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**PASSENGER TERMINAL LEVEL OF SERVICE MEASUREMENT:
A UTILITY THEORETIC APPROACH**

by

KHIZER FAROOQ OMER, B.Sc. (CRP)

**University of Engineering and
Technology. Lahore**

**A thesis submitted to
the Faculty of Graduate Studies and Research
in Partial fulfillment of
the requirement for the degree of**

Master of Engineering

Department of Civil Engineering

Carleton University

Ottawa, Ontario

May 1990

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**"PASSENGER TERMINAL LEVEL OF SERVICE MEASUREMENT:
A UTILITY THEORETIC APPROACH"**

Submitted by Khizer Farooq Omer, B.Sc.(CRP)
in partial fulfillment of the requirements for
the degree of Master of Engineering

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May 1990

ABSTRACT

The need for research on level of service criteria and standards for the design and evaluation of existing or proposed landside facilities arises from the requirement that these standards reflect technological development, increasing knowledge of airport user preferences and behavior, and the necessity to increase the efficiency and cost-effectiveness of existing or proposed airport systems. Air transportation, so far, has been following standards which have been arbitrarily developed and sparsely researched.

This thesis research presents the interrelationship of the existing space/service standards of various processors of an airport system i.e., check-in, baggage claim, boarding lounge and preliminary inspection line (PIL), and the user perceived values of these space/service standards. This formulates the utility of these standards and the level of service of various airport sub-systems. A utility theoretic approach is used in this thesis to measure the airport landside level of service.

Attitudinal Surveys of airport users were conducted at Ottawa and Toronto International airport. For the airport processors mentioned above, the selected performance measures were studied to arrive at individual, as well as, the composite utility of these processors. Equations for the utility functions of these processors have been calculated and their application in developing airport landside level of service standards have been discussed. The use of these individual and composite utility function for each processors has been discussed and recommendations for further research are made.

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CHAPTER 1

INTRODUCTION

1.1 Background

Airport landside level of service and capacity have been topics of research interest over the past two decades or so[1,2]. The need for research in level of service criteria and standards for the design and evaluation of existing or proposed new landside facilities arises from the requirement that they reflect technical developments, enhanced knowledge of user preferences and behavior, need to increase efficiency and cost-effectiveness of the airport system and the uncertainties of air travel demand. In air transportation, by and large reliance has been placed on arbitrary standards with hidden assumptions.

1.1.1 Overview of the Issue

Recently, owing to the critical nature of airport service issues, a number of studies have been initiated on the identification of the landside problems in general and on capacity and service measures in particular. Some progress has been made in terms of defining service levels based on degree of crowding and delays, etc. A joint Federal Aviation Administration (FAA)/Transportation Research Board (TRB) study published recently may serve as a background document on various facets of problems as well as international practices and

standard . However, more research is needed to define level of service gradations and capacity standards [3,4,5].

A high priority placed on landside research is hardly surprising, given the critical need for innovative research on this topic. A number of agencies, which have established criteria and standards for the design of airport landside facilities have come to realize that, by and large, reliance has been placed on design criteria that are limited in terms of accounting for the demand, as well as supply side concerns. It is now believed that design standards developed in the past were largely arbitrary with hidden assumptions. Consequently, oversize facilities have been provided at a number of airports. Also, owing to insufficient attention paid to the strategic planning, inadequate understanding of user value structure, absence of studies on the cost-effectiveness of level of service, and lack of flexibility to adapt to changing traffic conditions, the imbalances of demand and capacity have become apparent at some busy airports.

1.1.2 Thesis Objective

The objective of this thesis is two-fold. Firstly, it is intended to highlight the importance of the interrelationship of the level of service, and cost (to users as well as suppliers) of facilities, thus making a case for enhanced knowledge of the design and assessment of the airport landside facilities, and, secondly, it is also intended to develop a framework for the estimation of the utility (value) and cost-effectiveness of levels of service, based on the principles of utility (values)

and the cost-effectiveness theories.

1.1.3 Concept of Level of Service

Historically, airport facilities have been planned and investment decisions made without much assistance from scientific research in refining design criteria and standards. The transportation profession is very much familiar with the amount of research that went into the highway capacity area, which recently resulted in a third generation capacity manual. Consequently, it is hardly surprising that in recent years, airports - more than any other type of transportation facilities have been criticized in some cases as examples of wasted resources, and in other cases, as a focal point of users' discontent with the level of service. Indeed, the imbalances in demand and capacity at key components of airport terminals is a common occurrence.

It appears that there is a genuine lack of knowledge about users' acceptance of conditions at an airport as well as about the cost implications of providing various levels of service. Furthermore, the airport planning profession has not, so far, standardized its gradation of level of service in a manner that the highway planning profession has done since 1965. The absence of an appropriate definition of level of service ranges, and guidelines for design and evaluation criteria and standards has hindered the efficiency in airport planning and operations [6].

Recent reviews of airport planning and investments in Canada

have concluded that, in general, the level of service and unit costs of providing that service at airport systems are excessive. It was stated that the significant reduction in level of service could be achieved with minimum impact on air travelers and the air carrier industry [7]. Experiences gained from Pearson (Toronto) and Dorval (Montreal) airports were quoted as evidence to suggest that some additional crowding does not lead airlines and passengers to curtail their use of airports [8].

Clearly, given the increasingly complex nature of airport planning, design and investment decision making, the non-scientific treatment of capacity and level of service subjects are hardly acceptable. In fact, as is evident from the above noted reviews, an improved knowledge of the interrelationship of level of service, capacity and cost (to users as well as suppliers of facilities) is essential. A number of associated requirements are to be met as well. These include the refining of measures for assessing the performance of the airport landside subsystems and to deal with the uncertain nature of future air travel demand.

Airport planners in Canada have adopted a level of service framework used for planning and design of highways and pedestrian facilities, for the specification of operating conditions in airports. In order for the implementation of the Level of Service framework, a knowledge of the capacity of landside facilities as well as throughput at varying levels of service, i.e. densities, service flows would be required for planning and design for the facilities. It is necessary to bring the economic variable into

the picture, given that a throughput level to be achieved and the resulting quality of service are joint products that have cost implications to airport authorities, airlines, and the traveling public.

1.1.4 Concept of Capacity

Landside is a complex collection of individual functional components such as ground access, parking, check-in, baggage claim, aircraft parking, and support systems (e.g. water supply, sewer, and power supply,) that interact to serve air passengers and cargo moving between aircraft and origins and destinations within a large area served by an airport.

Landside capacity refers to the capability of these functional components (individually and working together as an airport system, including staffing and other operating policies that determine how facilities are used) to accommodate demands of passengers, visitors, cargo, ground access and aircraft. Demand characteristics include distribution of passenger arrivals over time, modes of travel to and from the airport, number of bags carried and checked, trip purpose, and other similar factors. In the face of these demand , some components of the airport become bottlenecks and cause crowding, delay, or other symptoms of inadequate capacity.

Passenger flow through a functional component or group of components is limited in principle by the maximum processing rate at which the component can operate. However, in practice this

maximum throughput is typically sustained for a brief period or periods of time, as excess passenger demand usually produces significant passenger delays, crowding ,or other indications of declining service level that disrupt operations. Capacity is measured by a usually lower service volume, the number of passengers that can be accommodated in a given period of time at given service level, given the pattern of demand placed on the component [3].

Estimates of passenger capacities are meaningful only when they are referenced to the service level provided to passengers. Service level includes factors such as waiting time, processing time, walking distance, and availability of passenger amenities for comfort and convenience. Passenger demands and facilities operations interact to determine service level and capacity, making the measurement of capacity, and the decision process, considerably difficult.

Landside capacity assessments must respond to a variety of questions and issues about airport operations and planning, ranging from how existing gates and ticketing facilities should be used to when a new terminal building may be required. The specific problems the capacity assessment must address determine which components, facilities and service must be considered. An airport's landside capacity can be measured only in terms of its individual functional components.

1.1.5 Concept Of Utility

A user under prevailing conditions of traffic and service at a subsystem perceives a state of the subsystem, with a number of impacts, for example, processing time, etc. The impacts are measured in their natural units, such as minutes of delay and/or subjective measures rated on a scale. The estimated impacts, revealed by users through a survey, could be transformed to utility numbers by means of functions, such as linear transformation which keep intact the performance achievement structures as perceived by the users of the subsystem. The various performance measures then can be rated and combined to get a single utility number.

Utility theory has been used in transportation projects. In this research, application of utility and cost-effectiveness theories is illustrated for the measurement of user perceived levels of service and establishment of economical design criteria. In contrast to previous approaches, airport terminal users are not asked to distinguish directly in the form of a single question between various gradations of service quality consisting of multi-attributes. Instead, through the use of attitudinal surveys, users could be asked to indicate the relative importance of level of service factors (for example, waiting time, processing time, space availability, etc.) and to rate each level of service attribute/factor through a semantic scaling method. In accordance with the utility theory, the stated rates can be transformed to a relative value scale and then combined into a utility measure. From these utility values, level of service offered by a facility under prevailing conditions can

be inferred.

Through the investigation of a facility under various levels of usage, and its correlation with user perceived quality i.e. utility, would enable the airport planner to objectively measure the performance indicators, so that space and service threshold could be identified.

1.2 Problem Identification

1.2.1 Hypothesis

As stated earlier, there is a need to research level of service criteria and standards for the design and evaluation of existing or proposed new landside facilities, as they reflect technical development, enhanced knowledge of user preferences and behaviour, need to increase efficiency and cost-effectiveness of airport systems and uncertainties of air travel demand. This thesis research would therefore attempt to validate the theory proposed in this thesis in order to come up with a methodology to ascertain interrelationships between space/service standards, user perceptions or utility of level of service based on the principles of utility and cost-effectiveness theories, in accordance with the proposed criteria for design and evaluation of landside facilities.

1.2.2 Scope of the Study

The scope of the study would then be to measure various performance measures of different processor i.e. waiting time, service time, and density, while the users of these processors,

or subsystems, are in the process of going through these subsystems.

This would be achieved through attitudinal surveys at various subsystems, at different airports to obtain passengers, or users, perceptions and preferences of selected performance measures. These perception and preference data would then be analyzed and transformed into utility (value) through linear transformation, so that a composite utility for each subsystem could be calculated.

This investigation would demonstrate that utility of each subsystem would be an excellent starting point for any further research to be conducted on level of service criteria and standards for design and evaluation of facility sizing, based on the theory and level of service framework put forth in this thesis.

1.3 Thesis Organization

This thesis is organized into seven chapters. The theoretical aspects of requirements of facility design and evaluation, and utility- theoretic framework for level of service and standards are extensively discussed in chapter two. Chapter three explains the study and survey design, the development of the questionnaire for attitudinal surveys, and analytical techniques to be used for the information. Chapter four describes the airports and the subcomponents surveyed, the selected

performance measures and statistical summary of results. Chapter five contains the detailed analysis of the results of the performance measures. Utility equations of the airport subsystems and their applications are discussed in chapter six. Chapter seven contains the conclusions and recommendations for further research. Glossary of the technical terms and appendices are attached at the end of this thesis.

CHAPTER 2

FACILITY DESIGN AND EVALUATION

2.1 Requirement For Facility Design And Evaluation

The landside part of the airport system consists of a number of interlinked subsystems which are intended to serve as processors, holding areas and links. The landside includes ground access, terminal building, roadways and parking, ticketing, baggage handling, and aircraft parking positions and gates. The landside capacity depends upon the type, size, configuration, and conditions of such facilities and how they are staffed, operated and regulated. Figure (2.1) illustrates a functional viewpoint of an airport [3]. Individual functional components of an airport interact to provide service to air passengers. Some of these components can become bottlenecks or "choke points" in the processing of passengers, causing delays and crowding. Often the symptoms of inadequate capacity may be apparent primarily to those passengers actually using the affected component. Whether or not such choke points occur depends upon the design and operation of the functional components and the demands placed on these components. Any of these components may become a constraint on landside capacity.

The term "demand characteristics" refers to the number of air passengers and those of aspects of their behaviour that

Figure 2.1: Functional Viewpoint of an Airport, Reference [3].

effect the ability of a functional component or group of components to accommodate passengers. Demand characteristics include distribution of passenger arrival over time, modes of travel to and from airport, number of bags carried and checked, passengers' age, trip purpose, number of people accompanying the passenger, and whether the passenger has a ticket and boarding pass. Airlines often try to tailor their services to passengers' demand characteristics.

Figure (2.2) illustrates a design process which is required to establish the facility sizing and configuration. This design process, in broad terms, is expected to yield cost effective size and configurations of the facilities, to ensure efficient interchanges between facilities, and also to meet other criteria (for example, safety and security) [9]. In this design process, a key initial step is to estimate "peak traffic" which requires the forecasting of traffic for the design year, the design day, and the design hour.

Capacity becomes a problem during those periods when the demand is high. Although these demand periods may be of short duration at some airports, at others, demand could be high during much of the day. Capacity assessment must estimate service volume and service level for a landside functional component or group of components during an analysis period.

The appropriate analysis period depends on the type of component or components and the characteristics of demand placed

Figure 2.2: The Design Process
Reference [21].

on that component or sub-system. For some sub-systems the appropriate period may be an hour or less, for others a series of hours, and for some perhaps as long as a day. Usually the analysis period is selected to coincide with a period of concentrated demand, for example, a peak hour or busy hour. Service volumes may be set for longer periods of time, such as a month or a year. However, capacity cannot be meaningfully assessed over these longer periods.

The prediction of the profiles of aircraft and person/goods traffic demand is a necessary prerequisite for design and analyses of facilities. Future demand, especially beyond a five-year period, cannot be forecasted with any degree of certainty; therefore, a recognition of sources of uncertainties and methods to cope with the uncertain nature of demand are also required.

Landside facilities of an airport are designed to serve a peak period traffic that is supposed to represent the design year busy period conditions [10]. It is expected that the various landside subsystems will have to cope with the usage level higher than the design peak level for a number of hours/periods during the year. There is, however, little agreement among airport agencies as to the definition as well as approach of measuring the planning and design peak period. Existing measures that have been in use, namely the xth (example 90th) percentage traffic and then nth (example 30th) highest hour in the year are known to be deficient in capturing the true nature of peak traffic profile [6,11].

Airport planners in Canada, who have been using the 90th percentile traffic in the past, are attempting to shift to a more realistic measure. The highest representative peak hour of the composite hourly traffic profile represents the busiest season. The busiest season is considered to be the three consecutive months of the year with the highest daily passenger traffic volume. To compare the two approaches, this new criterion would yield 91-93rd percentile traffic for Pearson International Airport (Toronto) and would equate to 85th-88th percentile traffic at smaller airports [11]. As for other agencies, the Federal Aviation Administration (FAA) of the U.S.A. has suggested flexible guidelines that define the design peak hour to be 6.25%-20% of the busy day total operations. Scheduled airlines in the U.S.A. generally design their facilities for the peak hour of the average day of the peak month of the selected design year. The British Airport Authority (BAA) applies its design standards in association with 95th percentile traffic. The Western European Airport Authority (WEAA) applies different criteria, depending upon site. A commonly used criteria, however, is the 30th busy hour [9,11,12].

Realistically speaking, the percentage of peak hour traffic out of average day peak month/season movement cannot be assumed with any degree of confidence to be a constant (for example, 9-10%), particularly for large airports. As schedules are spread throughout the day at major airports, this percentage logically drops. Also, experience gained from airport studies suggests that the characteristics of peaking are largely airport specific,

depending upon location of airports within the network. Recent experiences indicate that peaking phenomena can be influenced through policies and pricing, marketing, incentives/disincentives, and especially voluntary imposed scheduling.

2.1.1 Passenger Subsystems

Passenger subsystems for en-planing and de-planing passengers are explained in Table (2.1). Various activities, and space for these activities, describe the functions of these subsystems, such as reservoirs, processors, links and so on. The interaction of these subsystems and their total impact on an airport terminal has to be considered while designing the facility, sizing and configuration of a passenger terminal at an airport.

2.1.2 Effects of Under- and Over-Supply

A quick review of the existing literature would give the impression of oversupply of airport facilities in the past. However, more recently there are a growing number of cases where various interest groups are concerned about insufficient capacity to serve the rapidly rising demand. Considering that there are undesirable consequences of oversupply as well as undersupply, it should be an important objective of airport planning to seek a balance between demand and supply over time. An improved knowledge of appropriate design criteria demand for services is very important. Table (2.2) describes some of the possible impacts of oversupply and undersupply of airport

Table 2.1

Enplaning and Deplaning Passenger Subsystems

	<u>Enplaning</u>	<u>Deplaning</u>
Sector	Domestic Canada-U.S.A. International	Domestic Canada-U.S.A. International
Reservoir	Ticketing queue area Check-in queue area Preclearance queue area Waiting (general) Security queue area Holdroom etc.	Primary inspection (PIL) queue area Baggage claim hall Secondary examination queue areas Waiting etc.
Processor	Ticket counter Check-in Preclearance Secondary examinations etc.	Primary inspections line Baggage claim devices Secondary examinations etc.
Links	-----	
	Corridors Escalators Elevators Doorways People movers etc.	

