.520	0.238	2.180	0.029		-1.185	0.384	0.620	-1.912
wsh1_4	3.896	0.592	6.580	0.000		1.985	0.746	0.864	2.298
wsh2_4	2.278	0.509	4.470	0.000		0.908	0.518	0.720	1.261
wsh3_4	1.508	0.389	3.870	0.000		0.467	0.290	0.539	0.866
water	0.663	0.227	2.920	0.003		-0.695	0.169	0.411	-1.692
income_high (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Automated1_2	1.159	0.465	2.490	0.013		0.365	0.284	0.533	0.684
fltinfo1_4	2.824	0.518	5.450	0.000		0.881	0.337	0.581	1.517
fltinfo2_4	1.340	0.478	2.800	0.005		0.667	0.371	0.609	1.095
fltinfo3_4	2.380	0.427	5.570	0.000		0.867	0.279	0.528	1.641
info1_3	1.893	0.669	2.830	0.005		0.684	0.591	0.769	0.890
info2_3	1.705	0.572	2.980	0.003		1.430	0.474	0.689	2.076
wsh1_4	1.911	0.629	3.040	0.002		-1.466	0.650	0.807	-1.817
wsh2_4	1.370	0.509	2.690	0.007		-0.698	0.487	0.698	-1.000
wsh3_4	1.041	0.373	2.800	0.005		-0.825	0.302	0.550	-1.501
Water1_2	1.358	0.343	3.960	0.000		0.606	0.175	0.419	1.447

[46] The coefficient label has three parts, the attribute name (e.g. Automated: - automated services) and the attribute level and reference level (e.g. automated1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C6 for details on attribute service levels

E.2 Departure check-in area

E.2.1 Effects of trip frequency

Appendix Table E 8 shows the choice models estimated using data blocked based on trip frequency. It can be seen from the analysis results that the disutility of delay is significantly increasing with trip frequency. Hence frequent travelers are more likely to be dissatisfied due to delay compared to a less frequent traveler. According to Table 6-2 frequent traveler are often business travelers who arrive at the airport with very short time to spare are expect to be processed for the flight quickly. The utility of more convenient security screening also has increased significantly with trip frequency. Again this effect can be explain by the higher value of time and value of convenience placed by business travelers. This is also evident by average utility of automated kiosks increasing with trip frequency.

E.2.2 Effects of age group

Appendix Table E 9 shows the choice models estimated using data blocked based on age group. Results show that the disutility of waiting longer has significantly increased with age. Older passengers are more likely to get tired of standing in line or at the counter for a longer duration. However there was no clear evidence that the utility of security screening convenience has increased with age.

E.2.3 Effects of income group

Appendix Table E 10 shows the choice models estimated using data blocked based on income group. Results show that the disutility of longer wait time at check-in is increasing with income group. Higher income passenger tend to be business travelers and attribute a higher value of time for waiting in queues. Thus their disutility of waiting longer can be significantly higher than lesser income passengers. Also it can be seen from results that the utility of automated check-in kiosks have increased significantly with income group. This effect also can be attributed to the fast processing perceived at automated kiosks.

E.2.4. Effects of trip purpose

Appendix Table E 23 shows the choice models estimated using data blocked based on trip purpose. According to the comparison leisure travelers have placed a significantly higher utility on the availability of mobile staff for information. Furthermore it can be seen that business travelers have placed a significantly higher utility on the availability of automated kiosks compared to leisure travelers. This effect is consistent with the higher utility given to kiosks by frequent travelers. Therefore it can be seen that business travelers or frequent travelers place a higher impotence on self-serving facilities that enable fast processing.

Appendix Table E 8: Departure check-in area-choice model comparison-blocked by trip frequency

trip_low_Choice (b_1)	Coef.	Std. Err.	z	P>|z|	—	b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Chkin2_1[47]	-1.029	0.217	-4.730	0.000		0.077	0.101	0.318	0.243
Chkin3_1	-2.160	0.266	-8.130	0.000		0.076	0.149	0.386	0.197
info1_3	1.212	0.165	7.350	0.000		0.181	0.062	0.248	0.729
info2_3	0.702	0.264	2.660	0.008		-0.070	0.157	0.397	-0.177
Kiosk1_2	1.091	0.159	6.880	0.000		0.063	0.052	0.227	0.276
Sec_screening1_2	0.817	0.170	4.800	0.000		0.208	0.063	0.251	0.831
trip_mid_Choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Chkin2_1	-1.106	0.231	-4.780	0.000		-0.415	0.107	0.328	-1.268
Chkin3_1	-2.236	0.280	-7.990	0.000		0.843	0.184	0.430	1.963
info1_3	1.031	0.186	5.540	0.000		0.111	0.086	0.293	0.379
info2_3	0.772	0.296	2.610	0.009		-0.194	0.179	0.423	-0.458
Kiosk1_2	1.028	0.162	6.330	0.000		-0.422	0.078	0.278	-1.517
Sec_screening1_2	0.608	0.184	3.310	0.001		-0.755	0.083	0.288	-2.624
trip_high_Choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Chkin2_1	-0.690	0.232	-2.980	0.003		0.338	0.101	0.318	1.064
Chkin3_1	-3.079	0.326	-8.590	0.000		-0.919	0.177	0.420	-2.188
info1_3	0.920	0.227	4.060	0.000		-0.292	0.078	0.280	-1.042
info2_3	0.965	0.302	3.200	0.001		0.264	0.161	0.401	0.657
Kiosk1_2	1.451	0.226	6.410	0.000		0.360	0.076	0.276	1.302
Sec_screening1_2	1.363	0.221	5.610	0.000		0.547	0.078	0.279	1.959

[47] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

Appendix Table E 9: Departure check-in area-choice model comparison-blocked by age group

Age_low_Choice (b_1)	Coef.	Std. Err.	z	P>|z|	—	b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
Chkin2_1[48]	-1.077	0.249	-4.330	0.000		-0.083	0.100	0.316	-0.261
Chkin3_1	-1.764	0.282	-6.250	0.000		1.110	0.168	0.410	2.705
info1_3	1.306	0.195	6.700	0.000		0.188	0.067	0.259	0.726
info2_3	0.869	0.305	2.850	0.004		-0.099	0.162	0.403	-0.246
Kiosk1_2	1.039	0.177	5.880	0.000		-0.247	0.060	0.245	-1.009
Sec_screening1_2	0.615	0.193	3.190	0.001		-0.676	0.070	0.265	-2.546
Age_mid_Choice (b_2)						b_2-b_3	$seb_2{}^2 + seb_3{}^2$	$\sqrt{seb_2{}^2 + seb_3{}^2}$	z
Chkin2_1	-0.995	0.194	-5.120	0.000		-0.081	0.109	0.330	-0.246
Chkin3_1	-2.875	0.298	-9.650	0.000		-0.281	0.170	0.413	-0.680
info1_3	1.118	0.171	6.550	0.000		0.291	0.069	0.263	1.107
info2_3	0.968	0.263	3.680	0.000		0.438	0.155	0.394	1.113
Kiosk1_2	1.286	0.170	7.570	0.000		0.128	0.062	0.250	0.512
Sec_screening1_2	1.291	0.182	7.080	0.000		0.622	0.077	0.278	2.236
Age_high_Choice (b_3)						b_3-b_1	$seb_3{}^2 + seb_1{}^2$	$\sqrt{seb_3{}^2 + seb_1{}^2}$	z
Chkin2_1	-0.913	0.267	-3.420	0.001		0.164	0.133	0.365	0.448
Chkin3_1	-2.594	0.286	-9.070	0.000		-0.830	0.161	0.402	-2.065
info1_3	0.826	0.201	4.120	0.000		-0.479	0.078	0.280	-1.714
info2_3	0.529	0.293	1.810	0.071		-0.339	0.179	0.423	-0.803
Kiosk1_2	1.158	0.183	6.320	0.000		0.119	0.065	0.254	0.469
Sec_screening1_2	0.669	0.210	3.190	0.001		0.054	0.081	0.285	0.190

[48] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

Appendix Table E 10: Departure check-in area-choice model comparison-blocked by income group

Income_low_(b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Chkin2_1[49]	-0.968	0.222	-4.360	0.000		0.250	0.133	0.364	0.686
Chkin3_1	-1.762	0.263	-6.690	0.000		1.497	0.225	0.474	3.156
info1_3	1.075	0.180	5.960	0.000		0.078	0.075	0.275	0.282
info2_3	0.597	0.267	2.240	0.025		-0.395	0.190	0.435	-0.906
Kiosk1_2	0.813	0.158	5.150	0.000		-0.537	0.065	0.256	-2.099
Sec_screening1_2	0.790	0.174	4.550	0.000		-0.141	0.078	0.279	-0.507
Income_mid (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Chkin2_1	-1.218	0.289	-4.220	0.000		-0.287	0.157	0.396	-0.726
Chkin3_1	-3.259	0.394	-8.260	0.000		-0.528	0.269	0.518	-1.020
info1_3	0.998	0.207	4.820	0.000		-0.278	0.101	0.318	-0.873
info2_3	0.992	0.344	2.880	0.004		-0.038	0.233	0.482	-0.079
Kiosk1_2	1.350	0.201	6.710	0.000		-0.180	0.093	0.305	-0.589
Sec_screening1_2	0.932	0.218	4.260	0.000		-0.139	0.117	0.342	-0.407
Income_high (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Chkin2_1	-0.931	0.271	-3.430	0.001		0.037	0.123	0.350	0.107
Chkin3_1	-2.731	0.336	-8.120	0.000		-0.968	0.182	0.427	-2.267
info1_3	1.275	0.242	5.280	0.000		0.200	0.091	0.302	0.663
info2_3	1.030	0.338	3.050	0.002		0.433	0.185	0.430	1.006
Kiosk1_2	1.529	0.229	6.670	0.000		0.716	0.077	0.278	2.574
Sec_screening1_2	1.071	0.263	4.070	0.000		0.281	0.099	0.315	0.891

[49] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

E.3. Departure curb area

E.3.1. Effects of gender

Appendix Table E 11 shows the choice models estimated using data blocked based on gender. According to the results there is significant increase in the disutility of walking distance from curb to check-in for female respondents compared to male respondents. Furthermore the utility of having weather protection and baggage carts are significantly higher for female respondents compare to male respondents.