Source: Reference 11

Table 2.2

Possible Impacts of Landside Facility Oversupply and Undersupply

Interest Group	Negative Impacts of Oversupply	Negative Impacts of Undersupply
Users	. Increased charges to pay for oversized facilities	. Congestion, delays . Reduced level of service (inconvenience, cost of time, discomfort)
Carriers	. Increased charges (fees, leases)	. Cost of delay . Reduced level of service offered . Diversion of customers to other airports (carriers) and modes
Government (as airport owner)	. Reduced revenues . Political backlash	. Political backlash . Social loss due to congestion costs
Airport authority	. Reduced revenue . Increased overheads	. Operational problems . Complaints from travellers and carriers . Loss of potential customers
Airport concessionaires	. Increased charges (leases, fees) . Reduced revenue	. Reduced level of service offered to customers . Loss of potential customers

* Other interest groups are also impacted (e.g., land developers, adjacent property owners, environmentalists).

facilities.

2.1.3 Level of Service Framework

For the development of supply strategies (i.e. type, size, configuration of facilities, implementation schedules), level of service criteria and the associated space standards are required. Presently, a widely recognized level of service criteria is not available. A more basic deficiency is the absence of well-researched knowledge and understanding of the subject.

Airport planners in Canada have adopted the level of service framework used for planning and design of highway and pedestrian facilities, for the specification of operating conditions at airports. Table (2.3) presents a description of the various levels of service (LOS) that range from LOS A (excellent) to LOS E (capacity) and LOS F (system breakdown). Figure (2.3) illustrates the general concept of level of service to operating speeds and volume/capacity ratios. Figure (2.4) depicts various level of service A , C and E in the check-in area. Figure (2.5) illustrates a level of service A and E in a baggage claim area. Figure (2.6) describes a level of service A and E in a preliminary inspection line area.

In this research, level of service is defined as a measure that describes user-perceived operating conditions, (for example, the degree of congestion) at various processors, reservoirs and links. The capacity of a subsystem (facility) as the maximum

Table 2.3

Level of Service Framework

-
A	Excellent level of service; very low density; condition of free flow; no delays.
B	High level of service; very little traffic interference and delay.
C	Good level of service, acceptable level of density and delay; related systems in balance.
D	Adequate level of service but delays incurred; high density; condition acceptable for short periods of time.
E	Unacceptable level of service; represents limiting capacity of the facility; very high density; subsystems not in balance.
F	Subsystem breakdown; unacceptable congestion and delay.
-

Source: Reference 2, 6, 11 (modified).

Figure 2.3

General concept of relationship of level of service to operating speed and volume/capacity ratio (not to scale)
(Courtesy Transportation Research Board.)

Figure 2.4a

Level of Service (LOS) A

Checkin

Figure 2.4b

Level of Service (LOS) C Checkin

Figure 2-4c

Level Of Service (LOS) E Checkin

Figure 2.5a

Level of Service (LOS) A Baggage Claim

Level of Service (LOS) E Baggage Claim

Figure 2.6a

Level of Service (LOS) A Preliminary Inspection Line

Figure 2.6b

Level of Service (LOS) E Preliminary Inspection line

(saturation) level, throughput (density or volume - depending upon the nature of the subsystem) that can be served under prevailing conditions. Attempts have been made in the past to study user-perceived level of service and behavioral aspects of landside operations [13,14]. There are a number of reasons for adopting the LOS framework shown in the Table (2.3) for planning and design of landside facilities. As the experience of the highway transportation profession suggests, a framework based on the concept of "ultimate" and "practical" capacities is difficult to operationalize, and is inflexible due to the absence of the continuum of decreasing level of service from ideal conditions to saturation and to ultimately jam (breakdown) cases.

Another scheme, based on three levels of service, One as proposed by Mumayiz and Ashford, (1986) which describes the Perception-Response on a gradation of good, tolerable and bad, levels (see Figure 2.7) suffers from the similar weaknesses without offering any advantages. It is recognized here that the adoption of LOS A-F does not simplify the essential task of identifying the most appropriate performance measures and ranges of performances that correspond to the various levels of service. From a planning and design perspective, there is a logical appeal to a wider gradation of conditions represented by the LOS framework used for highway transportation.

As for the implementation of the LOS framework, a knowledge of the capacity of landside facilities as well as throughput at varying levels of service i.e. densities and service flows, would

CONCEPTUAL DRAWING OF PERCEPTION - RESPONSE MODEL.

Figure 2.7 Concept of Perception-Response Model.

Source: Borge and Fishburne (1956)

be required for planning and design activities. Also, information on the acceptable levels of service as well as the cost-effectiveness is of growing interest. It is necessary to bring the economic variable into the picture, given that a throughput level to be achieved and the resulting quality of the service are joint products and that these have cost implications to airport authorities, airlines and the traveling public. Economic considerations of landside planning and design have also been investigated in the past [15] and, they are of great interest today.

2.1.4 Design Criteria

In recent years, three types of criteria have become relevant for landside subsystem planning and design. These can be categorized as: functional performance (i.e. operational effectiveness, safety and security, comfort and convenience), flexibility (i.e. change/growth), and economy (i.e. cost and revenue/benefit balance). The operational effectiveness criterion is intended to ensure the smooth (without disruptions and other problems) functioning of the facility itself as well as its interchanges with other facilities. Its measures, which are diverse in nature, relate to flow of traffic and delay. As for safety and security, the design of landside facilities is beginning to respond to these requirements. The passenger convenience/comfort criterion deal with a large number of factors, namely travel time, walking distance, accessibility to amenities, servicing convenience, clarity of signage and opportunity for communication of passengers in respect of

orientation and information [12].

Flexibility to accommodate growth and change is an important criterion, given the uncertainties of future traffic (in terms of numbers, user characteristics and requirements) [16,17]. As stated earlier in this thesis, there is a growing emphasis on economic factors in the provision of airport facilities. Therefore the criterion of economy is an important one, given pressures to reduce the level of service and economic constraints for capacity expansion or facility modernization. Operational measures include economic efficiency or cost-effectiveness as the basis for investment decisions. The airport research community has come to recognize that life cycle costs (i.e. costs of construction, operation, maintenance and rehabilitation) as well as airline and traveler costs are to be included in design (capacity, level of service) and investment decisions.

2.2 Utility And Level Of Service

2.2.1 Rationale

The state of knowledge is deficient in capacity and level of service characteristics of land side subsystems in their present form. According to the present practice in airport planning and design, an ultimate capacity and a practical capacity are referred where an "acceptable" level of delay is used as a measure for practical capacity. As referred earlier, there are conceptual practical weaknesses in this practical capacity approach. Furthermore, this acceptability (to the user) of the level of delay is subjectively established by airport planners,

without definitive field studies.

The use of level of service framework (Table 2.3), appropriately supported with research on the estimation of the levels of service, would be an improvement to the existing practice in the sense that a wider classification of user clarity or volume indices could be used to specify design standards and trigger points for capacity expansion. Criteria and standards for performance measures for landside subsystems are not well developed. In all cases reviewed, single values for space standards are quoted. Space and Time standards, as adopted and followed by Airport Authorities in other countries, are summarized here for a quick comparison. Table (2.4) illustrates space and time standards as followed by the British Airport Authority (BAA), IATA, and Aero port De Paris Authorities, for the departing passengers. Table (2.5) outlines the time and space standards as followed by the same authorities for arriving passengers.

Transport Canada's recently adopted space standards for selected landside subsystems are a step in the right direction as they correspond to the various levels of service. However, the gradations are rather narrow and are set subjectively [9] Table (2.6).

Table 2.4
Selected Standards
Departures

Sub-system	BAA		IATA		PARIS	
	Space	Time	Space	Time	Space	Time
Check-In	² 0.8m /pass	95% of	² 0.8m /pass	95% of	30m	80% of
Baggage	with hold	pass	with	pass <	per	pass
Drop	luggage	< 3 min	luggage	3 min. at peak times	check- in unit	queue < 15 min.
	² 0.6m /pass		² 0.6m for			
	with cabin		visitors	80% <	10m	
	luggage			5 min.	min.	
					desk	
					front	
Departure	² 1.0m /seated	None	² ² 1.0m -1.5m/	None	² 1.5m	None
			seated pass.		seated	
Lounge	² pass. 1.0m		² 1.2m /standing		² 1.0m	
	per standing		Seats for 50%		standing	
	pass. Seating		of throughput.		seats	
	for 60%				50-75%	
	present				of pax.	
					20%	
					circ.	

Source [14].

Table 2.5
Selected Standards
Arrivals

Sub-system	BAA		IATA		PARIS	
	Space	Time	Space	Time	Space	Time
Baggage Claim	2 1.25m /dom pass. 2.0m/ shorthaul int.pass 2 3.25m / longhaul pass	max. of 25 min. from first pass out of im- migration to last bag on unit.	2 0.6m /dom & shorthaul int. pass 2 1.6m for longhaul pass.	max. of 25 min. from first pass to last bag on unit. 90% of pass < 20 min. wait	2 Reclaim frontage of 1.0m for each 5 pass. 8m betw- een wall & unit	max of 25 min. from first pass into the hall to last bag on unit.
Immig- ration	2 0.6m / pass.	UK/UEC 95% < 4 min. others 95% < 12 min.	2 0.6m per pass.	95% of all pass < 12 min. 80% of all < 5 min.	2 0.6m / pass.	95 % of all pass < 12 min.

Source [14].

Table 2.6

**Air Terminal Building Standards
(Square Metres per Occupant)**

	Level of Service					
	A	B	C	D	E	F
Check-in	1.6	1.4	1.2	1.0	0.8	
Wait/Circulate	2.7	2.3	1.9	1.5	1.0	
Holdroom	1.4	1.2	1.0	0.8	0.6	
Bag Claim Area (Without Device)	1.6	1.4	1.2	1.0	0.8	
Pre-PIL	1.4	1.2	1.0	0.8	0.6	

Transport Canada Standards

2.2.2 Utility Theory

There are situations in which it is reasonable to assume that an individual person, or a decision maker, will act provided there exists a reasonable basis to act on some measure of value, other than the expected value; in terms of expected time loss, the expected monetary loss etc.

The limitations of the expected-value criterion lie in the assumption that the value of each consequence representing the satisfaction of a person, or a decision maker, is tangible and can be expressed directly in a common scale, such as minutes lost, dollars lost, etc. and that the value of a consequence varies linearly with the measure of value expressed in the common scale. It would be convenient to have a common measure of value which retains the computational simplicity of the expected value but can be applied to any problem with both tangible and intangible gains and losses. If certain psychological assumptions concerning the manner in which the decision maker evaluates the consequences, are valid, then it can be shown that there exists a measure of value, called U or utility [18].

For any two consequences A_1 and A_2 , the corresponding utility values u_1 and u_2 will have the relationship $u_2 > u_1$ only if the decision maker prefers A_2 over A_1 . Furthermore, if an outcome O results in A_2 with a known probability p and A_1 with a probability $1 - p$, then the utility of this outcome is defined as

$$u(O) = p_1 u_1 + p_2 u_2 + \dots + p_n u_n$$

where $p_1 + p_2 + \dots + p_n = 1$.

With a utility function expressing the decision maker's own preference, the decision maker can evaluate the utility associated with any outcome.

2.2.2.1 Assumptions of Utility Functions

The concept of utility functions and of rational choice rest on some fundamental assumptions or axioms. These utility axioms are intuitively appealing as they set forth the kind of conditions which common sense indicates should surround a rational decision making process.

In practice, human mind is not as consistent as it would like it to believe. We frequently violate the fundamental axioms of rational choice which our own logic recommends to us. Repeated experiments demonstrate that people find it difficult to be consistent, especially when the choices are close. It is therefore sometimes difficult to determine utility functions.

These difficulties are precisely the reason why anyone should be interested in decision theory.

Described below are the utility axioms [19]:

Axiom 1: A decision maker can compare and make consistent choices between alternatives. Faced with a pair of alternatives A and B, he will always prefer one to other

($A > B$ or vice versa) or be indifferent between them ($A \simeq B$)

Axiom 2: A decision maker's choices are transitive. If he prefers A to B and B to C ($A > B > C$), then he will prefer A to C ($A > C$). Likewise, if $A \simeq B$ and $B \simeq C$, then $A \simeq C$.

This axiom is basic to the development of a utility function which is consistent for all choices.

Axiom 3: If two choices are indifferent to the decision maker, $A \simeq B$, they can be substituted for each other. This axiom implies the uniqueness of the utility function on any given scale.

Axiom 4: If a potential choice has several possible outcomes each with a particular probability, then it can be decomposed into more basic choices. Alternatively, more basic choices can be combined using probability theory. That is, if alternative A implies an outcome B and an outcome C, then these two events can be substituted for A. If the utility of B, which occurs at a probability p_b , is U_b and the utility of C, which occurs at probability p_c , is U_c , then their utilities can be combined to give

the utility of A:

$$U_A = p_b U_b + p_c U_c.$$

Axiom 5: If two alternatives A and B lead to same outcomes,

the decision maker will choose the alternative in which the preferred outcome has the greater probability.

These axioms are sufficient to define a utility function in a probabilistic context. Unless one is prepared to define rational decision-making in terms of a contrary set of assumptions, one is forced to accept the principle that decisions should be based on the principle of maximizing expected utility [18,19,20].

2.2.3 Application Of Utility Theory

Utility theory application is advanced here for its measurement of realistic density/capacity or volume/capacity ratios (i.e. indices) that correspond to the various LOS, and space standard for landside facilities. The use of density (i.e. occupancy per unit areas at any time) as a measure of the intensity of usage level is appropriate, given the nature of airport terminal processors. A user under prevailing conditions of traffic and service at a subsystem perceives a state of the subsystem, with various impacts (i.e. waiting time, service or processing time, congestion, etc.). For the given subsystem, the performance measure $pm_1, pm_2, \dots, pm_q$ are defined.

(These performance measures are outlined in Table 2.7). For example, for the check in area, performance measure would be waiting time in the queue, processing time at the counter, and density of space use in the check-in area. Other subsystems may have different performance measures. Through an attitudinal

survey, users are then asked to give their preference for each of the different performance measure, which can then be transformed into relative weights. Combining the level of service criteria (and space/facility standards) and demand state (i.e. peak hour/peak traffic) would result in the facility size alternative $a_1, a_2, \dots, a_m$ etc.

An alternative facility size that is selected or implemented will cause an outcome state O , previously unknown, in a set of various outcome states, with elements of $O_1, O_2, \dots, O_K$. An outcome state would consist of a number of impacts of various levels of performance attainment. The impacts can be measured in their natural units such as minutes of delay and/or subjective measures rated on a scale. Also, impacts, revealed by users through an attitudinal survey, can be transformed into utility numbers. The user's perception on a semantic scale can be transformed to a relative value or utility on a scale of 0 to 1, through linear transformation.

The individual or "pure" outcomes are then combined by logical operation to form outcome states:

$$O_1 = pm_{11} \wedge pm_{21} \wedge \dots \wedge (pm_{12} \wedge pm_{13} \wedge \dots) \wedge (pm_{22} \wedge pm_{23} \wedge \dots) \\ O_2 = \dots \dots \dots$$

etc.

Where pm_{11} is the first level of performance measure 1,

pm_{21} is the first level of performance measure 2,

etc. [21].

2.3 Concept Of Linear Transformation

2.3.1 Linear Transformation

In this case the utility functions mentioned above are allowed to undergo the following linear transformation, which keeps the performance achievement structure intact as perceived by the users of the subsystem:

$$u_g(pm_{gh}) = y_g v_g(pm_{gh}) + b_g \text{ for all } pm_{gh} \\ \text{in the } pm_g, \quad g=1,2,\dots,q$$

Where

u_g is a measured function on the g th performance measure.

$u_g(pm_{gh})$ is the transformed value of pm_{gh} (measured in its original unit or on a semantic scale)

$v_g(pm_{gh})$ is the original value of pm_{gh} ,

y_g and b_g are constant for criteria g . [21]

2.3.2 Weighting

The performance measure can be weighed and then combined to give

$$U(o_j) = w_{1j} u_1(pm_{1j}) + w_{2j} u_2(pm_{2j}) + \dots + w_{qj} u_q(pm_{qj})$$

where

$U(o_j)$ is the utility of outcome state j in relative value

units...utils measured on a scale of 0 to 1,
 u_g is a measured function on the g th performance measure,
 w_g is a scale transformation parameter on u_ga relative
 "weight" reflecting user preference for measure of
 effectiveness. [21]

2.3.3 probability

In order to allow planners and designers the opportunity to use their subjective judgment of the occurrence of an outcome state o_j , a conditional probability distribution $P(o_j/a_i,d_l)$ can be used which expresses the planner's assessment of the conditional probability of the occurrence of outcome o_j in O under the facility size alternative a_i , and demand state d_l combinations. The need to express such subjective judgment is clear since technical development (i.e. machine readable ticket/passport) and innovative procedure may change the existing relationship between throughput and performance of a subsystem [22,23]. The p 's are assigned such that all but a finite O in O have $p = 0.0$, and the sum of the p 's equals 1.0 for the subsystem size alternative demand state combination.

For a given demand state d_l , the utility of an alternative can be computed as:

$$U(a_i, d_l) = \sum_{j=1}^K p(o_j/a_i, d_l) U(o_j)$$

where

$U(a_i, d_j)$ is the utility of size alternative i and demand

state j for $i=1,2,\dots,m$ and $j=1,2,\dots,n$

The likelihood of the occurrence of demand states can now be treated as a variable. Let $P(d_j)$ be the planners probability of a proposition that d_j is the true state of demand. The expected utility of an alternative a_i , can now be given as [21]:

$$U(a_i) = \sum_{j=1}^n P(d_j) \cdot U(a_i, d_j).$$

2.4 Framework Of This Study

2.4.1 Methodological Factors

Concurring with the above theory, a perception or attitudinal survey of the users at selected subsystems could be carried out to ascertain users reaction to the quality of service. A semantic scale could be used to obtain user reaction on subjective, as well as objective, performance measures. Appropriate descriptions for holding areas, and time (delays) for processors, etc., could be used. In addition of obtaining a rating for each attitude, the relative importance of the attitudes could be extracted. Simultaneously, through video cameras, the density levels (i.e. no. of occupants per unit area) could be developed. A survey and associated analysis would result in a utility number (between 0 to 1) for the subsystem under known conditions. For the saturation case, the utility rating could be zero or nearly zero, corresponding to LOS E. The corresponding density index (d/c) or

volume index (v/c) would be 1.0 and space/service factors such as space/occupant and time spent in the subsystem could be found.