E.3.2. Effects of age group

Appendix Table E 12 shows the choice models estimated using data blocked based on age group. According to the results, the utility of having weather protection has significantly reduced with age group. Furthermore the utility of a very short walk (less than 1min) with reference to a moderate walk (5-10min walk) to access check-in has reduced with age group. This finding is contrary to the typical behaviour expected. It was expected that the utility of attributes such as weather protection and shorter walking to increase with age. A possible reason for this result could be the moderate correlation between age and gender in the sample of respondents used for the study. The correlation between age and gender was analysed using contingency tables. Results showed a significant correlation with a Cramer's V value of 0.32. Therefore it is possible that the same latent condition affecting the attribute utilities with respect to gender is evident in the analysis based on age groups.

Remaining characteristics such as data source, trip frequency and income group did not have a significant effect on attribute utilities.

Appendix Table E 11: Departure curb area-choice model comparison-blocked by gender

male_Choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Curb_space1_2[50]	1.550	0.215	7.220	0.000		-0.709	0.277	0.527	-1.345
Distckn1_2	0.848	0.342	2.480	0.013		-1.251	0.633	0.795	-1.572
Distckn3_2	-1.440	0.734	-1.960	0.050		-2.933	1.919	1.385	-2.117
Weather1_2	0.895	0.271	3.300	0.001		-1.733	0.531	0.729	-2.378
Carts1_2	1.674	0.199	8.430	0.000		-1.372	0.333	0.577	-2.378
Porter1_2	-0.694	0.459	-1.510	0.065		-1.344	0.492	0.701	-1.916
female_Choice (b_2)									
Curb_space1_2	2.259	0.481	4.700	0.000					
Distckn1_2	2.099	0.718	2.920	0.003					
Distckn3_2	1.493	1.175	1.270	0.204					
Weather1_2	2.628	0.677	3.880	0.000					
Carts1_2	3.046	0.542	5.620	0.000					
Porter1_2	0.650	0.530	1.230	0.220					

[50] The coefficient label has three parts, the attribute name (e.g. Curb_space: - Availability of curb space) and the attribute level and reference level (e.g. Curb_space 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C9 for details on attribute service levels

Appendix Table E 12: Departure curb area-choice model comparison-blocked by age group

age_low_Choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
Curb_space1_2[51]	2.789	0.651	4.280	0.000		1.174	0.516	0.718	1.634
Distckn1_2	2.816	1.087	2.590	0.010		1.992	1.394	1.181	1.687
Distckn3_2	1.093	1.736	0.630	0.529		2.085	3.736	1.933	1.079
Weather1_2	2.531	0.742	3.410	0.001		1.023	0.669	0.818	1.251
Carts1_2	2.616	0.620	4.220	0.000		0.338	0.484	0.696	0.486
Porter1_2	0.998	0.666	1.500	0.134		1.435	0.533	0.730	1.965
age_mid_Choice (b_2)						b_2-b_3	$seb_2{}^2 + seb_3{}^2$	$\sqrt{seb_2{}^2 + seb_3{}^2}$	z
Curb_space1_2	1.616	0.303	5.330	0.000		0.027	0.195	0.441	0.061
Distckn1_2	0.824	0.460	1.790	0.073		0.056	0.548	0.740	0.076
Distckn3_2	-0.992	0.850	-1.170	0.243		0.160	1.756	1.325	0.121
Weather1_2	1.507	0.344	4.380	0.000		1.105	0.271	0.520	2.124
Carts1_2	2.278	0.316	7.210	0.000		0.462	0.190	0.436	1.059
Porter1_2	-0.437	0.299	-1.460	0.144		0.652	0.239	0.489	1.332
age_high_Choice (b_3)						b_3-b_1	$seb_3{}^2 + seb_1{}^2$	$\sqrt{seb_3{}^2 + seb_1{}^2}$	z
Curb_space1_2	1.589	0.320	4.960	0.000		-1.201	0.527	0.726	-1.654
Distckn1_2	0.768	0.580	1.320	0.185		-2.048	1.518	1.232	-1.662
Distckn3_2	-1.152	1.016	-1.130	0.257		-2.245	4.046	2.011	-1.116
Weather1_2	0.402	0.391	1.030	0.303		-2.129	0.703	0.839	-2.538
Carts1_2	1.816	0.301	6.040	0.000		-0.800	0.475	0.689	-1.161
Porter1_2	-1.089	0.387	-2.810	0.005		-2.087	0.594	0.770	-2.709

[51] The coefficient label has three parts, the attribute name (e.g. Curb_space: - Availability of curb space) and the attribute level and reference level (e.g. Curb_space 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C9 for details on attribute service levels

E.4. Departure circulation

E.4.1 Effects of data source

Appendix Table E 13 shows the choice models estimated using data blocked based on data source. According to the results, signage for circulation and availability of electric carts are significantly more important for online respondents than the airport respondents. Several reasons could have caused this difference. Passengers responding at the airport may have been influenced by the circulation service quality available at the airport at the time of the survey. Online respondents may have been more conservative in terms of trading off the importance of signage and circulation information with other less important attributes.

E.4.2 Effects of trip frequency

Appendix Table E 14 shows the choice models estimated using data blocked based on trip frequency. According to the results there is significant increase in the disutility of level changing. This can be expected as frequent travelers prefer quick and convenient traverse through the terminal. However there is no significant increase in the utility of minimum walking distance with trip frequency.

Remaining socio-demographic characteristics such as gender, income group and age group did not show a significant variation on attribute coefficients.

Appendix Table E 13: Departure circulation-choice model comparison-blocked by data source

Online_Choice (b_1)	Coef.	Std.Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[52]	3.060	0.542	5.650	0.000		1.254	0.348	0.590	2.125
Ttnod1_2	1.897	0.601	3.160	0.002		1.141	0.422	0.650	1.757
chnglvl2_1	-0.931	0.393	-2.370	0.018		-0.354	0.315	0.562	-0.630
chnglvl3_1	-2.830	0.756	-3.740	0.000		-0.974	0.892	0.944	-1.031
Conv1_2	1.900	0.515	3.690	0.000		0.635	0.308	0.555	1.143
Eleccrt1_2	1.284	0.569	2.260	0.024		1.196	0.393	0.627	1.909
Airport_Choice (b_2)									
Signage1_2	1.807	0.234	7.710	0.000					
Ttnod1_2	0.756	0.248	3.050	0.002					
chnglvl2_1	-0.577	0.401	-1.440	0.150					
chnglvl3_1	-1.856	0.566	-3.280	0.001					
Conv1_2	1.266	0.207	6.100	0.000					
Eleccrt1_2	0.088	0.262	0.340	0.737					

[52] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C7 for details on attribute service levels

Appendix Table E 14: Departure circulation-choice model comparison-blocked by trip distribution

trip_low_Choice (b_1)	Coef.	Std.Err	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[53]	2.344	0.517	4.540	0.000		0.116	0.378	0.615	0.188
Ttnod1_2	1.381	0.651	2.120	0.034		0.461	0.554	0.744	0.619
chnglvl2_1	-0.350	0.485	-0.720	0.471		-0.220	0.478	0.691	-0.318
chnglvl3_1	-1.975	0.627	-3.150	0.002		0.921	1.555	1.247	0.738
Conv1_2	1.937	0.474	4.090	0.000		0.736	0.308	0.555	1.326
Eleccrt1_2	0.718	0.652	1.100	0.271		0.577	0.582	0.763	0.757
trip_mid_Choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Signage1_2	2.228	0.334	6.680	0.000		-0.364	0.286	0.535	-0.681
Ttnod1_2	0.920	0.361	2.550	0.011		-0.417	0.370	0.608	-0.687
chnglvl2_1	-0.129	0.493	-0.260	0.793		1.575	0.532	0.730	2.159
chnglvl3_1	-2.895	1.078	-2.690	0.007		-0.733	1.813	1.346	-0.545
Conv1_2	1.201	0.289	4.150	0.000		0.085	0.202	0.450	0.189
Eleccrt1_2	0.140	0.396	0.350	0.723		-0.602	0.335	0.579	-1.040
trip_high_Choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Signage1_2	2.592	0.418	6.200	0.000		0.248	0.442	0.665	0.373
Ttnod1_2	1.338	0.489	2.730	0.006		-0.044	0.663	0.814	-0.054
chnglvl2_1	-1.705	0.538	-3.170	0.002		-1.355	0.525	0.725	-1.870
chnglvl3_1	-2.162	0.806	-2.680	0.007		-0.187	1.043	1.021	-0.183
Conv1_2	1.116	0.345	3.240	0.001		-0.821	0.343	0.586	-1.401
Eleccrt1_2	0.743	0.423	1.760	0.079		0.025	0.604	0.777	0.032

[53] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C7 for details on attribute service levels

E.5. Arrival baggage claim

E.5.1. Effects of data source

Appendix Table E 15 shows the choice models estimated using data blocked based on data source. According to the results, the utility for space provision and the disutility for a longer curb access distance is significantly high for online respondents. A similar behaviour was aperant in departure circulation functional area where the online respondents allocate a higher utility on signage and electric carts. Hence the same explanation can be used to explain the current observation.