Similarly, for the various conditions of traffic studied, ranging from low traffic to very high usage levels, plots of utility against space use and utility against time level could be developed. These utilities may show breaks reflecting threshold. From threshold level (breaks in the utility curve), or an examination of appropriate gradations of utility values, LOS transition from E to D and from D to C could be found Figure (2.8). In the absence of well pronounced breaks, the planner and the airport authority can then divide the utility axis into LOS ranges.

Figure (2.8) shows a utility function that exhibit the properties of diminishing marginal utilities (value) [17]. It can be seen that under congested conditions (i.e. LOS E), reduction in delay would result in relatively large gain in the utility (value) of users as compared to less congested conditions such as these expressed during LOS B or even LOS C. Also, it can be seen that there are certain thresholds level of delay, which when eliminated, result in substantial gain in utility.

2.4.2 Survey Design

Keeping within the framework of the theory described above, it was decided to conduct surveys of the selected subsystems at various airports in Canada. The ideas was to get users or passengers perceptions of selected performance measures in different subsystems, through attitudinal surveys using semantic

Sq. ft./occu.

Figure 2.8: Level of Service and Utility: Check-In and Baggage Claim
Reference [21].

rating methods. This attitudinal survey would also be able to provide the passengers ranking of these performance measures. The usage of the subsystem is density, dwell time, service limit etc. would be simultaneously recorded at the time of interview, and the utility of the performance measured would than be calculated.

2.4.3 Level of Service Framework

As demonstrated earlier, the level of service framework LOS A to LOS E, as proposed and adopted by Transport Canada, is appropriate and hence was relied upon for the purpose of this study. [9].

2.4.4 Airports

Ottawa International Airport, Montreal Airport (Dorval) and Pearson International Airport (Toronto), initially were selected for the survey. However, Montreal Airport had to be excluded from the survey for reasons related to objections of the U.S. Carriers serving that airport.

2.4.5 Selected Subsystems

The subsystems selected for this study are as follows:

- i) Check-in
- ii) Baggage claim
- iii) Boarding lounge
- iv) Preliminary inspection line (PIL) area

2.4.6 Analysis

For the purpose of analysis, it was decided to use the Statistical Package for Social Sciences (SPSSX) version 2.1. The reasons for this decision are that it is available on Mainframe at Carleton University computing facilities and also, it is considered to be most appropriate for analysis of large and complex amounts of data.

2.4.7 Derivation of Composite Utility Functions And Example Applications

Once all the information is obtained, detailed analysis of the data would be conducted to obtain frequency, correlations, regression and multiple regression equations, to arrive at composite utility functions of each subsystem. Example applications of these utility functions would be demonstrated for studied subsystems of the airports. This analysis would then fulfill the requirement of the framework of the aforementioned theory and the scope of this study.

CHAPTER THREE

STUDY AND SURVEY DESIGN

3.1 Study And Survey Design

Study and survey design are an important part of any research. This is especially true in this case since the users or passengers in an airport are human beings. It has been demonstrated that passengers are normally under fairly high emotional stress in the airport environment, and, as such, have needs which are unique to that type of situation. It is necessary to consider the fact that none of the ultimate users of the airport really wish to be there. They are in the airport only for the purpose of getting somewhere else [24].

This study was aimed at getting most of the information from the users or passengers as quickly as possible with minimum disruption to the smooth operation of the various facilities. Keeping that in mind, it was decided to get the users perception of the various performance measures and the preferences of these performance measures through on-the-spot interviews. A questionnaire was designed to get the users perception on a rating scale and the airport users were asked to rank the performance measures, too. The information obtained was then corroborated with the usage of the subsystem. That information was be obtained simultaneously through video cameras.

The interview timing was synchronized with the video camera

so as to get the usage level of the subsystems at the very same moment at which the airport user was being interviewed. This provided the actual amount of time spent by the airport user for waiting, or service, etc. Video taping was used to find out the density or usage of the subsystem at the very same moment. This whole process was considered the most viable option to get information or a user's perception which would be required for the analysis.

As the logistics of this survey would not permit a survey of the same magnitude and scale in the near future, it was decided to have manual backup for all the secondary information to be required. That is, whereas the video camera was recording the densities, waiting time, service time etc. at least two people were recording densities, service time etc. at selected intervals at the same instant, depending upon the nature of activities at the particular subsystem.

This method ensured that in case of use of video camera faces operational problems, the same information required at that very moment would still be available.

3.2 Questionnaire Design

The design of a questionnaire is of paramount importance in any survey. Transportation survey forms, perhaps because many have been designed by those trained originally in engineering, seem to have particularly bad offenders in incorporating various

and sundry devices related to the eventual transfer of information for computer analysis of data. For example, many such forms contain a coding column, in which boxes or similar graphical devices are used for subsequent entry of the coded data, and card column numbers, numerical codes, and other paraphernalia are scattered indiscriminately over the survey form. The relatively recently published research on methodological aspects of survey and questionnaire designs has very convincingly demonstrated that the effect of poor design can be very detrimental to the quality and the quantity of the information collected and the cost per useful data points. While designing a questionnaire, the following main items should duly be considered:

A. Length: Good design and public relations are of greater influence on the quality and quantity of response. However, the questionnaire should aim at getting most of the information as quickly as possible with minimum length.

B. Wording: Common language (not planners terminologies) should be used and the questions should not be ambiguous and should be clear and comprehensible.

C. Structure: The questionnaire should be based on the total design concept. It should contain "warm-up" section, a main body or main questions and space for secondary information.

D: The questionnaire should make the interviewee feel that his or her contributions to the survey are significant and contribute to

the solution of his or her problems. It should also give the impression that the questions asked or the answers to those questions would be used as statistical points and the source of those answers would remain anonymous.

E. Interviewer: When an interviewer is used, the interviewer should be properly trained, and while approaching the subject, should not portray a hostile impression.

These features, when considered, should be able to provide a better questionnaire with increased chances of response rate [25,26,27,28,29].

3.2.1 Attitudinal Surveys

3.2.1.1 Existing Methods

It is useful here to discuss some classification procedure of surveys. The most obvious one is that involve a observer, who does not impact the observed in any manner, and those that involve the participation of those being observed as the survey objects. These are termed as observational and participatory surveys, respectively. Both types of surveys are used extensively in transportation to collect cross-sections of data. The primary purpose to be served by the survey data in transportation are [30]:

- a) to provide information from which to corroborate or validate models of procedures
- b) to provide factual information for direct input into

policy and investment decisions and

c) to provide a basis to apply a variety of forecasting methods to provide estimates of the future transportation system.

For the purpose of this study, it was decided to use the participatory style of survey methodology, since it was required to obtain users', or passengers', perceptions at the very instant at which the passenger experiences stimuli, along with observatory survey techniques for secondary information such as video taping etc.

3.2.1.1.1 Common Survey Techniques

In broad terms, there are a few other types of participatory surveys used in transportation. Among the most prevalent are:

- a. in-person interviews at home or at work
- b. in-person interviews aboard a public vehicle or at the roadside for private vehicles
- c. telephone interviews and
- d. self-administered survey forms to be returned by mail or by survey-return box.

In-person interviews involve the use of interviewers who are equipped with a survey form that the interviewer fills out and responds to the answers provided by the interviewee. Generally, the interviewee is not encouraged to look at the survey form questionnaire although aids to the interview may be used.

Systematic or random sampling is usually used to select

respondents for surveys of this type. For the reasons stated earlier, interview form of questionnaire was decided to be used for this research.

3.2.1.1.2 Current Practice

There are three basic classifications of methodologies to measuring attitudes, that have been employed to date. They are: unidimensional scaling techniques, multidimensional scaling techniques and experimental techniques. Within each category, there are differences among specific procedures and their application. Techniques vary with respect to their ability to analyze responses to either simple or complex stimuli, procedures for collecting data, assumptions concerning the integrity of data as either rank order, categorical or interval data and the ability of techniques to forecast behavior or to analyze belief constructs. In each case, a brief discussion of these assumptions and descriptions would be appropriate here.

i) Unidimensional Scaling Techniques

These are techniques that compare stimuli on one single scale at a time. Either simple or complex stimuli can be compared. An example would be to compare preference for different modes of transportation. One example of this approach is Thurstone scaling. Input to Thurstone scales are either paired comparisons or rankings. Outputs provide the relative preference on an interval scale. Individual characteristics or attributes (simple stimuli) can be analyzed using comparisons based on the

relevant scale. Transport services (complex stimuli) can be compared in a similar manner using preference as a criteria. Output again is the relative standing of attributes on an interval scale.

There are other ways of obtaining information about one attribute at a time. These include categorical indices such as satisfaction with, or importance of, transportation service attributes. There is a body of empirical evidence that indicates that these categorical responses can be analyzed as though they are interval-scaled, so that both input and output provide interval measures using conventional statistical measures such as the mean and standard deviation etc., [31].

Semantic differential questions are also categorical and elicit user attitudes on service, on bi-polar attributes. These enable direct comparisons of perceived quality of service such as expensive service versus inexpensive service, etc. The advantage of these scales is that they relate directly to attributes of the service without relegating the evaluations of expectations to the user.

Overall, unidimensional questions are easiest to use and have had the widest application. During the period of time around 1980, they were used as part of many transit development plans. Simple measures of satisfaction have been found to be best understood and therefore best utilized in developing a user information system [30]. Although the measurement of unidimensional scales is not state of the art, they have a high

unidimensional scales is not state of the art, they have a high potential for utilization in planners' and managers' decision-making process on a regular basis.

ii) Multidimensional Scaling Techniques

Multidimensional scaling techniques analyze attitudes toward stimuli in several dimensions simultaneously. The most widely used of these techniques is principal components analysis. The techniques are applicable to both simple and complex stimuli. Although they have been proven as a research tool for both market research as well as transportation analysis, aside from principal components analysis, they have found little practical application. This is no doubt due to their complexity and their need for sophisticated special-purpose programs.

Principal components analysis is well known. It is generally used to reduce a large set of unidimensional attribute ratings to a smaller set of underlying unrelated factors. Even this obviously useful application is not widely used outside of research studies.

iii) Experimental Techniques

Perhaps the techniques with the most untapped potential are experimental techniques. These include a variety of different techniques in which users reveal their preferences for existing and proposed new services by performing hypothetical choices or indicating preferences for service or modes under controlled conditions. These techniques included multi-dimensional

preference analysis (unfolding analysis), tradeoff analysis, conjoint measurement, direct utility assessment, and experimental choice modeling.

The techniques all assume that subjects are capable of making comparisons and indicating preferences under controlled hypothetical conditions. There is evidence that these hypothetical choices are closely related to the behaviors exhibited by individuals in actuality [32].

Direct utility assessment has potential because of the ease of obtaining assessments from users, by using usage as the criterion variable, and the ability to use standard statistical techniques such as regression analysis to analyze results.

One of the results of each analysis is a set of part-utilities, which, when combined according to some utility function (usually linear additive or polynomial) indicate the utility for any of the hypothetical, or real cases under study. The analysis may be cross-sectional, in which case average part-utilities are found for the entire sample. On the other hand, analysis may be individual resulting in different part utilities for each individual. This techniques can be used for forecasting also.

3.3 Selected Questionnaire Design

3.3.1 Concept

The methodology of the survey and the technique selected for this study was decided to take the form of on-the-spot

interviews to obtain the passengers', or users', perceptions, at various subsystems. Therefore the concept of the questionnaire would take direction from the fundamental aim to get as much information from the users as possible, and as quick as possible, without any delays or disruptions to the user's activities, or the smooth operation of the subsystem.

3.3.2 Design

At the stage of designing the questionnaire, professors from the psychology department at Carleton university were formally consulted. Length of time required to fill out a questionnaire form was the operating factor in deciding the length of the questionnaire. It was decided that the length of the questionnaire would be such that it should not take more than two minutes to obtain a passenger's response and to fill out the questionnaire, by the interviewer. Hence the questionnaire should contain questions which are absolutely essential to be answered by the respondent. All other information could be obtained through secondary sources. Questions contained in the questionnaire should be phrased such that the interviewer does not have to even think about the question - all that the interviewer should have to do is to read from the questionnaire. For each subsystem, the performance measures were selected and the perception from extreme satisfaction to extreme dissatisfaction was identified (performance measures will be discussed in the next chapter). The questionnaire would also have space to record information about the time and date etc. of the

interview, so that it could be properly identified and coded at a later stage.

3.3.3 Rating Scales

While selecting the rating scales, various scales were considered, i.e. scale of 1-3; scale of 1-5; scale of 1-9; scale of 1-10; scale of 1-11, etc. However, the scale of 1-7 was selected for this survey. Reasons being that the scale of 1-7 provides a sufficient range between two poles i.e. 1 and 7, enabling meaningful extraction of information. This scale provides a middle anchor i.e. rating of 4, still leaving sufficient room for gradations between 1-4 and 4-7. Other scales such as scale of 1-5, scale of 1-3, or scale of 1-10 either do not provide this freedom, or are too challenging for a user to be able to provide any reasonable gradations or ratings. The scale of 1-7 is widely used and is found to be useful eliciting passengers' perceptions. Hence, the scale of 1-7 was selected for the questionnaires for each subsystem, utilizing unidimensional scaling technique.

Scale Of 1-7

1	2	3	4	5	6	7
I-----I	I-----I	I-----I	I-----I	I-----I	I-----I	I-----I

3.3.4 Ranking

It was decided to directly ask the users, or the passengers, to rank their perceptions of the importance of selected performance measures for one over the other or for one

over the other two, as the case may be. The space to record this information was also provided in the questionnaire.

3.3.5 Translated Version

Canada is officially a bilingual country, it was therefore decided to get the designed questionnaire translated into french, so that the passengers who choose to speak french may get the opportunity to fill out the questionnaire. The translations of the questionnaires were obtained through three different sources, all with the certified knowledge of english to french translation.

The result of this effort was a set of four questionnaires, each for one subsystem i.e., check-in, preliminary inspection line (PIL), baggage claim and boarding lounge, which fulfills all the requirements of the survey design for this particular study (see Appendix A).

3.4. Video Taping

In order to have simultaneous information about the actual usage of the subsystem while the passenger or user was interviewed, it was decided to install video cameras at different subsystems. Synchronized timing with the start of the interview period and the start of the video taping would provide the secondary information needed for the analysis.

The arrangement of the video taping equipment was made through the Instructional Media Services at Carleton University,

and the arrangement was made to videotape the activities of different subsystems (i.e. check-in, baggage claim, etc.). A video monitor was also arranged, along with the video camera, so as to actually see what was being recorded at the same instant, so that if any adjustment was required while videotaping, it could be accomplished right away.

3.5 Manual Backup

Since all the secondary information was to be obtained through video cameras, it was decided to have a backup method to obtain that secondary information should the video camera technique fail, in any or all cases. As it turned out, there were some subsystems where it was not allowed to videotape because of security reasons. More over, at some subsystems there was no suitable place to locate and mount the video camera, without creating some major problems in traffic flow. Hence, the manual backup was used to acquire secondary information.

3.6 Sample Size

In order to ensure that the sample size would be statistically significant, the Statistical Consulting Services at Carleton University was consulted. Initially, elaborate schemes were devised to ensure to obtain unbiased data. However, the actual survey was conducted on the basis of acquisition of as many respondents as possible. There were times during the survey when more potential respondents were available to obtain responses from, but the manpower at hand was just not enough to

get all those potential respondents' perceptions of performance measures. Hence, the sample size for this study is based on the "get as many as you can" principle [33].

3.7 Selection Of Computer Facilities

It was decided to use the computer facilities available at Carleton University to do the statistical analysis of the data. Statistical Package for Social Sciences (SPSSX, version 2.1) was selected for the analysis of the data.

3.7.1 SPSSX, 2.1 (Brief Description)

The SPSSX information analysis system is a comprehensive tool for managing, analyzing and displaying information. SPSSX runs on a variety of computers and operating systems and its statistical procedures perform a wide range of analyses - from frequency tables to multivariate analyses of variances. Following are the examples of the few statistical outputs which can be obtained through SPSSX: they are frequencies, cross tabs, correlation co-efficients, multiple regression analysis, etc. These statistical procedures would be used in analysis of the data.

3.7.2 Coding Scheme

The design of the questionnaire is such that most of the information can directly be transferred to the SPSSX data files. For other variables, a coding scheme was devised which would be compatible with the SPSSX so that statistical analyses could be

performed. For example, in the questionnaire regarding the question of sex of the respondent, one was assigned to male, two to female and three to people who did not answer the question.

In the question about party size the actual number was used - i.e. one was used if the respondent was traveling alone; if not, number of the members in the party was used in the data file.

The complete coding scheme for each questionnaire for each subsection is described in detail in the Appendix B.

3.8 Selection Of Airports And Survey Dates

Initially, three airports (Ottawa International Airport - Ottawa, Pearson International Airport - Toronto, and Montreal Airport - Dorval) were selected for the study. However, Montreal Airport could not be included in the survey due to lack of cooperation from U.S. Carriers. Therefore, Ottawa airport and Pearson airport were chosen as survey sites. The surveys were conducted just before Christmas 1987, providing the opportunity to conduct surveys at both the airports in a high travel period conditions at both airports.