E.5.2. Effects of income class

Appendix Table E 16 shows the choice models estimated using data blocked based on income level. According to the results, the disutility of a short waiting time (less than 1min) with respect to a moderate wait (5-10min) for baggage delivery is decreasing. However the mean disutility of a moderate wait compared to a long wait is increasing. The average utility per unite time taken over the period of 17.5min (mean of 15-20min) has not changed considerably with income class.

E.5.3. Effects of trip purpose

Appendix Table E 25 shows the choice models estimated using data blocked based on trip purpose. According to the comparison, the utility of the availability of free baggage carts is significantly more important for leisure than the business travellers. This can be expected as most leisure travellers carry more luggage than a typical business traveller. Business travellers carry minimum amount of luggage while traveling. Also the leisure traveller is more price sensitive than the business travellers.

Appendix Table E 15: Arrival baggage claim-choice model comparison-blocked by data source

Online_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[54]	1.601	0.259	6.190	0.000		0.210	0.104	0.322	0.653
delt1_2	0.694	0.197	3.520	0.000		0.055	0.074	0.273	0.200
delt3_2	-1.538	0.284	-5.410	0.000		-0.495	0.124	0.352	-1.406
bbltl1_2	0.092	0.149	0.610	0.540		-0.316	0.047	0.216	-1.462
bbltl3_2	-0.693	0.199	-3.480	0.001		-0.477	0.082	0.286	-1.669
Space	1.087	0.192	5.660	0.000		0.655	0.059	0.244	2.689
bagc1_3	1.580	0.355	4.450	0.000		-0.250	0.194	0.441	-0.567
bagc2_3	0.222	0.292	0.760	0.447		-0.375	0.155	0.393	-0.953
Airport_choice (b_2)									
Signage1_2	1.391	0.192	7.250	0.000					
delt1_2	0.640	0.188	3.390	0.001					
delt3_2	-1.043	0.208	-5.020	0.000					
bbltl1_2	0.408	0.156	2.610	0.009					
bbltl3_2	-0.216	0.205	-1.050	0.292					
Space	0.432	0.150	2.880	0.004					
bagc1_3	1.830	0.261	7.010	0.000					
bagc2_3	0.596	0.264	2.260	0.024					

[54] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C2 for details on attribute service levels

Appendix Table E 16: Arrival baggage claim-choice model comparison-blocked by income level

income_low (b_1)	Coef.	Std. Err.	z	P>|z|	—	b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
Signage1_2[55]	1.337	0.207	6.460	0.000		-0.372	0.162	0.403	-0.924
delt1_2	1.015	0.197	5.140	0.000		0.202	0.120	0.347	0.583
delt3_2	-1.125	0.244	-4.610	0.000		0.104	0.163	0.404	0.258
bbltl1_2	0.291	0.175	1.670	0.096		0.163	0.086	0.293	0.558
bbltl3_2	-0.560	0.226	-2.480	0.013		0.017	0.133	0.365	0.048
Space	0.565	0.165	3.420	0.001		-0.531	0.094	0.307	-1.729
bagc1_3	1.508	0.291	5.180	0.000		-0.245	0.257	0.507	-0.485
bagc2_3	0.280	0.298	0.940	0.348		-0.411	0.234	0.484	-0.849
income_mid (b_2)						b_2-b_3	$seb_2{}^2 + seb_3{}^2$	$\sqrt{seb_2{}^2 + seb_3{}^2}$	z
Signage1_2	1.709	0.345	4.950	0.000		0.290	0.306	0.554	0.524
delt1_2	0.813	0.285	2.860	0.004		0.531	0.209	0.457	1.161
delt3_2	-1.229	0.322	-3.810	0.000		0.356	0.274	0.524	0.680
bbltl1_2	0.128	0.235	0.540	0.586		-0.122	0.105	0.324	-0.378
bbltl3_2	-0.578	0.286	-2.020	0.044		-0.069	0.176	0.419	-0.166
Space	1.095	0.259	4.230	0.000		0.235	0.158	0.398	0.591
bagc1_3	1.753	0.415	4.230	0.000		0.303	0.513	0.716	0.423
bagc2_3	0.690	0.382	1.810	0.070		0.792	0.388	0.623	1.272
income_high (b_3)						b_3-b_1	$seb_3{}^2 + seb_1{}^2$	$\sqrt{seb_3{}^2 + seb_1{}^2}$	z
Signage1_2	1.419	0.433	3.280	0.001		0.082	0.230	0.480	0.171
delt1_2	0.283	0.358	0.790	0.430		-0.733	0.167	0.409	-1.794
delt3_2	-1.585	0.413	-3.840	0.000		-0.460	0.230	0.480	-0.959
bbltl1_2	0.250	0.223	1.120	0.261		-0.041	0.080	0.283	-0.145
bbltl3_2	-0.508	0.306	-1.660	0.097		0.052	0.145	0.381	0.137
Space	0.860	0.302	2.850	0.004		0.296	0.118	0.344	0.859
bagc1_3	1.451	0.584	2.490	0.013		-0.057	0.425	0.652	-0.088
bagc2_3	-0.101	0.492	-0.210	0.837		-0.381	0.331	0.575	-0.663

[55] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C2 for details on attribute service levels

E.6. Arrival common amenities

E.6.1 Effects of trip frequency

Appendix Table E 17 shows the choice models estimated using data blocked based on trip frequency. According to the results the utility of restaurant availability, information and internet has decreased with trip frequency. Departing passengers tend to minimize the time they spend at the airport after disembarking from the air craft. Table 6-2 frequent travellers are more likely to be traveling for business purposes. These passengers tend to leave the airport as quickly as possible. Hence the utilization of internet or concessions at the arrival hall is minimum. Results indicate that arrival hall concessions are utilized more by less frequent travellers who are largely leisure travellers that tend to spend more time at the arrival hall.

E.6.2. Effects of income class

Appendix Table E 18 shows the choice models estimated using data blocked based on income level. It can be observed that income_mid level ($100,000-150,000) shows a significant less utility in restaurants, information and internet compared to the other two categories. Hence the observed relationship cannot be concluded as increase or decrease of utility with income level. Hence it is not consistent with previous observations. It is not possible to determine a possible behavioural aspect underling this finding with the available data. However this nonlinear effect may be caused by the significant correlation between income level and trip frequency. It was observed that trip frequency had an inverse relationship with utility of above attributes.

Appendix Table E 17: Arrival common amenities-choice model comparison-blocked by trip frequency

trip_low_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
cofres1_4[56]	2.897	0.712	4.070	0.000		2.109	1.031	1.015	2.077
cofres2_4	1.786	0.395	4.520	0.000		1.450	0.275	0.525	2.764
cofres3_4	0.855	0.422	2.030	0.043		1.035	0.392	0.626	1.654
info	1.680	0.353	4.760	0.000		1.599	0.287	0.536	2.986
wsh1_4	3.445	0.371	9.290	0.000		-0.064	0.337	0.581	-0.110
wsh2_4	1.845	0.266	6.940	0.000		0.152	0.178	0.421	0.360
wsh3_4	1.942	0.288	6.750	0.000		0.310	0.183	0.428	0.724
water	1.023	0.229	4.460	0.000		-0.086	0.114	0.337	-0.255
Intnt1_3	1.466	0.494	2.970	0.003		1.118	0.462	0.680	1.644
Intnt2_3	-0.706	0.355	-1.990	0.046		-0.192	0.222	0.471	-0.408
trip_mid_choice (b_2)						b_2-b_3	$seb_2{}^2 + seb_3{}^2$	$\sqrt{seb_2{}^2 + seb_3{}^2}$	z
cofres1_4	0.788	0.724	1.090	0.276		-0.225	0.944	0.972	-0.231
cofres2_4	0.336	0.345	0.970	0.331		-0.271	0.258	0.508	-0.534
cofres3_4	-0.181	0.463	-0.390	0.696		0.244	0.445	0.667	0.366
info	0.081	0.403	0.200	0.841		-0.593	0.278	0.527	-1.125
wsh1_4	3.509	0.447	7.840	0.000		0.180	0.464	0.681	0.264
wsh2_4	1.693	0.327	5.180	0.000		-0.095	0.265	0.515	-0.185
wsh3_4	1.632	0.317	5.150	0.000		-0.412	0.291	0.540	-0.764
water	1.109	0.247	4.490	0.000		-0.113	0.169	0.411	-0.276
Intnt1_3	0.349	0.466	0.750	0.455		-0.601	0.502	0.709	-0.848
Intnt2_3	-0.514	0.311	-1.650	0.098		-0.837	0.263	0.513	-1.631
trip_high_choice (b_3)						b_3-b_1	$seb_3{}^2 + seb_1{}^2$	$\sqrt{seb_3{}^2 + seb_1{}^2}$	z
cofres1_4	1.013	0.649	1.560	0.118		-1.884	0.928	0.963	-1.956
cofres2_4	0.607	0.372	1.630	0.103		-1.179	0.295	0.543	-2.172
cofres3_4	-0.424	0.481	-0.880	0.377		-1.279	0.409	0.640	-2.000
info	0.674	0.339	1.990	0.047		-1.006	0.240	0.490	-2.056
wsh1_4	3.329	0.514	6.480	0.000		-0.116	0.402	0.634	-0.183
wsh2_4	1.788	0.398	4.490	0.000		-0.056	0.229	0.479	-0.118
wsh3_4	2.045	0.437	4.680	0.000		0.103	0.273	0.523	0.196
water	1.222	0.328	3.720	0.000		0.199	0.160	0.401	0.498
Intnt1_3	0.949	0.533	1.780	0.075		-0.517	0.529	0.727	-0.711
Intnt2_3	0.323	0.408	0.790	0.429		1.029	0.292	0.541	1.904