3.8.1 Dates

The survey was planned and carried out at the two airports at the following dates:

<u>SUBSYSTEM</u>	<u>DATE</u>	<u>AIRPORT</u>
<u>Check-in</u>	Dec 3rd, 1987	Ottawa
	Dec 18th, 1987	Ottawa
	Dec 19th, 1987	Ottawa
	Dec 21st, 1987	Toronto
<u>Baggage Claim</u>	Dec 3rd, 1987	Ottawa
	Dec 19th, 1987	Ottawa
	Dec 21st, 1987	Toronto
<u>Boarding Lounge</u>	Dec 18th, 1987	Ottawa,
	Dec 22nd, 1987	Toronto
<u>Preliminary</u>	Dec 18th, 1987	Ottawa
<u>Inspection line</u>	Dec 22nd, 1987	Toronto
<u>(PIL)</u>		

CHAPTER 4

SURVEY RESPONSES

4.1 Description Of The Airports

The selected airports for this research were Ottawa International Airport (Ottawa) and Pearson International Airport (Toronto). Dorval Airport in Montreal could not be selected due to lack of cooperation from U.S. airlines.

4.1.1 Location and General Characteristics

4.1.1.1 Ottawa

Ottawa Airport is located 11 km south of downtown Ottawa. It caters mostly to domestic and transborder flights. Ottawa Airport also provides service for transatlantic and international flights. Ottawa International Airport is a fairly recently constructed airport and provides amenities of a modern airport.

The airport passenger terminal at Ottawa Airport is an elongated version of Linear shaped terminal concept, with Baggage check-in and Ticket counters at the west end of the terminal. Baggage claim and Immigration is at the east end of the airport with the Boarding lounges and Passenger Security clearance at the middle of the airport terminal, located on the second level.

4.1.1.2 Toronto (Terminal 1)

As the busiest airport in Canada, Pearson International

Figure 4.1

Pearson International Airport Toronto Terminal 1

Source Transport Canada, Public Works, 1981.

Airport in Toronto caters to a wide range of flight operations, including Domestic, Transborder, International, Charter and Recreational flights.

Terminal 1 has a complex passenger terminal structure. The first and second floors of the terminal cater to the baggage and passenger check-in facilities, baggage claim, customs and immigration etc. whereas the boarding gates and lounges are situated in a round structure which revolves around the terminal building.(See Figure 4.1) .

4.2 Description Of Sub-Components

4.2.1 Functions of a Sub-component

The functions and the descriptions of the various sub-components of a passenger transit complex could be well understood by examining Table 4.1 and Table 4.2 , illustrating passenger and baggage processing flow rates in an airport terminal. Table 4.1 illustrates flow rates for departing passengers. Table 4.2 illustrates passenger and baggage processing flow rate for arriving passengers. A quick look at both tables suggest that it is essential to have all these sub-systems operating at a level of service which could be synchronized to obtain maximum efficient flow. One bottleneck in any area would diminish the functionability of the other sub-components.

4.2.2 Definition of Sub-Components

######

######

Though the literature research produces various space and time standards associated with various processors and sub-components, there is, however, no clear cut definition as to what exactly is meant by a sub-component or what is a definition of the sub-component.

4.2.2.1 Check In

The Check-In area as defined by the Airport Terminal Reference Manual provides a very vague definition of the check-in area.

"The area around the check-in facility should be large enough to accommodate passengers without interference with the check-in process. Otherwise, the layout of the passenger check-in part of the building should permit the separation of passengers from their friends at this point. In all terminals, however, originating international passengers should be separated from their friends and from domestic passengers at the point where government and other controls procedures, if applicable, are carried out.

Passengers and Baggage are processed at check-in counters located in a common, central area, usually the departure concourse of the terminal. The counters may be divided into sections specifically designated for individual airlines or flights or, alternatively, passengers may be free to check-in at any counter position. The check-in counter configuration chosen will govern

the width and the depth of the building." [36]

In the absence of a clear cut definition, it was decided to assign specific space to the check-in area, so that the densities could be computed. A decision was made based on various factors of the of the check-in area, to be surveyed. Such as, what was the layout of the check-in area; what were the natural boundaries i.e. pillars, seats, sofas located; where the check-in counters were located, where the exits and entrances to the terminals were, etc.

4.2.2.1.1 Ottawa

The check-in area in Ottawa was selected as the area in front of the ticket counter, all the way back to where pillars are located. The space in-between the pillars is occupied by chairs and sofas and hence provides a natural boundary to the check-in area (see Figure 4.2). The dimensions of the check-in area are as follows :

The width of the check-in area is equal to 1.5 meters per counter, which is the actual width of the check-in counter. Depending upon the number of counters operating at the time of the survey, the check-in area would constitute of the length of the check-in area, multiplied by the width of the check-in counter, multiplied by the number of operating check-in counters. (Figure 4.2) provides the dimensions of the check-in area, as selected for this survey.

4.2.2.1.2 Toronto

Checkin Ottawa

Not to Scale
All dimensions in metres

Fig 4.2

The check-in area for Toronto Terminal 1 was selected as the area right in front of the check-in counter, extending all the way back to the pillars which delineate the check-in area. Beyond the pillars is an exit/entrance to the terminal, hence that area was not considered as part of the check-in area. The width per lane of the check-in area was taken as 1.5 meters, its actual width per counter. Depending upon how many counters or lanes were open, the check-in area would be the length of the check-in area multiplied by 1.5 meters per counter times the number of operating counters.(See Figure 4.3).

It should be noted that while allocating the dimensions of the check-in area for the survey purposes, it was assumed that the gross area for check-in would include space for circulation also. However, the net area for check-in would be the actual width of the lane times the length of the check-in counter.

Also, this allocated space is more than what is officially leased to the airlines. A space of 10 feet in front of the counter is leased out to airlines for check-in purposes. [34]

4.2.2.2 Performance Measures

The performance measures selected for the check-in area, to measure the utility of this sub-component were, service time at the counter, waiting time in the check-in queue, and net space available per person.

4.2.2.3 Method of Data Collection

Checkin Toronto

Not to Scale
All dimensions in metres

Fig 4.3

4.2.2.3.1 Ottawa

To observe the density in the check-in area, the video camera was placed at the opposite end of the check-in counters. The video camera would pan the designated check-in area, for this study, and record the density of passengers per lane at any given time, in order to calculate densities at the time of interview. The service time at the counter and the waiting time in the queue could also be calculated from the video tapes of the subsystem.

As indicated earlier, the manual back-up system was also deployed, and the same information was manually recorded, at regular intervals .

4.2.2.3.2 Toronto

As it turned out, no suitable place could be located to mount the video camera on the ground. Therefore, through the courtesy of the Airport Authorities, it was made possible to hook-up our video taping instruments to the airport security cameras for the video taping. However, what was not foreseen was that the information recorded through the video camera was recorded in an upside down position. The reason being the way the Airport Authority's video cameras are mounted. Hence it turned out to be quite difficult to interpret data from the video camera.

Nevertheless, the manual backup system performed well and the data on performance measures was obtained through visual

observation .

4.2.3.1 Baggage Claim

The Baggage claim area in Airport Terminal Reference Manual is defined as:

"where the passenger has access to the baggage displayed for recognition and claiming. For domestic flights, greeters generally have access to the area; for international flights, the greeter area is located directly adjacent to the exits from government control (Customs) area, through which the passengers passes with their bags.

Carousels and racetracks of a recirculating type allow the passenger to remain stationary, their bags being delivered to them." [36]

For the purposes of this study, the baggage claim area was defined as the area which would naturally delineate the baggage claim area. That would constitute the gross space for the baggage claim area, minus the area occupied by the baggage delivery device. The actual net space allocated for the baggage claim would be 1.5 meters on either side of the baggage delivery device, rest of the remaining area would constitute the circulation area.

4.2.3.1.1 Ottawa

The Baggage Claim area in Ottawa consists of the three

baggage delivery devices, and is located toward the east end of the terminal. This study was conducted at the very first baggage claim device, which the passenger encounters after emerging from the restricted arrival lounge. The baggage claim area for Ottawa can naturally be delineated around carousel 1. carousel 1 is bounded by two walls on the north and west sides, and by Maintenance & Information counter and seating arrangements at the south end. The east side, where the carousel is located, would be natural boundary for the gross space for baggage claim area in Ottawa (see Figure 4.4). The net space for the baggage claim was chosen to be 1.5 meters on either side of the carousel, the rest being circulation area.

4.2.3.1.2 Toronto

The Baggage Claim area in Toronto would constitute of the area where the debarking passenger come down through the stairs, onto the baggage collection level. The gross space for baggage collection would comprise of the area bounded by walls on the north and west sides, the stairs leading to the baggage claim area and barriers erected on the south and the east sides. The net area would constitute of 1.5 meters of space on either side of the Baggage Carousel. Rest would be for circulation (see Figure 4.5).

4.2.3.2 Performance Measures

The performance measures selected for this sub-system were net space availability for each person and the time spent in

Baggage Claim Ottawa

Not to Scale
All dimensions in metres

Fig 4.4

2

ALLEN BRADLEY
MEZED
A BENTON & BOWLES COMPANY

Baggage Claim Toronto

Not to Scale
All dimensions in metres

Fig 4.5

collecting baggage (see Figure 4.5).

4.2.3.3. Method of Data Collection

4.2.3.3.1 Ottawa

The video camera was placed at the southern side of the baggage claim area, where the seating arrangement is located. Hence the densities and waiting times could be calculated for this sub-system.

The manual backup was also employed, providing the same information, as being recorded on the video machine, at regular intervals.

4.2.3.3.2 Toronto

Once again, there was no suitable place available in the Baggage Claim area where the video camera could be placed, without seriously jeopardizing the passenger flow. Therefore, it was decided to use manual counts instead, and that information was used in the analysis of performance measure.

4.2.4.1 Boarding Lounge

As defined in Airport Reference Terminal Manual, the Boarding Lounge, or the Departure Lounge could be distinguished as three separate areas or in combination, i.e. gate lounge, common departure lounge and transit lounge, with boarding checkpoints as close to the aircraft as possible . The following functions should be considered for inclusion in the common

departure lounge [35].

- . adequate seating to accommodate the forecast passenger load,
- . flight information displays
- . airline information desks for passenger assistance
- . concessions
- . adequate washroom facilities
- . public address system

The Apron & Terminal Building Manual defines Boarding Lounge as a combination of seating, processing and circulation area.

The area required is a function of the number of passengers anticipated to be in the lounge fifteen minutes prior to boarding. The space standard assumes that not all passengers will have seats in the lounge [36].

For the purpose of this study, the boarding lounge was taken considered to be the area adjacent to the departure gate, and the area would have natural delineation as to form the boundaries of the departure lounge.

4.2.4.1.1 Ottawa

The boarding lounge surveyed at Ottawa was an area adjacent to the departure gate. It was almost rectangular in shape. The south side of the boarding lounge was bounded by a wall and the exit to the aircraft. To the east, the boarding lounge was bounded by seating arrangements, with circulation area immediately behind them. The circulation area and concessions on

Boarding Lounge Ottawa Gate 22

Not to Scale
All dimensions in metres

Fig 4.6

the west side form the boundary of the boarding lounge. Information display booths, telephone facilities and pillars mark the southern end of the boarding lounge (see Figure 4.6).

4.2.4.1.2 Toronto

The boarding lounges in Toronto are located in the circular building which revolves around the passenger terminal. When the passengers enter the boarding area, they can either go to the actual departure lounges attached to each gate, or they could wait around in the inner periphery of the boarding area.

The security clearance did not permit the survey to be undertaken inside the actual Boarding Lounges. Therefore, the waiting area outside the boarding lounge (which itself is a restricted area) was considered as the boarding lounge. That area being right in front of the departure gate but not inside the departure lounge.

For this study, the boarding lounge was considered to be the area mentioned above, in front of two separate gates. On the north and south sides of the selected areas were the walls of the departure lounge. On the east and west sides were the areas for circulation leading to other departure gates, providing natural boundaries for the Boarding Lounge (see Figure 4.7).

4.2.4.2 Performance Measures

The performance measures selected for this sub-system to

BOARDING LOUNGE TORONTO

Not to Scale
All Dimensions in Meters

Fig 4.7

obtain data were, net space available per person, number of seats available per person, and the availability of concessions.

4.2.4.3 Method of Data Collection

4.2.4.3.1 Ottawa

The video cameras were not allowed in the boarding lounge for security reasons. Hence the manual observation technique was used.

4.2.4.3.2 Toronto

Video cameras were not allowed in Toronto's boarding lounge area. Therefore manual observations were used in both boarding lounge areas.

4.2.5.1 Preliminary Inspection Line (PIL)

There is no formal definition for Preliminary Inspection Line (PIL) area. Airport Terminal Building Manual provides a definition of Customs and Immigration area. However, the customs and immigration area or PIL area is usually considered to be the area where the international passengers gather, right after disembarking from the plane to go through passport and immigration controls.

Passenger flow from aircraft to the PIL area should be as short as possible. Moreover, the passenger circulation must be so designed that there is no cross circulation between international and domestic passengers. The design must enable every arriving

passenger to move through the inspection area and eliminate any possibility of someone bypassing inspection.[35,36]

For the purpose of this study, the Preliminary Inspection Line (PIL) was considered to be the area where the arriving passengers wait for their documents to be inspected, immediately after deplaning.

4.2.5.1.1 Ottawa

The PIL area at Ottawa Airport is located at the east end of the terminal. It is well defined area since once the passenger enters the PIL area, the passenger walks into a rectangular hall where the east, west, and north sides are bounded by walls, and on the south side are the immigration officers' booth. This whole area was considered as the PIL area for Ottawa (see Figure 4.8).

4.2.5.1.2 Toronto

The PIL area for Toronto is based essentially on the same principles. The passengers arrive through a corridor and the hall in which they walk into is the PIL area. It is bounded by walls on two sides, and the opposite to the entrance to the PIL area, are the immigration officers' booths. This entire area was considered the PIL area (see Figure 4.9).

4.2.5.2 Performance Measures

The performance measures selected for the study were the net

PIL Ottawa

Not to Scale
All dimensions in metres

Fig 4 8

PIL Toronto

Not to Scale
All dimensions in metres

Fig 4.9

space available per person, the Service rate and the waiting time in the queue.

4.2.5.3 Method of Data Acquisition

The video cameras were absolutely not allowed in this sub-systems. Hence, manual counts were used.

4.2.5.3.1 Ottawa

The net space for passengers was considered to be space extending from the immigration booth all the way back to the first set of pillars, which naturally describe the queuing area for the preliminary inspection line. The width of the counter itself was taken as the width of the queuing line i.e. 1.5 meters. Depending on how many counters were open, the Net Space per lane would be the multiple of the number of counters by the net space per counter, times 1.5 meter square, yielding net space. The passengers were interviewed in the adjacent Baggage Claim area, immediately after they had progressed through the PIL area.

4.2.5.3.2 Toronto

The net space per passenger was considered on the same principles as was done in the case of Ottawa. Here also, a set of pillars defines the queuing space.

But in the case of Toronto, one additional difficulty was

encountered. It was not allowed to interview the passengers immediately after they had gone through the PIL. Therefore, the belated interviews for Pil area in Toronto were conducted at the public concourse after the passengers had gone through Customs, Baggage Claim, etc.

4.3 Statistical Summary Of Responses

Presented here in this section are the summary results of the information collected through the surveys. These results are the incorporation of information collected through the interviews, and the secondary information collected through other sources i.e., video taping, etc. Figure 4.10 provides a breakup of the number of interviews conducted at each sub-system, by each airport.

It must be noted here that though detailed information was collected in the survey through questionnaires, manual reading of performance measures, and video taping, not all the variables were used in the analysis of the information. This section deals with the information and variables used in the further analysis for utility composition. The information which was obtained but not used for detailed analysis will be outlined in the next section.

4.3.1 Check-in

A quick look at the questionnaire for the check-in area would explain the kind of information collected for the analysis

**TOTAL NO. OF QUESTIONNAIRES
BREAKDOWN BY SUBSYSTEMS**

<u>Sub-System</u>	<u>Ottawa</u>	<u>Toronto</u>
Check in	137	75
Baggage Claim	127	48
Boarding Lounge	24	27
PIL	59	88
	-----	-----
Sub-Total	347	238
	-----	-----
Grand Total	585	

Figure 4.10

purpose. Explained below are the summary outcome of the information obtained through questionnaires, and also, information obtained through secondary sources.