[56] The coefficient label has three parts, the attribute name (e.g. cofres: - Availability of restaurants) and the attribute level and reference level (e.g. cofres 1_4:- coefficient of attribute level-1 with reference to level-4). Refer Appendix Table C3 for details on attribute service levels

Appendix Table E 18: Arrival common amenities-choice model comparison-blocked by income class

income_low_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
cofres1_4[57]	3.902	1.104	3.540	0.000		4.332	1.458	1.207	3.588
cofres2_4	2.000	0.585	3.420	0.001		1.716	0.450	0.671	2.558
cofres3_4	1.388	0.586	2.370	0.018		2.527	0.555	0.745	3.393
info	1.463	0.452	3.240	0.001		0.993	0.316	0.562	1.766
wsh1_4	3.307	0.404	8.200	0.000		-0.921	0.547	0.740	-1.245
wsh2_4	1.522	0.273	5.580	0.000		-1.005	0.295	0.543	-1.852
wsh3_4	1.618	0.315	5.130	0.000		-0.821	0.299	0.547	-1.501
water	0.955	0.274	3.490	0.000		-0.916	0.198	0.445	-2.059
Intnt1_3	2.167	0.845	2.570	0.010		2.344	0.879	0.938	2.500
Intnt2_3	-0.412	0.456	-0.900	0.366		-0.022	0.360	0.600	-0.036
income_mid_choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
cofres1_4	-0.430	0.490	-0.880	0.380		-3.103	1.347	1.161	-2.673
cofres2_4	0.284	0.329	0.860	0.388		-1.478	0.396	0.629	-2.349
cofres3_4	-1.139	0.459	-2.480	0.013		-1.481	0.587	0.766	-1.934
info	0.470	0.335	1.410	0.160		-1.358	0.377	0.614	-2.211
wsh1_4	4.228	0.620	6.820	0.000		0.115	0.734	0.857	0.135
wsh2_4	2.528	0.469	5.390	0.000		0.055	0.424	0.651	0.085
wsh3_4	2.439	0.447	5.460	0.000		0.111	0.416	0.645	0.172
water	1.871	0.351	5.340	0.000		0.584	0.239	0.489	1.194
Intnt1_3	-0.177	0.407	-0.430	0.664		-1.608	0.704	0.839	-1.917
Intnt2_3	-0.390	0.390	-1.000	0.317		-0.154	0.349	0.591	-0.260
income_high_choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
cofres1_4	2.672	1.052	2.540	0.011		-1.229	2.325	1.525	-0.806
cofres2_4	1.762	0.536	3.280	0.001		-0.238	0.629	0.793	-0.300
cofres3_4	0.342	0.613	0.560	0.577		-1.046	0.720	0.848	-1.233
info	1.829	0.515	3.550	0.000		0.366	0.469	0.685	0.534
wsh1_4	4.113	0.591	6.950	0.000		0.806	0.513	0.716	1.125
wsh2_4	2.472	0.452	5.470	0.000		0.950	0.279	0.528	1.800
wsh3_4	2.328	0.465	5.000	0.000		0.709	0.316	0.562	1.262
water	1.287	0.341	3.770	0.000		0.332	0.191	0.437	0.758
Intnt1_3	1.432	0.734	1.950	0.051		-0.736	1.252	1.119	-0.657
Intnt2_3	-0.237	0.443	-0.530	0.594		0.175	0.405	0.636	0.276

[57] The coefficient label has three parts, the attribute name (e.g. cofres: - Availability of restaurants) and the attribute level and reference level (e.g. cofres 1_4:- coefficient of attribute level-1 with reference to level-4). Refer Appendix Table C3 for details on attribute service levels

E.7. Arrival curb area

E.7.1. Effects of gender

Appendix Table E 19 shows the choice models estimated using data blocked based on gender. According to the results there is a significant increase in the utility associated with automated teller machines and signage for female respondents compared to male respondents.

E.7.2. Effects of trip frequency

Appendix Table E 20 shows the choice models estimated using data blocked based on trip frequency. Attribute for banking machine availability was removed from analysis due to a significant negative coefficient. Closer examination showed that inadequate data points available in the high trip frequency category to estimate all five coefficients. Therefore ATM attribute as the least important attribute was removed from the analysis. Results obtained for the remaining attributes show that frequent travellers place a higher utility on curb front space and availability of ground transportation service counters at the curb. Both of these attributes relate to convenient transition to ground transportation at the curb. Peak period congestion at the arrival curb can cause considerable delay and inconvenience to passengers during the transition from air to ground. Onsite ground transportation service counters are convenient for arriving passengers for choosing the best ground transportation mode. Frequent travellers are very much time conscious and require fast transition from air to ground travel at the curb.

E.7.3. Effects of income class

Appendix Table E 21 shows the choice models estimated using data blocked based on income class. Inconsistent results was observed for banking machines and signage attributes in the analysis for highest income class. Similar to the analysis of trip frequency inadequate data points in the high income class is the possible reason for the inconsistent results. Hence ATM attribute was dropped from the analysis. Results of the proceeding analysis shows that utility of curb front space provision increased significantly for higher income respondents than lower income respondents. The correlation between income class and trip frequency can also be affecting this observation. In addition to that it can be expected that higher income passenger's expectation of level of service to be higher than ordinary passengers.

E.7.4. Effects of trip purpose

Appendix E 26 shows the choice models estimated using data blocked based on trip purpose. According to the comparison of coefficients, business travellers have a significantly higher utility for the availability of curb space than the leisure travellers. Furthermore it can be observed from the results that the leisure travellers have a significantly higher utility for the availability of signage than the business travellers at the arrival curb area.

Remaining socio demographic characteristics such as data source and age group did not show statistically significant evidence for affecting attribute coefficients.

Appendix Table E 19: Arrival curb area-choice model comparison-blocked by gender

Male_choice (b_1)	Coef.	Std. Err.	z	$P>\lvert z\rvert$		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[58]	2.031	0.348	5.830	0.000		-2.247	0.885	0.941	-2.388
Weather1_2	1.342	0.212	6.330	0.000		0.138	0.193	0.440	0.314
Curb_space1_2	1.422	0.198	7.200	0.000		-0.568	0.185	0.430	-1.321
TransitInfo1_2	1.423	0.245	5.810	0.000		-0.227	0.165	0.406	-0.560
ATM1_2	0.531	0.268	1.990	0.047		-1.128	0.323	0.568	-1.986
Female_choice (b_2)									
Signage1_2	4.278	0.874	4.890	0.000					
Weather1_2	1.204	0.385	3.130	0.002					
Curb_space1_2	1.990	0.382	5.210	0.000					
TransitInfo1_2	1.650	0.323	5.100	0.000					
ATM1_2	1.659	0.501	3.310	0.001					

[58] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

Appendix Table E 20: Arrival curb area-choice model comparison-blocked by trip frequency

trip_low_choice (b_1)	Coef.	Std. Err.	z	$P>\lvert z\rvert$	—	b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[59]	2.252	0.289	7.800	0.000		0.947	0.166	0.407	2.325
Weather1_2	1.012	0.226	4.490	0.000		-0.665	0.167	0.409	-1.626
Curb_space1_2	1.136	0.206	5.510	0.000		-0.147	0.186	0.431	-0.340
TransitInfo1_2	1.199	0.272	4.410	0.000		-0.695	0.381	0.618	-1.125
trip_mid_choice (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Signage1_2	1.305	0.287	4.540	0.000		-0.319	0.261	0.511	-0.624
Weather1_2	1.676	0.341	4.920	0.000		-0.274	0.452	0.672	-0.408
Curb_space1_2	1.282	0.379	3.380	0.001		-1.307	0.532	0.730	-1.792
TransitInfo1_2	1.894	0.554	3.420	0.001		-1.315	1.025	1.012	-1.299
trip_high_choice (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Signage1_2	1.624	0.422	3.840	0.000		-0.628	0.262	0.512	-1.228
Weather1_2	1.950	0.579	3.370	0.001		0.939	0.386	0.622	1.510
Curb_space1_2	2.590	0.624	4.150	0.000		1.454	0.431	0.657	2.214
TransitInfo1_2	3.209	0.847	3.790	0.000		2.010	0.791	0.890	2.260

[59] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

Appendix Table E 21: Arrival curb area-choice model comparison-blocked by income class

Income_low (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[60]	1.991	0.324	6.140	0.000		0.207	0.265	0.515	0.402
Weather1_2	1.276	0.236	5.400	0.000		-0.519	0.238	0.488	-1.063
Curb_space1_2	0.947	0.243	3.900	0.000		-0.149	0.269	0.518	-0.288
TransitInfo1_2	1.449	0.320	4.530	0.000		-0.321	0.460	0.678	-0.473
Income_mid (b_2)						b_2-b_3	$seb_2^2 + seb_3^2$	$\sqrt{seb_2^2 + seb_3^2}$	z
Signage1_2	1.784	0.400	4.460	0.000		0.294	0.298	0.546	0.538
Weather1_2	1.794	0.427	4.210	0.000		0.070	0.406	0.637	0.110
Curb_space1_2	1.097	0.458	2.400	0.017		-1.164	0.392	0.626	-1.860
TransitInfo1_2	1.770	0.598	2.960	0.003		-0.594	0.655	0.809	-0.734
Income_high (b_3)						b_3-b_1	$seb_3^2 + seb_1^2$	$\sqrt{seb_3^2 + seb_1^2}$	z
Signage1_2	1.490	0.372	4.010	0.000		-0.501	0.244	0.494	-1.015
Weather1_2	1.724	0.474	3.640	0.000		0.448	0.280	0.529	0.847
Curb_space1_2	2.261	0.427	5.300	0.000		1.314	0.241	0.491	2.675
TransitInfo1_2	2.364	0.545	4.340	0.000		0.915	0.399	0.632	1.448

[60] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

E.8. Arrival circulation

E.8.1. Effects of data source

Appendix Table E 22 shows the choice models estimated using data blocked based on data source. The effects of data source on arrival circulation service attributes is the same as the data source effects observed in departure circulation. Online respondents have allocated significantly higher utilities on circulation signage including access time/distance information and level changing means. Thus the same underling reasons can be attributes to the observations for arrival passenger responses.