Between Ottawa and Toronto, a total of 212 interviews were conducted. The summary results are of the information obtained from both the airports for the check-in sub-system.

i) TRIP. Of the 212 respondents interviewed, 76 of them or 35.8% of them were on a business trip; 127 or 59.9% were on a non-business trip and the rest of them i.e. 9 or 4.2% were on a combined trip, which puts the percentage of non-business travelers as the highest of the people interviewed (Figure 4.C.1).

ii) SIZE. Single travelers, or, in other words, people traveling alone were highest in number. 63.7% or 135 out of the total 212 travelers were traveling alone. People traveling in a group of 2 constituted 20.8% of the total respondents. The rest were the people traveling in a group of three or more, which is 33 respondents or 15.6% of the total respondents (Figure 4.C.2).

iii) SEX. 140 of the respondents interviewed were male, constituting 66.0% of the total respondents. 33.5% were female respondents and there was one person of whose sex could not be recorded. (Figure 4.C.3)

iv) SPACE. This variable represents the rating of space

CHECKIN TRIP

Figure 4.C.1: Checkin. Trip Purpose

CHECKIN SIZE

Figure 4.C.2: Checkin. Party Size

as perceived by the respondents as they were in the sub-system, ranging from 1 to be extremely dissatisfied to 7, which is extremely satisfied. 9.0% of the total respondents were extremely dissatisfied, where as, 16.5% respondents were extremely satisfied with space. There were 4 cases of strange or no answer, i.e. number 8, which constituted 1.9% of the total respondents. This information was not used in further analysis. Figure 4.C.4 provides the percentage of responses for space perception from 1 to 7.

v) WAIT. This variable represents the rating of waiting time in the queue as perceived by the respondent. Ranging from 1 to be extremely dissatisfied to number 7 (extremely satisfied). 14.2% of the respondents were extremely dissatisfied with the waiting time. 28.3% were extremely satisfied. There were 3 cases, or 1.4% of the respondents which provided strange answers or no answer, i.e. number 8; hence this information was not used for subsequent analysis. Figure 4.C.5 provides the percentage of the responses for waiting time on a scale of 1 to 7.

vi) SERV. This variable provided the perceptions of the passengers, of the service time at the counter. Where 1 being extremely dissatisfied to 7, extremely satisfied. No respondent was extremely dissatisfied with the service time. However, 50% of the respondents were extremely satisfied with the service time. Number 8 is one case of no answer. Figure 4.C.6 provides the percentage of responses for this variable on a

CHECKIN SEX

Figure 4.C.3: Checkin. Respondants' Sex

CHECKIN SPACE

Figure 4.C.4: Checkin. Rate of Space

CHECKIN WAIT

Figure 4.C.5: Checkin. Rate of Wait

CHECKIN SERV

Figure 4.C.6: Checkin. Rate of Service

scale of 1 to 7.

vii) RSPACE. This variable represents the ranking of space, as indicated by the respondent, i.e. that of all the three variables they were asked to rate, which would they prefer the most. Of the total 212 responses, only 5.2 percent ranked the availability of space as most important to them. To 10.8% of the passengers, availability of space was their second choice, and 78.8% of the respondents picked availability of space as their third choice. A total of 10 responses were either no answer, or strange answers, or all the variables were equally important to them. This is depicted in Figure 4.C.7 as 4, 5, and 6 respectively. Hence these responses were not used for subsequent analysis. Figure 4.C.7 provides percentages of all the responses to this question.

viii) RWAIT. This variable provides the passengers' ranking of short waiting time in the queue. To 70.3% of the respondents, short waiting time in the queue was most important to them. 19.3% of them considered short waiting time as their second choice. Only 5.7% of the respondents selected short waiting time in the queue as their third choice. Here again, 10 responses, which were either no answer, or strange or all three variables equally important to them, amounting to 4.7% of the total responses, were not used for further analysis. Figure 4.C.8 provides the percentage of responses for the ranking of short waiting time in the queue.

ix) RSERV. This question was asked to find out the rank of

CHECKIN RSPACE

Figure 4.C.7: Checkin Rank of Space

CHECKIN RWAIT

Figure 4 C 8: Checkin Rank of Wait

quick service at the counter to the respondents. To 20.3% of the passengers, quick service at the counter was most important. 65.1% of passengers stated this as second most important factor and to 9.9% of the respondents, quick service at the counter was their third choice. 10 cases or 4.7% of the cases were not considered for the same reason as explained in Ranking of Space and Ranking of Waiting Time. Figure 4.C.9 provides the percentage of the responses, to the question of ranking of service time at the counter.

x) SAPPN. The net space available per person was calculated according to the procedure explained earlier in this chapter. The net space available per person at the check-in subsystem ranged from 0.83 meters per person to 6.44 meters per person, on the average. This information is used for the analysis and the derivation of utility and utility functions.

xi) STIME. The service time at the counter was calculated as the average of time taken by individual passengers at the service counter, for every 10 or 15 minutes time interval, depending upon the intensity of activity at that particular check-in queue.

The time spent by the passenger at the service counter was assigned to each respondent according to the average service time for that particular time period (i.e. if a passenger was interviewed at 6:13 pm, the assigned service time was the average of the service time, in the time period of 10 minutes, from 6:05

CHECKIN RSERV

Figure 4 C.9: Checkin. Rank of Service

CHECKIN PERFORMANCE MEASURES

Figure 4 C.10: Checkin. Rankings

to 6:15. At times, this time block was reduced to 5 minutes, and other times, it was extended to a 20 minute period period).

xii) WTIME. The waiting time in the queue was calculated basically on the same principles as of service time. However, there were times in the actual time period of interviews, where it was possible to track an individual respondents actual time spent waiting in the queue, hence the calibration of this information with the averages of the waiting time improved the waiting time allocation.

4.3.2 Baggage Claim

An examination of the questionnaire for the baggage claim area would explain the kind of information collected for the analysis purpose. Explained below are the summary results of the information obtained through questionnaires, and also, information obtained through secondary sources.

Among Ottawa and Toronto, a total of 175 questionnaires were completed. The summary results are of the information obtained from both the airports for the baggage claim sub-system.

i) TRIP. Of the 175 respondents interviewed, 68 of them or 38.9% of them were on a business trip; 98 or 56.0% were on a non-business trip and the rest of them i.e. 8 or 4.6% were on a combined trip. One respondent did not answer this question. which puts the percentage of non-business travelers as the highest percentage of the people interviewed (Figure 4.B.1).

BAGGAGE CLAIM TRIP

Figure 4 B.1: Baggage C. Trip Purpose

BAGGAGE CLAIM SIZE

Figure 4 B.2: Baggage C. Party Size

ii) SIZE. Single travelers, or, in other words, people traveling alone were highest in number. 63.4% or 111 out of the total 175 travelers were traveling alone. People traveling in a group of two constituted 21.1% of the total respondents. The rest were the people traveling in a group of three or more, which is 27 respondents or 15.3% of the total respondents (Figure 4.B.2).

iii) SEX. 109 of the respondents interviewed were male, constituting 62.3% of the total respondents. 34.3% were female respondents and there were 6 respondents who did not answer this question. (Figure 4.B.3)

iv) SPACE. This variable represents the rating of space as perceived by the respondents while they were in the sub-system. The values of this variable range from 1 (extremely dissatisfied) to 7 (extremely satisfied). 2.3% of the total respondents were extremely dissatisfied. 20.6% were extremely satisfied with space. Figure (4.B.4) provides the percentage of responses for each level of rating for space as assigned by users.

v) WAIT. This variable represents the rating of waiting time spent in collecting the baggage as perceived by the respondent.. ranging from 1 (extremely dissatisfied) to number 7 (extremely satisfied). 10.9% of the respondents were extremely dissatisfied with the time spent. 24.1% were extremely satisfied. There was one case constituting 0.6% of the total respondents who did not answer this question; hence this information was not used

BAGGAGE CLAIM SEX

Figure 4.B.3: Baggage C. Respondants' Sex

BAGGAGE CLAIM SPACE

Figure 4.B.4: Baggage C Rate of Space

for subsequent analysis. Figure (4.B.5) provides the percentages of the responses for waiting time on a scale of 1 to 7.

vii) RSPACE. This variable represents the ranking of space, as indicated by the respondent, i.e. that of the two variables they were asked to rate, which one would they prefer the more. Of the total 175 responses, only 8.6 percent ranked the availability of space as more important to them. To 88.8% of the passengers, short time in collecting their baggage was their first choice. A total of six respondents disclosed of both variables as equally important to them. Hence these responses were not used for subsequent analysis. Figure 4.B.6 provides percentages of the responses to this question.

x) NSAPP. The net space available per person was calculated according to the procedure explained earlier in this chapter. The net space available per person at the baggage claim sub-system ranged from 1.36 meters per person to 8.98 meters per person, on the average. This information is used for the analysis and the derivation of utility of space.

xi) CTIME. The time spent in the baggage collection was calculated by taking the average amount of time taken by passengers in the baggage collection area, divided by the number of observations, for every 10 or 15 minute intervals, depending upon the nature of activity in the baggage claim area.

The time spent by a passenger in collecting the baggage

BAGGAGE CLAIM WAIT

Figure 4.B.5: Baggage C. Rate of Wait

BAGGAGE CLAIM PERFORMANCE MEASURES

Figure 4.B.6: Baggage C. Rankings

was assigned to each respondent according to the average baggage collection time taken by a passenger for that particular time period (i.e. if a passenger was interviewed at 6:10 pm, the assigned baggage collection time was the average of the baggage collection time, in the time period of 10 minutes, from 6:05 to 6:15. At times, this time block was reduced to 5 minutes, and at other times, it was extended to 20 minute per time period) average. Average time spent by a passenger in collecting baggage ranged from 8.63 minutes per passenger to 13.0 minutes per passenger.

4.3.3 Boarding Lounge

Explained below are the summary results of the information obtained through questionnaires, and secondary sources, in the boarding lounge area.

A total of 51 interviews were conducted. The summary results are of the information obtained from both the airports for the boarding lounge sub-system.

i) TRIP. Of the 51 respondents interviewed, 15 or 29.4% of them were on a business trip; 33 or 64.7% were on a non-business trip and the rest of them i.e. 3 or 5.9% were on a combined trip, which puts the percentage of non-business travelers as the highest among the people interviewed (Figure 4.L.1).

BOARDING LOUNGE TRIP

Figure 4.L.1: Boarding L. Trip Purpose

BOARDING LOUNGE SIZE

Figure 4.L.2: Boarding L. Party Size

ii) SIZE. Single travelers, or, in other words, people traveling alone were highest in number. 58.8% or 30 respondents out of the total of 51 were traveling alone. People traveling in a group of two constituted 37.3% of the total respondents. The rest were the people traveling in a group of three or more, which is 5.9% of the total respondents (Figure 4.L.2).

iii) SEX. 34 of the interviewed respondents were male, constituting 66.7% of the total respondents. 31.4% were female respondents and there was one person of whom we do not have conclusive information. (Figure 4.L.3)

iv) SPACE. This variable represents the rating of space as perceived by the respondents while they were in the boarding lounge, ranging from 1 (extremely dissatisfied) to 7, (extremely satisfied). Not a single respondent was extremely dissatisfied, whereas, 37.3% were extremely satisfied. Figure (4.L.4) provides the percentage of responses for space perception from 1 to 7.

v) SEAT. This variable represents the rating of seating availability in the boarding lounge area as perceived by the respondent. Ranging from 1 (extremely dissatisfied) to 7 (extremely satisfied). No one was extremely dissatisfied with the seating, whereas 39.2% were extremely satisfied. (Figure 4.L.5) provides the percentage of the responses for waiting time on a scale of 1 to 7.

BOARDING LOUNGE SEX

111

Figure 4.L.3: Boarding L. Respondants' Sex

BOARDING LOUNGE SPACE

Figure 4.L.4: Boarding L. Rate of Space

vi) CONCESS. This variable provided the perceptions of the passengers, about the availability of Concessions at the boarding lounge. Where 1 being extremely dissatisfied to 7, extremely satisfied. 7.8% respondents was extremely dissatisfied with the availability of concessions. However, 15.7% of the respondents were extremely satisfied. There were 3 cases of "no answer". (Figure 4.L.6) provides the percentage of responses for this variable on a scale of 1 to 7.

vii) RSPACE. This variable represents the ranking of space, as indicated by the respondent, i.e. that of all the three variables the users were asked to rate, which one would they prefer the most. Of the total 51 responses, only 15.7% percent ranked the availability of space as most important to them. To 60.8% of the passengers, availability of space was their second choice, and 15.7% of the respondents stated availability of space as their third choice. A total of 9 responses were either no answer, or strange answers, or all the variables were equally important to them. Hence these responses were not used for subsequent analysis. (Figure 4.L.7) provides percentages of the responses to this question.

viii) RSEAT. This variable provides the passengers' ranking of seat in the boarding lounge. To 70.6% of the respondents, availability of seat was most important. 17.6% of them considered this as their second choice. Only 3.9% of the respondents selected availability of seat as their third choice.

BOARDING LOUNGE SEAT

Figure 4 L 5: Boarding L. Rate of Seat

BOARDING LOUNGE CONCESSION

Figure 4.L.6 Boarding L. Concession Rate

Here again, 9 responses, which were either no answer, or strange or all three variables equally important to them, amounting to 7.8% of the total responses, were not used for further analysis. (Figure 4.L.8) provides the percentage of responses for the ranking of availability of seat in the boarding lounge area.

ix) RCON. This question was asked to extract the rank of the availability of concessions in the boarding lounge area from the respondents. To 5.9% of the passengers, concessions were most important. 13.7% of them considered it as their second choice. and to 72.5% of the respondents, availability of concessions was least important. 9 cases or 7.8% of the cases were not considered for the same reason as explained in Ranking of Space and Ranking of Seat. (Figure 4.L.9) provides the percentage of the responses to this question.

xii) ADDCON. The Passengers were asked whether they wanted to see additional concessions added to the boarding lounge area. 37.3% of the passengers wanted to see more concessions in the boarding lounge area.. 17.5% answered no to this question . However 45.1% of the total passengers did not answer this question.

x) SPAPER. The net space available per person was calculated according to the procedure explained earlier in this chapter. The net space available per person in the boarding lounge area, on the average, ranged from 7.16 meters per person to 8.95 meters per person. This information would be used for the analysis and the derivation of utilities.

BOARDING LOUNGE RSPACE

Figure 4.L.7: Boarding L. Rank of Space

BOARDING LOUNGE RSEAT

Figure 4.L.8: Boarding L. Rank of Seat

BOARDING LOUNGE RCON

Figure 4.L.9:Boarding L. Concession Rank

BOARDING LOUNGE ADDCON

Figure 4.L.10:Boarding L.Add Concessions

xi) SEAPER. The seat available per person was calculated by counting the number of unoccupied seats in the boarding lounge area at the time of interview. Subtracting that from the total number of seats in the boarding lounge would yield available number of seats at the time of interview.

xii) AVACON. Airport Terminal Reference Manual [35] and Airport Terminal Building Manual [36] describe a list of concessions which are appropriate for a boarding lounge area. Ideally all of these concessions should be provided in a boarding lounge. According to the guidelines outlined in these reference manuals, a set of criteria was evolved for the availability of concessions in a boarding lounge area. According to this criteria, an ideal boarding lounge would have seven sets of concessions providing concession facilities. By this definition, boarding lounge surveyed in Ottawa scores five sets of concessions out of possible seven, where as, boarding lounges in Toronto scored three sets out of seven. The correlation of rate of concession with Avacon is based on this criteria.(see Figure 4.L.11).

4.3.4. Preliminary Inspection Line (PIL).

4.3.4.1 PIL (Ottawa)

A total of 59 interviews were conducted at Ottawa airport. The summary results explained in this section are of the information obtained from the PIL sub-system, for Ottawa airport

BOARDING LOUNGE PERFORMANCE MEASURES

Figure 4.L.11: Boarding L. Rankings

BOARDING LOUNGE CONCESSIONS LIST

- Bar / Lounge
- Restaurant / Snack Bar
- Book Store, Newspaper, Smoke Shop
- Coffee / Pop / Vending Machines
- Travel Accessories, Currency Exchange, Information Screens
- Souvenir / Gift Shops, Toy Shops
- Video Games / Pinball Machines, Television Screens

Figure 4.L.12 Boarding L. Concessions list

only.

i) TRIP. Of the 59 respondents interviewed, 27 or 45.8% were on a business trip; 29 or 49.2% were on a non-business trip and the rest of them i.e. 3, constituting 5.1% of the total respondents were on a combined trip, which puts the percentage of non-business travelers as the highest among the people interviewed in the PIL area. (Figure 4.P.O.1).

ii) SIZE. People traveling alone were highest in number. 76.3% or 45 out of the total 59 travelers were traveling alone. People traveling in a group of two constituted 15.3% of the total respondents. The rest were the people traveling in a group of three or more, which is a total of 5 responses or 8.5% of the total responses (Figure 4.P.O.2).

iii) SEX. 38 of the respondents interviewed were male, constituting 64.4% of the total respondents. 28.8% were female respondents and there were 4 respondents of whom the identification of sex could not be recorded. (figure 4.P.O.3)

iv) SPACE. This variable represents the rating of space as perceived by the respondents as they were in the sub-system, ranging from 1 (extremely dissatisfied) to 7 (extremely satisfied). None of the respondents were extremely dissatisfied with space. Where as, 37.3% of the total respondents were extremely satisfied with space. (Figure 4.P.O.4) provides the percentage of responses for space perception on a scale of 1 to 7.

PIL OTTAWA TRIP

Figure 4.PO.1: PIL. Trip Purpose

PIL OTTAWA SIZE

Figure 4.PO.2: PIL. Party Size

PIL OTTAWA SEX

Figure 4.P0.3: PIL.Respondants' Sex

PIL OTTAWA SPACE

Figure 4.P0.4: PIL.Rate of Space

v) WAIT. This variable represents the rating of waiting time in the queue as perceived by the respondent. Ranging from 1 (extremely dissatisfied) to 7 (extremely satisfied). 3.4% of the respondents were extremely dissatisfied with the waiting time. 30.5% were extremely satisfied. (Figure 4.P.O.5) provides the percentage of the responses for waiting time on a scale of 1 to 7.

vi) SERV. This variable provided the perceptions of the passengers, of the service time at the counter. Where 1 being extremely dissatisfied to 7, extremely satisfied. No respondent was extremely dissatisfied with the service time. However, 69.5% of the respondents were extremely satisfied with the service time. (Figure 4.P.O.6) provides the percentage of responses for this variable on a scale of 1 to 7.

vii) RSPACE. This variable represents the ranking of space, as indicated by the respondent, i.e. that of all the three variables they were asked to rate, which would they prefer the most. Of the total 59 responses, only 1.7% percent ranked the availability of space as most important to them. To 11.9% of the passengers, availability of space was their second choice, and 86.4% of the respondents picked availability of space as their last choice. (Figure 4.P.O.7) provides percentages of the responses to this question.

PIL OTTAWA WAIT

123

Figure 4 PO.5: PIL. Rate of Wait

PIL OTTAWA SERV

Figure 4 PO.6: PIL. Rate of Service

viii) RWAIT. This variable provides the passengers' ranking of short waiting time in the queue. To 78.0% of the respondents, short waiting time in the queue was most important to them. 16.9% of them considered short waiting time as their second choice. Only 1.7% of the respondents selected short waiting time in the queue as their third choice. Here two responses, which were either "no answer", or strange or all three variables equally important to them, amounting to 3.4% of the total responses, were not used for analysis. (Figure 4.P.O.8) provides the percentage of responses for the ranking of short waiting time in the queue.

ix) RSERV. This question was asked to assess the rank of quick service at the counter, to the passengers. To 16.9% of the passengers, quick service at the counter was most important. 67.8% of them considered it as the second most important and to 11.9% of the respondents, quick service at the counter was their third choice. Two cases or 3.4% of the total cases were not considered for the same reason as explained in Ranking of Waiting Time. (Figure 4.P.O.9) provides the percentage of the responses for the ranking of service time at the counter.

x) NSAPP. The net space available per person was calculated according to the procedure explained earlier in this chapter. The net space available per person at the PIL subsystem in Ottawa ranged from 19.22 meters per person to 5.94 meters per person, on the average. This information was used for the analysis and the derivation of utility of space.

PIL OTTAWA

RSPACE

125

Figure 4.P0.7: PIL Rank of Space

PIL OTTAWA

RWAIT

Figure 4.P0.8: PIL Rank of Wait

Figure 4.PO.9: PIL. Rank of Service

xi) **STIME.** The service time at the counter was calculated by taking the average amount of time taken by passengers at the counter, for every 10 or 15 minute time intervals, depending upon the nature of activity at that particular Preliminary Inspection Line.

The time spent by the passenger at the service counter was assigned to each respondent according to the average service time for that particular time period.

However, it is important to note here that since the passengers interviewed could not be associated with the corresponding lane through which the passenger had been checked out of the PIL line, therefore, the service times assigned to a passenger is the average service time of all the service counters, depending upon the number of service counters in operation in that time period.

xii) **WTIME.** The waiting time in the queue was calculated basically on the same principles as of service time. Here the waiting time was similarly assigned as the average waiting time per passenger per lane, to the particular respondent.

4.3.4.2 PIL (Toronto)

A total of 88 interviews were conducted at Toronto airport. The summary results explained in this section are of the information obtained from the PIL sub-system, for Pearson

International Airport (Toronto) only.

i) TRIP. Of the total 88 respondents interviewed, 16 or 18.2% of the respondents were on a business trip; 69 or 78.4% were on a non-business trip and the rest of them i.e. 3 or 3.4% were on a combined trip, which puts the percentage of non-business travelers as the highest among the people interviewed in the PIL area. (Figure 4.P.T.1).

ii) SIZE. People traveling alone were highest in number. 59.1% or 52 out of the total 88 travelers were traveling alone. People traveling in a group of two constituted 28.4% of the total respondents. The rest were the people traveling in a group of three or more, which is 11 responses or 12.5% of the total responses (Figure 4.P.T.2).

iii) SEX. 55 of the respondents interviewed were male, constituting 62.5% of the total respondents. 36.4% were female respondents and there was one respondents whose gender could not be recorded (Figure 4.P.T.3).

iv) SPACE. This variable represents the rating of space as perceived by the respondents while they were in the sub-system, ranging from 1 (extremely dissatisfied) to 7 (extremely satisfied). 5.7% of the respondents were extremely dissatisfied with space. Where as, 35.2% of them were extremely satisfied. (Figure 4.P.T.4) provides the percentage of responses for space perception from 1 to 7.

PIL TORONTO TRIP

Figure 4.PT.1: PIL. Trip Purpose

PIL TORONTO SIZE

Figure 4.PT.2: PIL. Party Size

PIL TORONTO SEX

Figure 4.PT.3: PIL.Respondants' Sex

PIL TORONTO SPACE

Figure 4 PT.4: PIL.Rate of Space

v) WAIT. This variable represents the rating of waiting time in the queue as perceived by the respondent. Ranging from 1 (extremely dissatisfied) to 7 (extremely satisfied). 4.5% of the respondents were extremely dissatisfied with the waiting time. 40.9% were extremely satisfied. (Figure 4.P.T.5) provides the percentage of the responses for waiting time on a scale of 1 to 7.

vi) SERV. This variable provided the perceptions of the passengers, of the service time at the counter. Where 1 being extremely dissatisfied to 7, extremely satisfied. 2.3% of the total respondents were extremely dissatisfied with the service time. However, 60.2% of the respondents were extremely satisfied with the service time. (Figure 4.P.T.6) provides the percentage of responses for this variable on a scale of 1 to 7.

vii) RSPACE. This variable represents the ranking of space, as indicated by the respondent, i.e. that of all the three variables they were asked to rate, which would they prefer the most. Of the total 88 responses, only 3.4% percent ranked the availability of space as most important to them. To 12.5% of the passengers, availability of space was their second choice, and 81.8% of the respondents picked availability of space as their last choice. There were two cases of no response or all equally important cases. (Figure 4.P.T.7) provides percentages of the responses to this question.

PIL TORONTO WAIT

132

Figure 4.PT.5: PIL. Rate of Wait

PIL TORONTO SERV

Figure 4 PT 6: PIL. Rate of Service

viii) RWAIT. This variable provides the passengers' ranking of short waiting time in the queue. To 60.2% of the respondents, short waiting time in the queue was most important to them. 31.8% of them considered short waiting time as their second choice. Only 5.7% of the respondents selected short waiting time in the queue as their third choice. Here two responses, which were either "no answer", or strange or all three variables equally important to them, amounting to 2.2% of the total responses, were not used for analysis purpose. (Figure 4.P.T.8) provides the percentage of responses for the ranking of short waiting time in the queue.

ix) RSERV. This question was asked to assess the rank of quick service at the counter, to the respondents. To 34.1% of the passengers, quick service at the counter was most important. 53.4% of them considered it as the second most important and to 10.2% of the respondents, quick service at the counter was their third choice. 2 cases or 2.2% of the cases were not considered for the same reason as explained in Ranking of Space and Ranking of Waiting Time. (Figure 4.P.T.9) provides the percentage of the responses.

x) NSAPP. The net space available per person was calculated according to the procedure explained earlier in this chapter. The net space available per person at the PIL subsystem in Toronto ranged from 1.5 meters per person to 4.25 meters per person, on the average. This information was used for the analysis and the derivation of utility of space.

PIL TORONTO

RSPACE

134

Figure 4.PT.7: PIL Rank of Space

PIL TORONTO

RWAIT

Figure 4.PT.8: PIL Rank of Wait

PIL TORONTO R SERV

135

Figure 4.PT.9: PIL. Rank of Service

PIL TORONTO PERFORMANCE MEASURES

Figure 4.PT.10: PIL Rankings

xi) **STIME.** The service time at the counter was calculated by taking the average amount of time taken by passengers at the counter, for every 10 or 15 minute intervals, depending upon the nature of activity at that particular Preliminary Inspection Line.

The time spent by the passenger at the service counter was assigned to each respondent according to the average service time for that particular time period.

However, it is important to note here that since the passengers interviewed could not be associated with the corresponding lane through which the passenger had been checked out of the PIL line, therefore the service times assigned to a passenger is the average service time of all the service counters, depending upon the number of service counters in operation at that particular time period.

xii) **WTIME.** The waiting time in the queue was calculated basically on the same principles as of service time. Here the waiting time was similarly assigned as the average waiting time per passenger per lane, to the particular respondent.

4.4 Variables Not Used in the Analysis

As mentioned earlier, information was obtained about other variables too. But that information is not used in this study since it is beyond the scope of this study. However, that

information is very useful and could be analyzed for further study of relationships between variables.

Contained below is a brief description of such variables, according to the respective sub-systems.

4.4.1 General

i) FLIGHT Flight Number

When passengers were asked for their flight number, it was considered to use the flight number as to find out what type of a flight the passenger was on i.e. was it a short haul flight or a long haul flight, or whether it was a domestic flight, charter flight, or an international flight.

This information can provide an insight to whether the passengers on different types of flights have different perceptions about space, waiting time, service time, etc. Does the ranking of these performance measures changes for the respondents or it remains the same, etc.

ii) ID Identification Number

An identification number was assigned to each questionnaire so that each respondent could be related with where and when that particular interview was conducted. These identification numbers are from 001 to n, for each sub-system.

iii) TIME Time of Interview.

The actual time of the interview is recorded on each

questionnaire. The reason behind recording the time of the interview is two-fold: to relate the time of the interview with other secondary information i.e. density, service rate, etc. and also the relationship of responses on the performance measure with the time of the day could be of interest. That is, to see how do the responses differ from day to night, or from mornings, to afternoons, to evenings etc.

This information is available, but not used in this study.

iv) DATE Interview Date

This information is recorded on each questionnaire. This provides the information on the day and date on which that particular information was obtained on the questionnaire. This information could provide an insight or whether people's perceptions differ from a weekday to a weekend, etc. This information was not used in the subsequent analysis.

CHAPTER 5

STATISTICAL ANALYSIS OF SURVEY RESPONSES

5.1 Analysis

This chapter deals with the analysis of the variables selected, in the different Sub-systems. The performance Measures selected for the derivation of composite utilities would be discussed and the equations would be derived for the composite utilities of each sub-system.

As mentioned earlier, SPSSX version 2.1 is a very powerful tool to utilize in the analysis of the kind of data accumulated in the surveys. SPSSX , therefore, was used to run various different analyses on this data. e.g. frequencies, barcharts, histograms, regressions among different variables, crosstabs, breakdown tables etc.

The variables selected for analysis in the previous chapter would be analysed for variance amongst themselves to find out the effect of one variable over an other. ANOVA, a statistical package available within SPSSX would be used to analyse the selected variables.

Following are the results of the this analysis. These results would be discussed according to each sub-system. It should be noted that the results discussed here are a summary of what the computer programme has produced. The variables which had any significance in relation to any other variable would be

any significance in relation to any other variable would be discussed here. Following tables contain the breakdown of variables as analysed by the ANOVA process. Then again, though each and every variable was analysed, only those variables which were of any significance to each other have been included.

5.1.1 Check-in

The following tables present the breakdown of variables in the check-in area.

Table 5.1 Breakdown Of Variables : Check-in

Table 5.1 (a)

	SPACE	WAIT	SERV
SPACE	--	.7347 * (208) ** P=.000 #	.3230 (207) P=.000
WAIT		--	.3894 (208) P=.000
SERV			--

Table 5.1 (b)

	SAPPN	STIME	WTIME
SPACE	0.4311 (208) P=0.000	-0.1291 (208) P=0.032	-0.4890 (208) P=0.000
SERV	0.0767 (211) P=0.134	-0.0644 (211) P=0.176	-0.1399 (211) P=0.021
WAIT	0.4808 (209) P=0.000	-.2046 (209) P=0.001	-0.5353 (209) P=0.000

Where * is the correlation coefficient
 ** is the no. of observations
 # is the significance level (p=.000 means 100%)

Table 5.1 (c)

	RSPACE	RWAIT	RSERV
RSPACE	--	-0.5127 (200) P=0.000	-0.4207 (200) P=0.000
RWAIT		--	-0.5631 (200) P=0.000
RSERV			--

Table 5.1 (d)

	TRIP	SIZE	SEX
SPACE	-.0627 (208) P=.184	-.0967 (208) P=.082	-.0519 (208) P=.228
WAIT	-.1388 (209) P=.023	.0977 (209) P=.080	-.2026 (209) P=.384
SERV	.0030 (211) P=.482	.0035 (211) P=.480	.1381 (211) P=.023
RSPACE	-.0964 (201) P=.087	.0401 (201) P=.286	-.0550 (197) P=.219
RWAIT	.0458 (202) P=.259	.0748 (202) P=.145	.0494 (202) P=.243
RSERV	.0367 (202) P=.302	-.1118 (202) P=.057	.0174 (202) P=.403
SAPPN	-.1584 (212) P=.011	.0411 (212) P=.276	-.1376 (212) P=.023
STIME	.4779 (212) P=.000	.0785 (212) P=.127	.1459 (212) P=.017
WTIME	.4459 (212) P=0.000	.0045 (212) P=.474	.2110 (212) P=.001

Explained below are the variables which have have a relationship with each other, and each individual variable's effect on every other variable is discussed, as outlined in the above noted tables. Variables which have no significant relationship of each other, or are included in the calculation of utilites, are described in Appendix C.

(i) SPACE: Rate of Space

- Space and Wait. There is a very strong direct correlation between the rate of Space and the rate of Wait. It means that the passengers' rating of Space is directly correlated with the rate of waiting time in the queue. If the waiting time is longer, the rate of space decreases, and vice versa (see Figure 5.C.1).

- Space and Service. The rating of service is also directly correlated to the rating of space. It means that if the service time at the counter goes up, the rate of space decreases and vice versa. (See Fig 5.C.2)

- Space and RSpace. Rank of Space is not influenced by the rate of Space.

- Space and RWait. The rate of Space is not related to the ranking of Wait.

- Space and RServ. The rate of Space is not related to the ranking of Wait.

CHECKIN

Correlations Of Two Variables

Fig 5C1

CHECKIN

Correlations Of Two Variables

Fig 5C2

(ii) WAIT: Rate of Wait

- Wait and Space

The rate of Wait is directly correlated to the rate of Space. This means that the rate of Space would increase from 1 (extremely dissatisfied) to 7 (extremely satisfied) as the rate of Wait decreased from 7 (extremely satisfied) to 1 (extremely dissatisfied). (Figure 5.C.1) might help explaining this interrelationship.

- Wait and Service. The rate of Wait is also correlated to the rate of Service. As the rate of Service goes down, the rate of Waiting Time goes up, and vice versa (see Figure 5.C.3).

- Wait and RSpace. There is no relation between the rate of Wait and the rank of Space.

- Wait and RWait. There is no relation between the rate of Wait and ranking of Wait; in other words, the rank of Waiting Time is not influenced by the rate of Waiting Time.

- Wait and RServ. There is no relation between the rank of Service time at the counter and the rate of Wait.

5.1.2 BAGGAGE CLAIM

The following tables present the breakdown of variables in the baggage claim area.

CHECKIN

Correlations Of Two Variables

Fig 5C3

BAGGAGE CLAIM

Correlations Of Two Variables

Fig 6B1

Table 5.2 Breakdown Of Variables : baggage claim

Table 5.2 (a)

	SPACE	WAIT	CTIME
SPACE	--	.2147 (174) P=.002	-.2192 (175) P=.002
WAIT		--	-.4331 (174) P=.000
SERV			--

Table 5.2 (b)

	NSAPP	CTIME
SPACE	0.2711 (175) P=0.000	-0.2192 (175) P=0.002
WAIT	0.0877 (174) P=0.125	-.4331 (174) P=0.000

Table 5.2 (c)

	TRIP	SIZE	SEX
SPACE	-.0333 (175) P=.331	.0225 (175) P=.384	.0101 (175) P=.447
WAIT	-.0535 (174) P=.242	-.0813 (174) P=.143	.0269 (174) P=.362
RSPACE	-.1042 (169) P=.089	-.0802 (169) P=.150	.0483 (169) P=.362
NSAPP	.0682 (175) P=.185	.0333 (175) P=.331	.0628 (175) P=.204
CTIME	-.0607 (175) P=.213	.1077 (175) P=.078	.0089 (175) P=.453

Explained below are the variables which have have a relationship with each other, and each individual variable's effect on every other variable is discussed, as outlined in the above noted tables. Variables with no significant relationships are described in Appendix C.

i) SPACE: Rate of Space

- Space and Wait. Though not very significant, the rate of Space is correlated to the rate of Wait. In other words, if the rate of Waiting Time goes down, i.e. from 7 to 1, the rate of Space goes up from 1 to 7 (see Figure 5.B.1).

- Space and RSpace. The ranking of Space and the ranking

of Waiting Time is independent of the rating of Space.

ii) SIZE: Size of Party

- Size and Space. The Size of the Party has no relation with the rating of Space.

- Size and Wait. The Size of the Party has no relation to the rating of Wait.

- Size and RSpace. The Size of the Party has no relation to the ranking of Space or ranking of Waiting Time.

iii) WAIT: Rate of Waiting Time

- Wait and Space. Has a weak correlation, as described in Space and Wait (see Figure 5.B.1).

- Wait and RSpace. The rate of Waiting Time is independent of the rank of Waiting Time and the rank of Service Time.

5.1.3 Boarding Lounge

The following tables present the breakdown of variables in the boarding lounge area.