Remaining socio demographic characteristics such as gender, age group, trip frequency and income level did not show statistically significant evidence for affecting attribute coefficient.

Appendix Table E 22: Arrival circulation-choice model comparison-blocked by data source

Online_Choice (b_1)	Coef.	Std.Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[61]	2.629	0.352	7.480	0.000		1.113	0.199	0.446	2.494
Ttnod1_2	1.463	0.430	3.400	0.001		1.268	0.312	0.559	2.269
chnglvl2_1	-1.125	0.426	-2.640	0.008		-1.292	0.309	0.556	-2.323
chnglvl3_1	-1.488	0.461	-3.230	0.001		1.233	0.607	0.779	1.583
Conv1_2	1.642	0.327	5.020	0.000		0.366	0.171	0.414	0.883
Eleccrt1_2	1.038	0.381	2.730	0.006		0.469	0.261	0.511	0.917
Airport_Choice (b_2)									
Signage1_2	1.516	0.275	5.510	0.000					
Ttnod1_2	0.195	0.357	0.550	0.585					
chnglvl2_1	0.166	0.358	0.460	0.642					
chnglvl3_1	-2.721	0.628	-4.330	0.000					
Conv1_2	1.277	0.254	5.030	0.000					
Eleccrt1_2	0.570	0.340	1.670	0.094					

[61] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C1 for details on attribute service levels

Appendix Table E 23: Departure lounge-choice model comparison-blocked by trip purpose

Business_choice (b_1)	Coef.	Std.Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
seating1_2[62]	0.528	0.179	2.960	0.003		-0.099	0.067	0.259	-0.384
seating3_2	-1.585	0.243	-6.540	0.000		-0.555	0.125	0.354	-1.567
shops	0.489	0.144	3.400	0.001		-0.121	0.047	0.216	-0.560
restaurants	1.366	0.155	8.810	0.000		0.309	0.049	0.220	1.401
chargingstn	0.786	0.163	4.820	0.000		0.510	0.056	0.237	2.149
intnt1_3	1.904	0.186	10.210	0.000		0.120	0.068	0.261	0.461
intnt2_3	0.101	0.214	0.470	0.637		0.098	0.086	0.294	0.332
Leisure_choice (b_2)									
seating1_2	0.628	0.187	3.350	0.001					
seating3_2	-1.030	0.258	-3.990	0.000					
shops	0.610	0.161	3.780	0.000					
restaurants	1.057	0.156	6.760	0.000					
chargingstn	0.275	0.173	1.600	0.110					
intnt1_3	1.784	0.182	9.800	0.000					
intnt2_3	0.003	0.201	0.020	0.986					

[62] The coefficient label has three parts, the attribute name (e.g. seating: - seating availability) and the attribute level and reference level (e.g. seating1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C5 for details on attribute service levels

Appendix Table E 24: Departure check-in area-choice model comparison-blocked by trip purpose

Business_Choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1{}^2 + seb_2{}^2$	$\sqrt{seb_1{}^2 + seb_2{}^2}$	z
Chkin2_1[63]	0.968	0.176	5.510	0.000		-0.137	0.073	0.270	-0.507
Chkin3_1	-1.477	0.266	-5.550	0.000		0.030	0.158	0.397	0.077
info1_3	0.902	0.153	5.910	0.000		-0.366	0.048	0.219	-1.670
info2_3	0.494	0.235	2.100	0.035		-0.328	0.113	0.336	-0.977
Kiosk1_2	1.348	0.150	8.980	0.000		0.317	0.042	0.205	1.542
Sec_screening1_2	0.312	0.188	1.660	0.096		0.116	0.061	0.248	0.468
Leisure _Choice (b_2)									
Chkin2_1	1.104	0.205	5.400	0.000					
Chkin3_1	-1.507	0.295	-5.100	0.000					
info1_3	1.269	0.157	8.070	0.000					
info2_3	0.822	0.241	3.420	0.001					
Kiosk1_2	1.032	0.140	7.370	0.000					
Sec_screening1_2	0.196	0.162	1.210	0.225					

[63] The coefficient label has three parts, the attribute name (e.g. Chkin: - Check-in waiting time) and the attribute level and reference level (e.g. Chkin2_1:- coefficient of attribute level-2 with reference to level-1). Refer Appendix Table C8 for details on attribute service levels

Appendix Table E 25: Arrival baggage claim area-choice model comparison-blocked by trip purpose

Business_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[64]	1.27	0.17	7.56	0.00		-0.42	0.11	0.33	-1.27
delt1_2	0.56	0.17	3.33	0.00		-0.27	0.08	0.28	-0.98
delt3_2	-1.03	0.20	-5.17	0.00		0.51	0.13	0.36	1.42
bbltl1_2	0.20	0.15	1.32	0.19		-0.09	0.05	0.21	-0.41
bbltl3_2	-0.41	0.18	-2.20	0.03		0.15	0.08	0.28	0.56
Space	0.65	0.14	4.63	0.00		-0.26	0.06	0.24	-1.09
bagc1_3	1.20	0.23	5.28	0.00		-0.87	0.20	0.45	-1.96
bagc2_3	0.32	0.24	1.34	0.18		-0.10	0.16	0.40	-0.26
Leisure choice (b_2)									
Signage1_2	1.68	0.28	5.99	0.00					
delt1_2	0.83	0.22	3.77	0.00					
delt3_2	-1.53	0.30	-5.16	0.00					
bbltl1_2	0.28	0.15	1.85	0.06					
bbltl3_2	-0.56	0.21	-2.72	0.01					
Space	0.91	0.20	4.64	0.00					
bagc1_3	2.07	0.38	5.40	0.00					
bagc2_3	0.42	0.32	1.33	0.19					

[64] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C2 for details on attribute service levels

Appendix Table E 26: Arrival curb area-choice model comparison-blocked by trip purpose

Male_choice (b_1)	Coef.	Std. Err.	z	P>|z|		b_1-b_2	$seb_1^2 + seb_2^2$	$\sqrt{seb_1^2 + seb_2^2}$	z
Signage1_2[65]	2.111	0.400	5.280	0.000		-1.407	0.465	0.682	-2.064
Weather1_2	0.889	0.226	3.930	0.000		-0.415	0.180	0.425	-0.978
Curb_space1_2	2.232	0.195	6.330	0.000		0.994	0.167	0.408	2.437
TransitInfo1_2	1.227	0.233	5.260	0.000		-0.176	0.175	0.418	-0.421
ATM1_2	0.424	0.268	1.580	0.113		-0.525	0.282	0.531	-0.988
Female_choice (b_2)									
Signage1_2	3.518	0.552	6.370	0.000					
Weather1_2	1.304	0.360	6.010	0.000					
Curb_space1_2	1.238	0.359	6.240	0.000					
TransitInfo1_2	1.403	0.347	5.480	0.000					
ATM1_2	0.949	0.458	3.600	0.000					

[65] The coefficient label has three parts, the attribute name (e.g. signage: - Availability of clear signage) and the attribute level and reference level (e.g. signage 1_2:- coefficient of attribute level-1 with reference to level-2). Refer Appendix Table C4 for details on attribute service levels

Appendix F: Results of the Brant test of parrellel regression assumption

Appendix Table F 1: Brant test results for departure lounge area

Variable	chi2	p> chi2	df
All	18.88	0.17	14
seat1_2	1.19	0.553	2
seat3_2	1.74	0.419	2
retail shops1_2	1.96	0.375	2
restaurants1_2	9.25	0.01	2
charging stations1_2	4.12	0.127	2
intent1_3	2.16	0.339	2
intent2_3	3.21	0.201	2

Appendix Table F 2: Brant test results for departure common amenities

Variable	chi2	p> chi2	df
All	61.58	0.000	20
Automated services1_2	16.1	0.000	2
fltinfo1_4	0.17	0.917	2
fltinfo2_4	7.58	0.023	2
fltinfo3_4	9.04	0.011	2
Info_com1_3	2.5	0.287	2
Info_com2_3	1.25	0.536	2
wsh1_4	8.18	0.017	2
wsh2_4	1.79	0.409	2
wsh3_4	6.63	0.036	2
water1_2	0.88	0.646	2

Appendix Table F 3: Brant test results for departure check-in area

Variable	chi2	p>chi2	df
All	17.28	0.241	14
Chkin1_2	1.03	0.599	2
Chkin3_2	0.42	0.809	2
info_check-in1_3	1.1	0.578	2
info_check-in2_3	0.2	0.904	2
Check in Kiosk1_2	3.25	0.197	2
Signage_check-in1_2	4.6	0.1	2
Sec_screening1_2	4.36	0.113	2

Appendix Table F 4: Brant test results for departure curb area

Variable	chi2	p>chi2	df
All	26.13	0.01	12
space_curb1_2	1.89	0.389	2
Distckn1_2	0.32	0.85	2
Distckn3_2	2.87	0.239	2
weathercover1_2	2.55	0.28	2
bagc1_2	0.54	0.763	2
porter1_2	16.07	0.00	2