Table 5.3 Breakdown Of Variables : boarding lounge

Table 5.3 (a)

	SPACE	SEAT	CONCESS
SPACE	--	.5898 (51) P=.000	.2913 (48) P=.022
SEAT		--	.2232 (48) P=.064
CONCESS			--

Table 5.3 (b)

	SPAPER	SEAPER	AVACON
SPACE	0.0337 (51) P=0.407	0.0121 (51) P=0.467	0.4323 (51) P=0.001
SEAT	0.2253 (51) P=0.056	0.1679 (51) P=0.120	0.4344 (51) P=0.001
CONCESS	-0.2778 (48) P=0.028	-.3475 (48) P=0.120	0.4974 (48) P=0.000

Table 5.3 (c)

	TRIP	SIZE	SEX
SPACE	-.1280 (51) P=.185	.0256 (51) P=.429	-.2094 (51) P=.070
SEAT	-.1987 (51) P=.081	.1454 (51) P=.154	-.1310 (51) P=.180
CONCESS	-.4196 (48) P=.001	-.0571 (48) P=.350	.2372 (48) P=.052
SEAPER	-.0194 (51) P=.446	-.0846 (51) P=.278	-.1001 (51) P=.242
SPAPER	-.0882 (51) P=.269	-.0594 (51) P=.340	-.1801 (51) P=.103
AVACON	-.3135 (51) P=0.013	.1497 (51) P=.147	-.1117 (51) P=.218

Explained below are the variables which have have a relationship with each other, and each individual variable's effect on every other variable is discussed, as outlined in the

above noted tables. Not significant relationships are discussed in Appendix C.

i) TRIP: Purpose of Trip

- Trip and Size. There is a relationship between the purpose of the Trip and the Size of the Party in the boarding lounge area. Business people, on the average, were traveling alone. Non-business people were traveling with more than one person on the average. Combined categories were, on the average, traveling with higher numbers of people.

- Trip and Sex. There is a relationship between the purpose of the Trip and the Sex of the respondent. More males were on a business trip than females.

- Trip and Space. There is no relationship between the rate of Space and purpose of the Trip.

- Trip and Seat. There is no relationship between the purpose of the Trip and the rating of Seat.

- Trip and Concessions. There is a strong relationship between the Trip purpose and the rating of Concessions. People traveling on business rated Concessions higher than the people traveling on non-business trips (see Figure 5.L.1).

- Trip and RCON. However, there is no relationship between the ranking of Concessions and the Trip purpose.

- Trip and RSEAT. There is no relationship between the ranking of Seat and the Trip purpose.

BOARDING LOUNGE

Correlations Of Two Variables

Fig 5.1

BOARDING LOUNGE

Correlations Of Two Variables

Fig 5.2

- Trip and RSPACE. There is a very weak relationship between the ranking of Space and Trip purpose, where the business travelers ranked Space very slightly more than that of non-business travelers.

- Trip and ADDCON. There is no connection between the desire, or lack of, for additional Concessions and the purpose of the Trip.

ii) SPACE: Rate of Space

- Space and Seat. There is a very strong relationship between the rating of Space and rating of Seat. As the rate of Space increases, the rate of Seat also increases and vice versa (see Figure 5.L 2).

- Space and Concessions. The rate of Concessions are also related. The rate of Space decreases with the decrease in rate of Concessions, and vice versa.(see Figure 5.L.3)

- Space and RCON. There is no significant relationship between the rate of Space and the ranking of Concessions.

- Space and RSEAT. There is no significant relationship between the rate of Space and the ranking of Seat.

- Space and RSPACE. There is no relationship between the rate of Space and the ranking of Space.

- Space and AVACON. There is a strong relationship between the rate of Space and available Concessions. As the rate of

BOARDING LOUNGE

Correlations Of Two Variables

Fig 613

Fig 613

available Concessions goes up, the rate of space goes up from 1 to 7 and vice versa.(see Figure 5.L.3.1).

iii) SEAT: Rate of Seat

- Seat and Space. This relationship was discussed earlier under SPACE. (See Figure 5.L.2).

- Seat and Concessions. There is a weak relationship between the rate of Seat and the rate of Concessions. As the rate of Concessions goes higher, the rate of Seat goes higher and vice versa.(see figure 5.L.4)

- Seat and RCON. There is no relationship between the rate of Seat and the ranking of Concessions.

- Seat and RSEAT. There is no relationship between the rate of Seat and the ranking of Seat.

- Seat and RSPACE. There was no relationship between the rate of Seat and the rank of Space.

- Seat and AVACON. There was a strong relationship between the rating of Seats and availability of Concessions. As more concessions were available, the rate of Seat was higher. One of the possible explanations of this phenomenon could be that, as more concession type facilities are available, people may tend to move around and check these facilities out, which in turn may result in less occupancy time per seat. This could be translated into more number of seats available per person,hence the relationship.

iv) CONCESSIONS: Rate of Concessions

- Concessions and Space. There is a relationship between the rate of Concessions and rate of Space. It has been described earlier.

- Concessions and Seat. This relationship has also been described under SEAT.

- Concessions and RCON. There is a strong relationship between the rate of Concessions and the rank of Concessions. Less the rank of Concessions the lower is the rate of Concessions. It could mean that though the travelers rated the available concessions on the lower range of the scale, it was not their priority in terms of its utility.

- Concessions and RSEAT. There is no significant relationship between the rate of Concessions and the ranking of Seat.

- Concessions and RSPACE. There is a weak relationship between the rate of Concessions and the rank of Space. Those who rated Concessions low, rated rank of Space as high. It could mean that though the passengers rated the available concessions low, but their priority was to have more space available to them.

- Concessions and AVACON. There was a very strong relationship between the available Concessions for the passenger and the rating of Concessions. (See figure 5.L.6).

BOARDING LOUNGE

Correlations Of Two Variables

Fig 5.1.4

BOARDING LOUNGE

Correlations Of Two Variables

Fig 5.1.5

5.1.4 Preliminary Inspection Line (PIL)

5.1.4.1 Ottawa

The following tables present the breakdown of variables in the PIL area.

Table 5.4 Breakdown Of Variables : PIL Ottawa

Table 5.4 (a)

	SPACE	WAIT	SERV
SPACE	--	.3227 (59) P=.006	.3396 (59) P=.004
WAIT		--	.1813 (59) P=.085
SERV			--

Table 5.4 (b)

	NSAPP	STIME	WTIME
SPACE	-0.2415 (59) P=0.033	-0.1625 (59) P=0.109	-0.3228 (59) P=0.006
SERV	0.1255 (59) P=0.172	-0.0158 (59) P=0.453	-0.0583 (59) P=0.330
WAIT	-0.4133 (59) P=0.001	-.2390 (59) P=0.034	-0.6234 (59) P=0.000

Table 5.4 (c)

	TRIP	SIZE	SEX
SPACE	-.0591 (59) P=.328	-.2876 (59) P=.014	.1413 (59) P=.143
WAIT	.2035 (59) P=.061	.0030 (59) P=.491	-.1407 (59) P=.144
SERV	-.1880 (59) P=.077	.0299 (59) P=.411	-.0307 (59) P=.409
NSAPP	.0254 (59) P=.424	.2130 (59) P=.053	-.0923 (59) P=.243
STIME	.1765 (59) P=.091	.0885 (59) P=.252	-.0300 (59) P=.411
WTIME	.1010 (59) P=0.223	.1263 (59) P=.170	-.1809 (59) P=.085

Explained below are the variables which have have a relationship with each other, and each individual variable's effect on every other variable is discussed, as outlined in the above noted tables. Non significant variables are discussed in Appendix C.

i) TRIP: Trip purpose

- Trip and Size. There is a strong relationship between Trip purpose and the Size of the the party. Almost all the

people traveling on business were traveling alone. Those on a combined trip were, on the average, traveling with more than one companion. (See Figure 5.P.O.1).

- Trip and Sex. There is a relationship between Trip and the Sex of the respondent. Almost all the business persons were traveling alone.

- Trip and Space. There is no relationship between purpose of the Trip and the rating of Space.

- Trip and Wait. There is a weak relationship between Trip purpose and rate of Wait. People traveling on business rated Waiting lower than those people on non-business or combined trips.

- Trip and Service. There is a weak relationship between Trip and rate of Service. People on business rated Service higher than the people on non-business or combined trips.

- Trip and RSPACE. There is no relationship between purpose of the Trip and the ranking of Space.

- Trip and RWAIT. There is no relationship between purpose of Trip and the ranking of Wait.

- Trip and RSERV. There is no relationship between Trip purpose and the ranking of Service.

ii) SIZE: Size of Party

- Size and Space. There is a relationship between party

PIL OTTAWA **Correlations Of Two Variables**

FIGURE

BOARDING LOUNGE **Correlations Of Two Variables**

FIGURE

Size and the rate of Space. People traveling alone rated space higher than the people traveling in a group.

- Size and Wait. There is no relationship between Size of the party and the rate of Waiting Time.

- Size and Service. There is no relationship between the Size of the party and the rate of Service.

- Size and RSPACE. There is a strong correlation between Size and the rank of Space. People traveling alone ranked Space as their last choice.

- Size and RSERV. There is a correlation between party Size and RSERV. Except for the people traveling as a group of 5, everyone else ranked Service as their second choice. For the group of 5, RSERV was their third choice.

- Size and RSPACE. Here again, for people traveling in a group of 5, rank of Space was second, for all others, it was their third choice.

iii) SPACE: Rate of Space

- Space and Wait. Rate of Space and rate of Waiting are related to each other. The rate of Space goes higher as the rate of Wait goes higher, i.e. when Space goes from 1-7, the rate of Wait goes from 1-7.(See Figure 5.P.O.2).

- Space and Service. Here again, the rate of Space is related to rate of Service. If the rate of Space goes up, the rate of Service goes up and vice versa.(See Figure 5.P.O.3).

- Space and RSPACE. There is no correlation between the

PIL OTTAWA Correlations Of Two Variables

FIG 5 PC 3

PIL OTTAWA Correlations Of Two Variables

FIG 5 PC 2

rate of Space and the ranking of Space.

- Space and RWAIT. There is no correlation between the rate of Space and the ranking of Wait.

5.1.4.2 Toronto

Table 5.5 Breakdown Of Variables : PIL Toronto

Table 5.5 (a)

	SPACE	WAIT	SERV
SPACE	--	.6786 (88) P=.000	.4773 (88) P=.000
WAIT		--	.6466 (88) P=.000
SERV			--

Table 5.5 (b)

	NSAPP	STIME	WTIME
SPACE	0.2573 (88) P=0.008	-0.3196 (88) P=0.001	-0.3745 (88) P=0.000
SERV	0.2025 (88) P=0.029	-0.2186 (88) P=0.020	-0.2553 (88) P=0.008
WAIT	0.3680 (88) P=0.000	-.4384 (88) P=0.000	-0.4347 (88) P=0.000

Table 5.5 (c)

	TRIP	SIZE	SEX
SPACE	-.1269 (88) P=.119	-.2111 (88) P=.024	.1742 (88) P=.052
WAIT	-.2019 (88) P=.030	-.3411 (88) P=.001	.0734 (88) P=.248
SERV	-.1014 (88) P=.174	-.2080 (88) P=.026	.1813 (88) P=.045
NSAPP	-.1142 (88) P=.145	-.2376 (88) P=.013	.0789 (88) P=.233
STIME	.2030 (88) P=.029	.0865 (88) P=.211	-.0754 (88) P=.243
WTIME	.2208 (88) P=0.019	.1540 (88) P=.076	-.1230 (88) P=.127

Explained below are the variables which have have a relationship with each other, and each individual variable's effect on every other variable is discussed, as outlined in the above noted tables.

i) SPACE: Rate of Space

- Space and Wait. This relationship has been the strongest so far. It is positively related to each other i.e. if the rating of Space goes up, the rank of Wait goes up, and vice versa.(See Figure 5.P.T.1).

- Space and Service. There is a strong relationship

between rate of Space and Rate of Service. If the rate of Space goes up, the rate of Service goes up and vice versa.(See Figure 5.P.T.2).

- Space and RSPACE. There is a correlation between the rate of Space and the ranking of Space. To almost all of the passengers, rank of Space was the lowest.

- Space and RWAIT. The correlations are the same as RSPACE, but rank of Waiting Time is second to almost all of them.

- Space and RSERV. There is no significant relationship between the rate of Space and the ranking of Service.

ii) WAIT Rate of Wait

- Wait and Space. This relationship has been described earlier.

- Wait and Service. There is a very strong relationship between the rate of Wait and rate of Service. They are positively related i.e. as the rate of Wait goes up, the rate of Service goes up, and vice versa.(See Figure 5.P.T.3).

- Wait and RSPACE. There is a relationship between the rate of Wait and the rank of Space. As the rate of Waiting Time goes up, the rank of Space goes down.

- Wait and RWAIT. Rank of Wait has no relation with the rate of Wait.

- Wait and RSERV. There is no correlation between the rate of Waiting Time and the rank of Service.

PIL TORONTO Correlations Of Two Variables

FIGURE 1

PIL TORONTO Correlations Of Two Variables

FIGURE 2

PIL TORONTO Correlations Of Two Variables

FIGURE 13

iii) SERV: Rate of Service

- Service and Space. The correlation of these variables have been discussed earlier.

- Service and Wait. This variable has a very strong relationship. If the rate of Service goes up, the rate of Wait goes up and vice versa.

- Service and RSPACE. There is no relation between the rate of Service and the rank of Space.

- Service and RWAIT. There is no relation between the rate of Service and the rank of Waiting Time.

- Service and RSERV. The rank of Service has no relation to the rank of Service.

This concludes the analysis of selected variable and their relationship to each other, for each sub-system. As mentioned earlier, these analysis are of the variables which are of relatively important use and significance.

CHAPTER 6

DERIVATION OF COMPOSITE UTILITIES

6.1 Derivation of Utility Functions

This chapter will deal with the derivations of individual utilities for selected performance measures, for each subsection. These individual utilities could then be combined to produce composite utilities of the selected performance measure of each sub-component.

The utilities for each performance measure would be transformed from the perception measure of 1-7 to the utility level from 0 to 1, or (0 to 10 or 0 to 100). This would be achieved through the linear transformation concept of utilities, as described in the second chapter.

The utility axioms described in the second chapter illustrate the concept of the linear transformation of the utilities.

However, for the purpose of clarity, the concept of linear transformation is discussed briefly here with an illustration, as it deals with the concept of measurement.

6.2 Concept of Linear Transformations

Measurement in its broadest sense is the assignment of numbers to entities. The process of measurement has three aspects which should be distinguished at the outset. First is the

purpose of measurement, second is the process by which one measures something, i.e. assigns numerical values to some aspect of an entity, and the third is the arbitrariness, or uniqueness, of the set of numerical values inherent in the purpose and process.

Degree of Measurability

First the difference between monotone transformations and linear transformations would be explained. We shall begin with monotone transformations and then come to linear transformations via two of its special cases, additive and multiplicative constants.

The columns of Table 6.1 are sequences of numbers illustrating the concept of the "degree of measurability." The entities, some aspect of which we wish to measure, are denoted by letters.

Table 6.1

Entities	Alternative Measures of Utilities								
	1	2	3	4	5	6	7	8	9
A	1	2	6	11	2	6	5	6	3
B	2	4	7	12	4	12	7	10	7
C	3	5	8	13	6	18	9	14	13
D	4	8	9	14	8	24	11	18	21
E	5	11	10	15	10	30	13	22	31
F	7	14	12	17	14	42	17	30	43

We shall begin with monotone transformations and then come to linear transformations via two of its special cases, additive and multiplicative constants.

Monotone Transformations

Let there be assigned a numerical magnitude (measure) to each entity concerned. For example in Table 6.1, for the seven , A-F, listed in the extreme left-hand column, nine different sets of numbers are utilized to assign nine different numbers to each of the entities. If two sets of numbers (measures) result in the same ranking or ordering of the entities (according to the numbers assigned), then the two sets are monotone transformations of each other. In Table 6.1 it will be seen that all nine measures give the same ranking, thus all nine measures are monotone transformations of each other. If this property holds true over the entire class of entities concerned, then the two measures are monotone transformations of each other for that class of entities. The possible set of monotone transformations obviously is very large.

Linear Transformation: Additive Constants

We shall approach the linear transformation by considering two special forms. The numbers in column 3 are the same as those in 1 except that a constant has been added, in this case 5, i.e. they are the same "up to" (except for) an additive constant. The measure in column 4 is equivalent to that in column 1 with 10 added. Columns 1, 3 and 4 are transforms of each other "up to"

(by means of) additive constants. This can also be expressed by saying they are equivalent except for an additive constant. The term "up to" implies that we may go through some simpler types. For example, all the transforms up to an additive constant are also contained in the larger, less restricted class of possible transforms known as monotone transforms. An additive constant is a quite strong restriction, even though it may not seem so at first since there is an unlimited number of available constants.

Linear Transformations : Multiplicative Constants

Column 5 is equivalent to column 1 except for the multiplication by a constant, in this case 2. Column 5 is a monotone transform of column 1, and it is also a "multiplicative by a constant". Column 6 is multiplied by 6. Thus, while columns 1, 2 and 6 are monotone transforms of each other, they are also a more particular type of transforms. They are transforms up to a multiplicative constant.

Of greater significance, however, is the following attribute of linear transforms: if difference between numbers in one sequence increases (or decreases) from entity to entity, then the difference between the same entities in all of its linear transformations will also be increasing (or decreasing). Moreover, the property of increasing or decreasing increments is not affected by switching from one sequence of numbers to any linear transformation of that given sequence [18].

Now that the concept of linear transformation is established, this would be used to transform the perception of

passengers as stated in the questionnaire for the utility value.