Appendix Table F 5: Brant test results for departure circulation

Variable	chi2	p>chi2	df
All	10.46	0.576	12
signage_cir1_2	0.02	0.988	2
Ttnod1_2	1.75	0.417	2
chnglvl1_2	1.54	0.463	2
chnglvl1_3	1.58	0.454	2
walking1_2	0.08	0.959	2
eleccrt1_2	3.69	0.158	2

Appendix Table F 6: Brant test results for arrival baggage claim

Variable	chi2	p>chi2	df
All	40.88	0.001	16
signage_bag1_2	8.08	0.018	2
delt1_2	5.92	0.052	2
delt3_2	3.34	0.189	2
bbltl1_2	3.57	0.168	2
bbltl3_2	0.24	0.885	2
space_bag1_2	6.06	0.048	2
bagc1_3	6.18	0.046	2
bagc2_3	0.05	0.977	2

Appendix Table F 7: Brant test results for arrival common amenities

Variable	chi2	p>chi2	df
All	45.61	0.001	20
cofres1_4	2.45	0.294	2
cofres2_4	0.28	0.868	2
cofres3_4	0.52	0.77	2
info_com1_2	10.65	0.005	2
wsh1_4	1.24	0.538	2
wsh2_4	1.73	0.421	2
wsh3_4	0.51	0.777	2
Water1_2	2.62	0.27	2
intnt1_3	0.21	0.9	2
intnt2_3	7.17	0.028	2

Appendix Table F 8: Brant test results for arrival curb area

Variable	chi2	p>chi2	df
All	26.84	0.003	10
Signage_curb1_2	0.08	0.958	2
Weathercover1_2	6.51	0.039	2
curb_space1_2	9.69	0.008	2
Transitinfo1_2	9.97	0.007	2
atm1_2	1.09	0.579	2

Appendix Table F 9: Brant test results for arrival circulation

Variable	chi2	p>chi2	df
All	6.98	0.859	12
Signage_cir1_2	0.96	0.62	2
ttnod1_2	1.41	0.494	2
chnglvl1_2	1.59	0.453	2
chnglvl1_3	1.34	0.513	2
walk_dis1_2	1.22	0.542	2
ele_cart1_2	0.83	0.661	2

Appendix G: Definition of overall service quality standards using objectively defined service performance criteria

Appendix Table G 1: Definition of overall service quality standards for the departure passenger flow path

Functional area	Attribute label	Importance category	Requirement for basic terminal operations	Type of marginal effect observed	Attribute range of service availability	Basic Level-1	Average Level-3	Above average Level-5	Score
Common amenities	Automated services	Moderate to low	Non-essential	Increasing	Basic	0	1		0.23
					Average	0	0	1	0.46
					High	0	0	0	0.69
	Flight information	Moderate to high	Essential	Constant	Basic	1			0.61
					Average	0	1		1.22
					High	0	0	1	1.83
	Information desk/staff	Moderate to low	Non-essential	Decreasing	Basic	0	1	1	0.21
					Average	0	0	0	0.42
					High	0	0	0	0.63
	Availability of washrooms	High	Essential	Increasing	Basic	1			1.00
					Average	0	0		2.00
					High	0	0	1	3.00
	Water fountains	Moderate to low	Non-essential	Constant	Basic	0	1		0.22
					Average	0	0	1	0.44
					High	0	0	0	0.66
Check-in hall	Check-in process time	High	Essential	Constant	LOC=D	1			0.00
					LOC=C	0	1		1.00
					LOC=B	0	0	1	2.00
					LOC=A	0	0	0	3.00
	Information desk/staff	Moderate to high	Non-essential	Constant	Basic	0			0.58
					Average	0	1		1.16
					High	0	0	1	1.74
	Automated check-in	Moderate to high	Non-essential	Increasing	Basic	0			0.80
					Average	0	1		1.60
					High	0	0	1	2.40
	Signage in the check-in area	Low	Essential	Increasing	Basic	1	1		0.17
					Average	0	0	1	0.34
					High	0	0	0	0.51
	Security screening	Moderate to high	Essential	Increasing	Basic	1			0.60
					Average	0	1		1.20
					High	0	0	1	1.80

Functional area	Attribute label	Importance category	Requirement for basic terminal operations	Type of marginal effect observed	Attribute range of service availability	Basic	Average	Above average	Score
						Level-1	Level-3	Level-5	
Lounge area	Seating availability	Moderate to high	Essential	Constant	LOC=D	1			0.71
					LOC=C	0	1		0.71
					LOC=B	0	0	1	1.42
					LOC=A	0	0	0	2.13
	Seating variety	Moderate to low	Non-essential	Constant	Basic	0	1		0.30
					Average	0	0	1	0.60
					High	0	0	0	0.90
	Shopping options	Moderate to low	Non-essential	Increasing	Basic	0	1		0.30
					Average	0	0	1	0.60
					High	0	0	0	0.90
	Restaurant options	Moderate to high	Essential	Increasing	Basic	1			0.65
					Average	0	1		1.30
					High	0	0	1	1.95
	Mobile device stations	Moderate to low	Non-essential	Increasing	Basic	0	1		0.30
					Average	0	0	1	0.60
					High	0	0	0	0.90
	Internet availability	High	Non-essential	Increasing	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
Curb area	Curb space	High	Essential	Decreasing	LOC=D	1			0.84
					LOC=C	0	1	1	1.68
					LOC=B	0	0	0	2.52
					LOC=A	0	0	0	3.36
	Distance to check-in from curb/parking	Moderate to high	Non-essential	Constant	Basic	0			0.55
					Average	0	1		1.10
					High	0	0	1	1.65
	Weather protection	Moderate to high	Non-essential	Decreasing	Basic	0	1		0.62
					Average	0	0	1	1.24
					High	0	0	0	1.86
	Baggage carts	High	Essential	Constant	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00

Functional area	Attribute label	Importance category	Requirement for basic terminal operations	Type of marginal effect observed	Attribute range of service availability	Basic	Average	Above average	Score
						Level-1	Level-3	Level-5	
Circulation	Signage for circulation	High	Essential	Constant	LOC=D	1			0.97
					LOC=C	0	1		1.94
					LOC=B	0	0	1	2.91
					LOC=A	0	0	0	3.88
	Access time/distance information/maps	Moderate to low	Non-essential	Constant	Basic	0	1		0.48
					Average	0	0	1	0.96
					High	0	0	0	1.44
	Level changing	High	Essential	Constant	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
	Walking distance	Moderate to high	Essential	Increasing	LOC=D	1			0.60
					LOC=C	0	1		1.20
					LOC=B	0	0	1	1.80
					LOC=A	0	0	0	2.40
	Electric carts	Low	Essential	Increasing	Basic	1	1		0.17
					Average	0	0	1	0.34
					High	0	0	0	0.51
					Minimum score	**6.2**	**20.7**	**36.56**	

Appendix Table G 2: Definition of overall service standards for the arrival passenger flow path

Functional area	Attribute label	Importance category	Requirement for basic terminal operations	Type of marginal effect observed	Attribute range of service availability	Basic	Average	Above average	Score
						Level-1	Level-3	Level-5	
Baggage claim	Signage at baggage claim	High	Essential	Increasing	LOC=D	1			0.91
					LOC=C	0	1		1.82
					LOC=B	0	0	1	2.73
					LOC=A	0	0	0	3.64
	Baggage delivery time	Moderate to high	Essential	Constant	LOC=D	1			0.00
					LOC=C	0	1		0.78
					LOC=B	0	0	1	1.56
					LOC=A	0	0	0	2.34
	Distance to curb/parking from baggage claim	Moderate to low	Non-essential	Increasing	Basic	0	1		0.29
					Average	0	0	1	0.58
					High	0	0	0	0.87
	Space at baggage claim area	Moderate to high	Essential	Increasing	LOC=D	1			0.48
					LOC=C	0	1		0.96
					LOC=B	0	0	1	1.44
					LOC=A	0	0	0	1.92
	Baggage carts	High	Essential	Increasing	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
Curb area	Signage at curb area	High	Non-essential	Constant	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
	Weather protection	Moderate to high	Non-essential	Increasing	Basic	0			0.51
					Average	0	1		1.02
					High	0	0	1	1.53
	Curb space	Moderate to high	Essential	Increasing	LOC=D	1			0.59
					LOC=C	0	1		1.18
					LOC=B	0	0	1	1.77
					LOC=A	0	0	0	2.36
	Ground transportation service desk	Moderate to high	Non-essential	Increasing	Basic	0			0.57
					Average	0	1		1.14
					High	0	0	1	1.71
	ATM	Moderate to low	Non-essential	Constant	Basic	0	1		0.32
					Average	0	0	1	0.64
					High	0	0	0	0.96

Functional area	Attribute label	Importance category	Requirement for basic terminal operations	Type of marginal effect observed	Attribute range of service availability	Basic Level-1	Average Level-3	Above average Level-5	Score
Circulation	Signage for circulation	High	Essential	Constant	LOC=D	1			0.89
					LOC=C	0	1		1.78
					LOC=B	0	0	1	2.67
					LOC=A	0	0	0	3.56
	Access time/distance information/maps	Moderate to low	Non-essential	Constant	Basic	0	1		0.30
					Average	0	0	1	0.6
					High	0	0	0	0.9
	Level changing	High	Essential	Constant	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
	Walking distance	Moderate to high	Essential	Constant	LOC=D	1			0.00
					LOC=C	0	1		0.62
					LOC=B	0	0	1	1.24
					LOC=A	0	0	0	1.86
	Electric carts	Moderate to low	Essential	Constant	Basic	1			0.31
					Average	0	1		0.62
					High	0	0	1	0.93
Common amenities	Restaurant options	Moderate to low	Essential	Decreasing	Basic	1	1		0.46
					Average	0	0	1	0.92
					High	0	0	0	1.38
	Information desk/staff	Moderate to low	Non-essential	Decreasing	Basic	0	1	1	0.25
					Average	0	0	0	0.5
					High	0	0	0	0.75
	Washrooms	High	Essential	Constant	Basic	1			1.00
					Average	0	1		2.00
					High	0	0	1	3.00
	Water fountains	Moderate to low	Non-essential	Increasing	Basic	0	1		0.32
					Average	0	0	1	0.64
					High	0	0	0	0.96
	Internet	Moderate to low	Non-essential	Constant	Basic	0	1		0.26
					Average	0	0	1	0.52
					High	0	0	0	0.78
					Minimum score	**7.64**	**20.12**	**31.73**	

Appendix H: Summary of the literature review

Appendix Table H 1: Literature review summary

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
1	Lupo, T. (2015)	Fuzzy ServPerf model combined with ELECTRE III to comparatively evaluate service quality of international airports in Sicily	Subjective data	Airport experts Travel agencies Frequent flyers	AHP, Fuzzy set theory	N/A	Processing time Convenience Comfort Information Staff Safety and security	0.1 0.09 0.12 0.2 0.12 0.34
2	Bogicevic, V., Yang, W., Bilgihan, A., & Bujisic, M. (2013)	Airport service quality drivers of passenger satisfaction	Subjective data	Online reviews	Content analysis	N/A	Check-in Security-check Signage Accessibility Parking Baggage/luggage Staff Shopping Dining options Cleanliness Adequate seating Internet kiosk Charging stations WiFi	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
3	Chang, Y.-C., & Chen, C.-F. (2012)	Service needs of elderly air passengers	Subjective data	Passengers, aged 65 and over	Importance performance analysis IPA	N/A	Special services for elderly Announcement of canceled flights and delay Information on direction in the airport terminal Transport information to and from the airport Information broadcast User-friendly boarding Check-in counter staff's service attitude Restroom at terminal Exclusive customs counter Assistance in boarding Ground staff's service attitude Waiting area at check-in count	High importance High importance High importance High importance High importance High importance High importance low importance low importance low importance low importance low importance

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking (if given)
4	Chien-Chang, C. (2012)	Evaluating the quality of airport service using the fuzzy multi-criteria decision-making method: a case study of Taiwanese airports	Subjective data	Departing	Direct rating, Fuzzy set analysis	Departure terminal	**Check-in** Ticketing waiting time Total time for check-in process Courtesy of airline staff Congestion level of check-in waiting area **Immigration process** Waiting time for immigration processing Total time for immigration processing Courtesy of immigration bureau staff Congestion level of the immigration area **Customs inspection** Total time for Customs inspection Courtesy of Customs staff Congestion level of inspection area **Overall** Airport facilities Response to phone calls Availability of lifts/escalators/moving walkways Walking distance Cleanliness and lighting level of airport Art and exhibitions Availability of information display for flights Service in case of flight delay Visibility and availability of signpost	-- 4.19 4.21 4.53 3.39 -- 4.06 4.08 4.46 3.5 -- 4.15 4.48 3.69 -- 3.71 4.2 4.1 4.03 4.23 3.77 4.34 4.02 4.34
5	Jeon, S., & Kim, M.-s. (2012)	The effect of the services cape on customers' behavioral intentions in an international airport service environment	Subjective data	Departing Arriving	Explanatory factor analysis Confirmatory factor analysis Structural equation modeling	N/A	Ambient factor Functional factor Esthetic factor Safety factor Social factor	N/A N/A N/A N/A N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking (if given)
6	Liou, J. J. H., Tang, C.-H., Yeh, W.-C., & Tsai, C.-Y. (2011)	A decision rules approach for improvement of airport service quality	Subjective data	Departing passengers	Factor analysis Decision rule analysis	Departure terminal	Washroom facilities	N/A
							Shops-variety	N/A
							Restaurants-variety	N/A
							Money exchange	N/A
							Cash machines	N/A
							Luggage carts	N/A
							Telephone and Internet	N/A
							Cleanliness of the environment	N/A
							Lighting of the terminal	N/A
							Congestion level	N/A
							Walking distance	N/A
							ICQ Immigration	N/A
							Customs and quarantine	N/A
							Baggage claim	N/A
							Ground transportation	N/A
							Parking	N/A
							Rental facilities	N/A
							Helpfulness of the information desk	N/A
							Friendliness of the staff	N/A
							Information visibility Guidance/sign/directions	N/A
							Flight displays	N/A
							Efficiency of inspection	N/A
							Courtesy of inspectors	N/A
							Prices at shops and restaurants	N/A
7	Tsai, W.-H., Hsu, W., & Chou, W.-C. (2011)	A gap analysis model for improving airport service quality	Subjective data	Departing Arriving Transferring	AHP VIKOR	N/A	Sanitary condition of lavatory	9.67
							Environment beauty and cleanliness	4.88
							Facilities allocation and space design	4.9
							Internal direction line arrangement	10.27
							Exterior surrounding circulation planning	8.73
							Convenience of public transportation	9.49
							Airport receptionist’s attitude	7.43
							Security inspection procedure	6.36
							Check-in and baggage delivery service	8.33
							On-time departure of flights	11.85
							Clarity of broadcasting system	8.03
							Accuracy of flight information board	10.06

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking (if given)
8	TRB(2010)	ACRP Report 25: Airport Passenger Terminal Planning and Design	Objective data	N/A	N/A		Check-in Queue Area Wait/Circulate Hold Room Baggage Claim Government Inspection	N/A N/A N/A N/A N/A
9	Correia, Wirasinghe, and de Barros (2008)	A global index for level of service evaluation at airport passenger terminals	Subjective data	Departing passengers	Linear regression	Departure terminal	Enplaning curbside Orientation Purpose of travel (Business/non-business) Departure lounge Ticket counter baggage deposit Concessions walking distance circulation	0.25 0.23 0.21 0.15 0.14 0.00 0.00 N/A
10	Mikulić, J., & Prebežac, D. (2008)	Prioritizing improvement of service attributes using impact range-performance analysis and impact-asymmetry analysis	Subjective data	Departing passengers	N/A	Departure terminal	Ease of finding your way Check-in procedure Offer of restaurants Shopping possibilities Cleanliness Comfort level of the building Staff politeness Offer of flights Availability of luggage carts	0.10 0.14 0.16 0.15 0.19 0.29 0.25 0.20 0.06
11	Correia, A., Bandeira, M. P., & Wirasinghe, S. C. (2007)	Degree of Importance of Airport Passenger Terminal Components and their Attributes	Subjective data	Departing passengers	AHP	Departure terminal	Check-in Departure lounge Departure Hall Parking concession	0.33 0.23 0.13 0.11 0.10

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
12	de Barros, Somasundaraswaran, and Wirasinghe (2007	Evaluation of level of service for transfer passengers at airports	Subjective data	Transfer passenger	Linear regression	Transfer area	Courtesy/helpfulness of security staff	1.04
							Quality of Flight Information Displays	0.58
							Availability of drinking water	0.34
							Quality of guidance/signage/directions	0.31
							Availability of seats in transfer area	0.15
							Quality of audio information/staff	0.14
							Rest rooms	N/A
							Restaurants & bars	N/A
							Duty free shops	N/A
							Toilet facilities	N/A
							Telephone/Internet facilities	N/A
							Prayer rooms	N/A
							Medicine/Pharmacy	N/A
13	Correia, A. (2005)	Evaluation of Level of Service at Airport Passenger Terminals: Individual Components and Overall Perspectives	Objective and subjective	Departing passengers	Psychometric scaling Linear regression	N/A	Effective curb utilization	N/A
							Walking distance from curb to entrance	N/A
							Time waiting to park	N/A
							Check-in waiting time	0.2
							Processing time	0.28
							Space availability	0.5
							Security service time	N/A
							space availability at the departure lounge	N/A
							Seats availability	N/A
							Baggage claim-processing time	0.5
							Claim frontage	0.5
							Total service time	N/A
							Total walking distance	N/A
							Tradity differential	N/A
14	Fodness, D., & Murray, B. (2005)	Passengers' expectations of airport service quality	Subjective data	Frequent flyers	Explanatory Factor analysis Confirmatory factor analysis	N/A	**Function**	N/A
							Effectiveness	N/A
							Efficiency	N/A
							Interaction	N/A
							Diversion	N/A
							Productive	N/A
							Maintenance	N/A
							Decor	N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking (if given)
15	Tam and Lam (2004)	Determination of service levels for passenger orientation in Hong Kong International Airport	Objective data	Departing Transfer	Passenger importance rating	Terminal way finding	Entrance	1.00
							Check in counters by airline	1.00
							Immigration	1.00
							Boarding gate	1.00
							Toilets	0.89
							Flight information board	0.85
							Trolleys	0.84
							Seats in restricted area	0.84
							Airline information counter	0.82
							lost and found	0.81
							Lifts	0.77
							Public telephones	0.77
							Seats in public area	0.77
							Automated people mover	0.76
							Restaurants	0.76
							Money exchange outlet	0.75
							Drinking fountain	0.75
							Banks	0.74
							Auto teller machine	0.74
							Internet lounge	0.73
							Duty-free shops	0.71
							Cafeteria/bars	0.68
							Television	0.68
							Non-duty free shops	0.66
							Children play area	0.65
							Airline lounge	0.64
							Prayer room	0.57
							photo kiosk	0.56
16	Yen, J.-R., & Teng, C.-H. (2003)	Effects of Spatial Congestion on the Level of Service at Airport Passenger Terminals	Objective and subjective	Departing Arriving	Fuzzy set theory	Check-in Baggage claim	Space available at check-in	N/A
							Space available at baggage claim	N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
17	Lam, Tam, Wong, and Wirasinghe (2003)	Way-finding in the passenger terminal of Hong Kong international airport	Objective data	Departing Transferring	Proportion of passenger usage	Terminal way finding	Entrance	1.00
							Check-in	1.00
							Departure gate/Security check	1.00
							Boarding gate	1.00
							Seats in departure hall	0.98
							Toilets	0.88
							Elevators	0.86
							Conveyer belt	0.85
							Flight information board	0.84
							Trolleys	0.74
							Lifts	0.58
							Restaurants	0.5
							Automated people mover	0.48
							Duty free shops	0.48
							Seats in non-restricted area	0.38
							Telephones	0.34
							Information counter	0.33
							Non-duty free shops	0.31
							Television	0.26
							Money exchange outlet	0.23
							Cafeteria/bars	0.23
							Banks	0.18
							Drinking fountain	0.17
							Auto teller machine	0.15
							Airline lounge	0.1
							Internet lounge	0.1
							Children play area	0.06
							Photo kiosk	0.05
							Lost and found	0.05
							Prayer room	0.02
18	Yeh, C.-H., & Kuo, Y.-L. (2003)	Evaluating passenger services of Asia-Pacific international airports	Subjective data	Tour operator	Fuzzy set theory	N/A	Comfort	76.6
							Processing time	73
							Convenience	82
							Courtesy of staff	93
							Information visibility	68
							Security	92

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
19	Fernandes, E., & Pacheco, R. R. (2002)	Efficient use of airport capacity	Objective data	N/A	Data envelopment analysis	N/A	Area of apron Departure lounge area Number of check-in counters Curb frontage Number of vehicle parking spaces Baggage claim area	N/A N/A N/A N/A N/A N/A
20	Rhoades, D. L., Jr, B. W., & Young, S. (2000)	Developing a quality index for US airports	Subjective data	Airport experts	Explanatory factor analysis	N/A	Parking Rest-rooms Baggage claim facilities Information display systems Gate boarding areas Ground transportation Food and beverage Intra-terminal transportation Rental car services Retail Special services Duty free shops	84.6 82.8 80.8 79.4 78.9 77 75.9 75 74.5 62.8 57.5 45.3
21	Senevirathne and Martel (1994)	Criteria for Evaluating Quality of Service in Air Terminals	Objective data	Departing passengers	N/A	Waiting areas Circulation Processing facilities	Seat availability Walking distance Crowding density Waiting time Sight lines	N/A N/A N/A N/A N/A
22	Martel, N., & Senevirathne, P. (1990)	Analysis of Factors Influencing Quality of Service in Passenger Terminal Buildings	Subjective data	Departing passengers	N/A	Circulation Waiting areas Processing	**Circulation element** Information walking distance space for circulation level changes **Waiting element** availability of seats variety/location of concessions/amenities Internal environment **processing elements** waiting time and processing time convenience Availability of space	 0.53 0.38 0.06 0.03 0.44 0.34 0.22 0.60 0.31 0.09

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
23	Dada and Wirasinghe (1999)	Development of a new orientation index for airport terminals	Objective data	Departing Arriving Transferring	Passenger importance rating	Terminal way finding	Wash rooms	0.96
							Phone	0.94
							Flight information monitor	0.93
							Car rental	0.86
							Ticket sales counter	0.85
							Airport terminal map board	0.85
							Information booth	0.85
							Restaurant	0.81
							water fountain	0.81
							Lost and found office	0.81
							Banking machine	0.79
							Hotel's phone board	0.77
							Currency exchange	0.75
							Juice/dairy/Coffee shop	0.74
							Airline offices	0.72
							Bookstore	0.71
							post office	0.69
							locker	0.66
							Coin change machine	0.63
							Duty free shop	0.59
							gift shop	0.59
							Nursing room	0.58
							Bar	0.57
							Automatic business	0.56
							Children's play room	0.54
24	Ndoh and Ashford (1993)	Evaluation of Airport Access Level of Service	Subjective data	Departing passengers	Psychometric scaling	Airport access	Ease of luggage handling	N/A
							Access to terminal	N/A
							Expected journey time	N/A
							Comfort	N/A
							Parking space	N/A
							Convenience of interchange	N/A
							Journey time	N/A
							Delay and congestion	N/A
							Economy of mode	N/A
							Overall opinion of access	N/A
							Access information	N/A
							parking cost	N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
25	Siddiqui (1994)	A Statistical Analysis of the Factor Influencing the Level of Service of Airport Terminal Curb Sides	Objective and subjective	Departing Arriving	Linear regression Utility theory	Terminal curb	Distance to entrance Delay for parking	N/A N/A
26	Park (1994)	An Evaluation Methodology for the Level of Service at the Airport Land Side System	Subjective data	Departing	Expert panel rating Fuzzy set analysis	Departure terminal	Service processing time complexity of service procedures Courtesy of personnel No. of service Facility Overall environment Service variability Crowding Information system Seat availability Internal Environment Accessibility to concessions Walking distance Sign system Level changes Crowding Aids to handicapped Assistant to facility to pax Walking distance to entrance Level of congestion Sign system No. of pedestrian crossings Access distance to concessions Variety of choice Cost to user Courtesy of personnel Visibility Display and location Space availability for parking Simplicity of access Parking fare Sign system Linkage to terminal	0.55 0.49 0.32 0.30 0.29 0.17 0.35 0.41 0.21 0.29 0.24 0.50 0.50 0.34 0.31 0.19 0.26 0.33 0.25 0.31 0.11 0.43 0.44 0.29 0.35 0.24 0.36 0.40 0.31 0.16 0.27 0.35

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
27	Omer and Khan (1988)	Airport Landside Level of Service Estimation: Utility Theoretic Approach	Objective and subjective	Departing Arriving	Linear regression Utility theory	N/A	Check-in Baggage claim Boarding lounge Preliminary inspection line	N/A N/A N/A N/A
28	Muller (1987)	A Framework for Quality of Service Evaluation at Airport terminals	Objective and subjective	Departing passengers	Psychometric scaling	Check-in process	Crowding Waiting time	N/A N/A
29	Muller (1987)	A Framework for Quality of Service Evaluation at Airport terminals	Subjective data	Departing passengers	Psychometric scaling	Departure terminal	Parking Curb Lobby check-in Gate check-in Security Boarding area Restrooms Shops Eating facilities Information Crowding Walking distance Aesthetics	N/A 5.30 7.53 8.30 7.32 5.40 6.92 1.00 5.44 8.07 4.87 3.37 3.21
30	Mumayiz, S. A. (1985)	A methodology for planning and operations management of airport passenger terminals: a capacity/level of service approach	Subjective and objective	Departing Arriving	P-R model	All processing elements	Service time	N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
31	Tosic and Babic (1984)	Quantitative evaluation of passenger terminal orientation	Objective data	Domestic passengers Departing and arriving	Proportion of passenger usage	Terminal way finding	Entrance Check-in Central information board Security check gates Cafeteria Bar Restaurant telephone toilets Airline tickets Tourist information Shops post office rental car Elevator Nursery First aid	1.00 1.00 1.00 1.00 1.00 0.15 0.10 0.10 0.10 0.09 0.05 0.05 0.04 0.03 0.03 0.02 0.02 0.02
32	Paul, S. (1981)	Methodology for Modelling Passenger Evaluations of Airport Terminal Functions and Components	Objective and subjective	Departing Transferring Arriving	Linear regression	N/A	Ticket counter Security check Waiting area Enplaning means Deplaning means Number of public telephones baggage claim Number of restaurants Number of water fountains Number of washrooms Number of news-stands Storage locker availability	N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A

#	Author (year)	Title	Data type	Passenger type	Method of analysis	Study area	Service quality factors considered	Relative importance weights/ranking
33	Skytrax Airport Awards	Skytrax passenger survey	Subjective data	Airline passengers	N/A	N/A	Getting to and from the Airport	N/A
							Public transport options	N/A
							Taxi availability and prices	N/A
							Availability of luggage trolleys	N/A
							Terminal comfort, ambience and design	N/A
							Terminal cleanliness	N/A
							Seating facilities throughout terminals	N/A
							Immigration - queuing times / system	N/A
							Immigration - staff attitude	N/A
							Waiting times at Security screening	N/A
							Courtesy and Attitude of Security staff	N/A
							Check-In facilities, queuing systems	N/A
							Terminal signage	N/A
							Clarity of Boarding Calls / Airport PA's	N/A
							Flight Info Screens - clarity	N/A
							Friendliness of Airport Staff	N/A
							Language skills for Airport Staff	N/A
							Ease of Transit through Airport	N/A
							Location of Airline Lounges	N/A
							Washroom and Shower facilities	N/A
							Cleanliness of Washroom facilities	N/A
							TV and Entertainment facilities	N/A
							Quiet areas, Day rooms, Hotel facility	N/A
							Children's play area	N/A
							Choice of Shopping	N/A
							Prices charged in retail outlets	N/A
							Choice of bars, cafes and restaurants	N/A
							Prices charged in bars, cafes	N/A
							Internet facilities and WiFi availability	N/A
							Business centre facility	N/A
							Telephone and fax locations	N/A
							Bureau de change facilities	N/A
							ATM facilities	N/A
							Smoking policy / Smoking lounges	N/A
							Standards of disabled access and facilities	N/A
							Baggage Delivery times	N/A
							Priority Baggage Delivery efficiency	N/A
							Lost luggage services	N/A
							Perception of security and safety standard	N/A