These transformations are as follows:

Rating Scale	Utility Scale	Alternative Relative Value Scale
(1-7)	(0-1)	(0-100)
7	1.00	100
6	0.83	83
5	0.67	67
4	0.50	50
3	0.33	33
2	0.17	17
1	0.00	0

It means that if a passenger has assigned, say 6 in response to a question, the corresponding utility value would be 0.83. If a passenger has assigned 3 to a question, it would be transformed to 0.33 on a utility scale.

As indicated in earlier chapters, the measurement of the usage of the sub-system and the performance measures was done simultaneously, at the time of interview, that information would now be used to derive individual utilities of selected performance measures of each sub-system.

The detailed discussion of selected performance measures and their utilities would be discussed later; however, the general concept is explained here for the sake of clarity.

Suppose we wish to find out the utility of space. That would be calculated by assigning the reciprocal density of the

sub-system or the space available per person, at the time of interview. This information would be related to the passenger's response to the question of satisfaction of space on a scale of 1-7. The multiplication of the transformed value of 1-7 on a scale of 0-1, with the space available per person, at that particular instant, would yield the utility of space for that particular individual. A summation of all the individual utilities of all the passengers in the sub-system would yield the overall utility of space for the total number of passengers, experiencing the availability of space in that sub-system. The same method would be used for the calculation of overall utilities or other related performance measures.

Once the linear transformations have been accomplished, and individual utilities for each performance measure been calculated, then with the permission of axiom 5 of the utility theory, these utilities of each performance measure would be combined to produce the composite utilities of each sub-system, as perceived by the passengers.

6.3 Concept of Weighting

As indicated earlier, the independent utility function can be combined to provide composite utilities. This is a practical approach in the development of multiple attribute utility function, proceeding on the assumption that the utilities for each attribute are independent of the level of any other attribute. Attributes which are more closely related can be

blended together in order to develop useful multi-attribute utility functions.

In order to develop a multi-attribute utility function based on independent utility function for each attribute, it requires some sort of measurement of relative importance of each attribute, to the user.

There have been various studies on the concept of development of weighting schemes and weights to be attached to these independent utility functions, to derive a multi-attribute utility function. The background research to establish a weighting scheme for the derivation of multiple attribute utilities for this study, come up with a few techniques, used in various situations. These techniques suggest that the weights for individual utilities be assigned through some ordinal and cardinal ranking schemes.

Here the utility measures have been calculated and the actual preference of the users of the sub-system has been obtained through direct questions to the passengers. Hence it was decided to use the actual percentage of the responses for each preference as the weight assigned to each independent utility. The sum of the weights would be 100% of 1.

Here again SPSSX was used to run multiple regression analysis to provide the utility equations for each sub-section. The multiple regression analysis would yield the regression equations of the composite utilities of each sub-system, with the

performance measure for each sub-system.

This would enable the calculation of the composite utility of an airport user.

Discussed below are the individual, and composite utilities of selected performance measures for each sub-system. The equations for individual and composite utilities are also described here.

6.4 Utilities

6.4.1 Check-in

The performance measures selected for the sub-system were:

- i) space per person
- ii) waiting time in the queue
- iii) service time at the counter

The individual utilities of each of these performance measures is described below.

i) Space per Person

The utility of the space available per person would be calculated by first transforming the passengers' perception of the availability of space on the scale of 0-1, then multiplying it by the weight assigned to this performance measure and the actual space available per person at the particular instant of the interview.

The different space per person calculations were considered

3

for the derivation of utility of space. They are as follows:

- a) SAPPN Net space available per person, in the waiting line.
- b) TGSAPP Total gross space available per person in the check-in area. This includes the area for circulation also.
- c) TNSAPP Total net space available per person in the check-in area. It does not include circulation.

The best correlation of passenger perception of SPACE was obtained with SAPPN, net space available per person. Hence this variable was used to calculate the individual utility of space in the check-in area (see Figure 6.1).

The simple regression equation for this performance measure would be

$$USPACE = 2.44 + (0.1522) NSAPP$$

Where 2.44 is a constant.

The other statistics for this equation are:

$r = 0.4315$
 $F = 47.128$
 $\text{Sig of } F = 0.000$
 $DF = 206 \text{ for Residual}$
 $DF = 1 \text{ for Regression}$

This equation can be used to find out the individual utility of space for every respondent as he or she goes through the check-in sub-system.

ii) Waiting Time: WTIME

CHECKIN

Utility of Space

Fig 62

CHECKIN

Utility of Wait

Fig 63

The waiting time for each individual was calculated at the time of interview and it was used to find the utility of waiting time in the check-in area (see Figure 6.2).

The simple regression equation for this performance measure is

$$UWAIT = 60.044 + (-1.078) WTIME$$

Where 60.044 is a constant

The other statistics for this equation are:

$r = 0.5355$
 $F = 83.211$
 Sig of $F = 0.000$
 $DF = 207$ for Residual
 $DF = 1$ for Regression

This equation can be used to find out the individual utility of waiting time for every respondent as he or she goes through the check-in sub-system.

iii) Service Time: STIME

Service time at the counter for each passenger was calculated and was correlated with the passenger perception of service time (see Figure 6.3).

The method of assigning the waiting time per passenger and the service time for each passenger is explained in chapter 4.

The regression equation for this performance measure is

$$USERV = 21.648 + (-1.348) STIME$$

The other relevant statistics for this equation are:

$r = 0.2080$
 $F = 9.45$
 Sig of $F = 0.002$
 $DF = 209$ for Residual
 $DF = 1$ for Regression

This equation can be used to find out the individual utility of every respondent for the service time at the counter at check-in sub-system.

A computer programme was developed for the SPSSX to run the multiple regression analysis (see Appendix B). The program yields the following equation for the composite utility of the check-in area, using space, waiting time and service time as performance measures.

$$U_{\text{composite}} = 75.489 + (1.430) \text{ SAPPN} + (-0.864) \text{ WTIME} + (-1.30) \text{ STIME} \\ (3.32) \quad (-4.74) \quad (-0.36)$$

where 75.489 is constant.

The other relevant statistics for this equation are:

R = 0.5726
F = 33.001
Sig of F = 0.000
DF = 203 for Residual
DF = 3 for Regression

This equation can be used to find out the composite utility of every respondent as he or she goes through the check-in sub-system. This equation is valid only for this sub-system with the selected assumptions.

Appendix B contains the computer programme used for the determination of composite utilities for the check-in area, along with the details of the equation and comprehensive analysis.

6.4.2 Baggage Collection

CHECKIN

Utility of Service

Fig 63

BAGGAGE CLAIM

Utility of Space

Fig 64

The variables selected for this sub-system are:

- i) space
- ii) baggage collection time

i) Space

The calculation of space was done on basically the same principles as in the check-in area, except that here the space is referred to as the space available is the baggage claim area minus the space taken up by the carousel.

Here the variables created for the calculation of space were:

a) GSAPP Gross space available per person, including space for circulation

b) NSAPP Net space available per person. It does not included circulation and was calculated as described in chapter 4.

c) GSAPP 2 Gross space available per person, 2 minutes before the interview.

This information was calculated to infer whether the time spent in the interview process (approximately 2 minutes) changes the passenger's perception of space while the passenger was in the sub-system, to when the interview was completed.

d) NSAPP 2 Net space available per person 2 minutes before interview. It was calculated for the same reasons as for

space.

e) GSAPP 5 Gross space available per person 5 minutes before the interview time. Includes area for circulation. This information was calculated to find whether there was a correlation of passengers' perceptions to the conditions 5 minutes before the interview time.

f) NSAPP 5 Net space available per person 5 minutes before the interview. This information was calculated for the same reasons as GSAPP 5.

The analysis of the correlation yields the best correlation of rating of SPACE with NSAPP, at the time of interview, hence this variable was used to calculate the utility of space at the baggage collection (see Figure 6.4).

The Regression equation for the utility of space is

$$USPACE = 6.00 + (0.076) NSAPP$$

Where 6.00 is a constant.

The other relevant statistics for this equation are:

$$\begin{aligned} r &= 0.2737 \\ F &= 13.924 \\ \text{Sig of } F &= 0.000 \\ \text{DF} &= 172 \text{ for Residual} \\ \text{DF} &= 1 \text{ for Regression} \end{aligned}$$

ii) Waiting Time CTIME

Time spent in baggage collection was assigned to each passenger (explained in chapter 4). This variable was related with the rate of wait, to find the utility of waiting time in baggage collection (see Figure 6.5).

The individual utility for short baggage collection time is

$$UWAIT = 94.478 + (-3.605) CTIME$$

Where 94.478 is a constant.

The other relevant statistics for this equation are:

$$\begin{aligned} r &= 0.4329 \\ F &= 39.659 \\ \text{Sig of } F &= 0.000 \\ DF &= 172 \text{ for Residual} \\ DF &= 1 \text{ for Regression} \end{aligned}$$

This equation can be used to find out the individual utility of baggage collection time.

Multiple regression analysis was conducted for these variables to calculate the composite utility of the baggage claim area, using Net Space Available Per Person, NSAPP, and waiting time is collection Baggage, CTIME.

The following equation is derived for the baggage collection.

$$U \text{ composite} = 102.16 + (0.0024) NSAPP + (-3.732) CTIME \\ (0.009) \quad (-6.23)$$

Where 102.16 is a Constant.

The other relevant statistics for this equation are:

$$\begin{aligned} R &= 0.4407 \\ F &= 20.604 \\ \text{Sig of } F &= 0.000 \\ DF &= 171 \text{ for Residual} \\ DF &= 2 \text{ for Regression} \end{aligned}$$

This equation can be used to find out the composite utility of each respondent as he or she goes through the baggage

BAGGAGE CLAIM Utility of Wait

Figure

BOARDING LOUNGE Utility of Space

Figure

collection sub-system. For planning and analysis purposes, this equation can be used to estimate utility and therefore level of service for the processor.

Appendix B contains the computer programme used for the determination of composite utilities for the baggage claim area, along with the details of the equation and comprehensive analysis.

6.4.3 Boarding Lounge

The variables selected for this sub-system are as follows:

- i) space
- ii) Seat
- iii) Concessions

i) Space SPAPER

Space available per person was calculated to relate it with the passengers' rating of space. This space does not include the space occupied by seats and sofas. This space, however, does include the area for circulation. The rating of space was correlated with this variable to provide the utility of space for the boarding lounge area (see Figure 6.6).

The Regression equation for utility of space is

$$USPACE = 13.50 + (.013) SPAPER$$

Where 13.50 is a constant.

The other relevant statistics for this equation are:

$r = 0.037$
 $F = 0.063$
 Sig of $F = 0.801$
 $DF = 46$ for Residual
 $DF = 1$ for Regression

ii) Seat SEAPER

SEAT available per person was calculated at the time of interview (see chapter 4 for the methodology of calculation). This variable was then related to the passenger's perception of the availability of seats. This yielded the utility of the availability of the seats, to the passenger, is the boarding lounge area (see Figure 6.7).

Here $USEAT = 56.377 + (0.813) SEAPER$

Where 56.377 is a constant.

The other relevant statistics for this equation are:

$r = 0.1802$
 $F = 1.54$
 Sig of $F = 0.220$
 $DF = 46$ for Residual
 $DF = 1$ for Regression

iii) Concessions AVACONS

The actual availability of concessions was related to the passenger's perception of the availability of space. Available concessions were allocated to each respondent, as explained in chapter 4. Figure 6.8 provides the utility of the availability of concessions for passengers in the boarding lounge area.

The individual utility function for the concessions is

BOARDING LOUNGE

Utility of Seat

Fig 67

BOARDING LOUNGE

Utility of Concession

Fig 68

$$UCON = - 0.251 + 1.00 (AVACON)$$

Where -0.251 is a constant.

The other relevant statistics for this equation are:

$r = 0.4981$
 $F = 15.174$
 $\text{Sig of } F = 0.000$
 $DF = 46 \text{ for Residual}$
 $DF = 1 \text{ for Regression}$

This equation can be used to find out the individual utility of every respondent.

The composite utility of this sub-system would therefore be:

$$U \text{ composite} = 10.8 + 14.389 (AVACON) + 0.493 (SEAPER) + 0.833$$

(5.337)
(0.344)

(SPAPER)
 (1.461)

where 10.8 = constant

The other relevant statistics for this equation are:

$R = 0.646$
 $F = 10.556$
 $\text{Sig of } F = 0.000$
 $DF = 44 \text{ for Residual}$
 $DF = 3 \text{ for Regression}$

This equation would yield the composite utility of each individual, as the passenger perceives it, in the boarding lounge area, This equation can also be used to estimate the level of service of the processor.

Appendix B contains the computer programme used for the

determination of composite utilities for the boarding lounge area, along with the details of the equation and comprehensive analysis.

6.4.4 Preliminary Inspection Line

As stated earlier, some of the variables, which are essential for the utility assessment, could not be directly observed due to procedural, technical or otherwise limitation. Hence the PIL area had to be broken down for by the two airports - i.e. Ottawa and Toronto.

Therefore, the composite utilities for each of the airports will be discussed separately.

6.4.4.1 PIL Ottawa

The performance measures selected for this PIL sub-system for Ottawa are:

- i) Space
- i) Waiting time in the queue
- ii) Service time at the counter

i) Space Per Person

In order to relate the rating of space, as perceived by the passengers, with the actual space available per person, the following variables were calculated :

- a) NSAPP Net space available per person.

Net space available per person was calculated as the space available per person, at the time of interview in the PIL area per queue. This space does not include the circulation area.

ii) GSAPP Gross space available per person.

This variable was calculated to find the gross space available per person at the time of the interview. This variable includes the area for circulation, as well as area for waiting.

This variable was supposed to be used to relate to the passengers perception of space, so that the utility of space could be derived.

However, a strange phenomenon was observed here in terms of the correlation of the rate of space with the NSAPP. The relationship is a strongly correlated, but it is negative.

What it means is that the passengers perception of the availability of space per person was decreasing, as the amount of space available was increasing. This does not make logical sense.

The explanations of this phenomenon could be various and equally interesting. However, here are a few suggestions to explain this phenomenon.

i) The passengers did not understand the question at all.

This is not a very rational explanation in the sense that

why would all the passengers interviewed in all sub-sections respond in a manner which is concurrent to the theory of utility and rational behavior. One can expect this bizarre behavior from one or two persons in a group, not all of them.

Therefore, this idea of passengers not understanding the questions does not hold ground.

ii) Absence of the lower end of Rating of space

All the passengers interviewed rated the space question from 4 to 7. Since nobody rated space 1, 2 or 3, i.e. the bottom end of the spectrum, this might have been a contributing factor in the negative correlation of space and NSAPP.

iii) Reverse Claustrophobia

Another idea could be that, as opposed to other sub-sections like the check-in, baggage claim, or boarding lounge, where the passengers are exposed to space for a relatively longer period of time, perhaps, they are able to orient themselves to the amount of space available to them and hence provided rational values to the question of rating of space.

However, in the PIL area, the passengers usually come out from a cramped space of the interior of an aircraft, where they could have been sitting for as short a time as an hour to as long as 8-10 hours. So when they come out of the planes, they are overwhelmed by the amount of space and hence their perception is totally reversed, therefore providing a negative correlation.

All of the above ideas are an attempt to explain this abnormal behavior of passengers in the PIL area.

However, since the correlation of space with the NSAPP does not provide a logical explanation, consistent with the theory of utility, this variable was dropped for the derivation of composite utilities. (See Figure 6.9)

ii) Waiting Time WTIME

The waiting time for each passenger was calculated as the passengers went through the PIL queue, and this variable was used to correlate with the rating of wait, to calculate the utility of waiting time in the PIL area (see Figure 6.10).

The Regression equation for utility of Wait is

$$UWAIT = 93.97 + (-8.105) WTIME$$

where 93.97 is a constant.

The other statistics for this equation are:

$r = 0.6225$
 $F = 32.904$
 $\text{Sig of } F = 0.000$
 $DF = 52 \text{ for Residual}$
 $DF = 1 \text{ for Regression}$

This equation can be used to find out the individual utility of waiting time in the queue for every respondent as he or she goes through the PIL area.

iii) Service Time STIME

Service time was assigned to each passenger, as the

PIL OTTAWA Utility of Space

Fig 09

PIL OTTAWA Utility of Wait

Fig 010

passenger went through the PIL service counter. This variable was used to calculate the utility of service at the PIL area (see Figure 6.11).

The simple regression equation for this performance measure would be

$$\text{USERV} = 16.499 + (-0.139) \text{ STIME}$$

Where 16.499 is a constant.

The other statistics for this equation are:

$r = 0.0164$
 $F = 0.015$
 Sig of $F = 0.908$
 $DF = 57$ for Residual
 $DF = 1$ for Regression

The composite utility for this sub-system would then be the combined utility of wait and service time which is as follows:

$$\text{U composite} = 105.67 + 18.04 (\text{STIME}) + (-9.66) \text{ WTIME}$$

(1.36) (-5.54)

Where 105.67 is constant.

The other relevant statistics for this equation are:

$R = 0.635$
 $F = 17.261$
 Sig of $F = 0.000$
 $DF = 51$ for Residual
 $DF = 2$ for Regression

The +ive sign for STIME is not logical. This the programme generates unconstrained equations, it would be appropriate to use Ridge Regression Analysis to eliminate this problem since the independent variables are somewhat strongly correlated.

This equation would explain that the utility of the PIL sys-

PIL OTTAWA Utility of Service

Fig 6 11

PIL TORONTO Utility of Space

Fig 6 12

system using the service time and wait time as performance measures.

This equation describes the utility of a passenger as it was perceived at that time or the utility and level of service of the PIL processor.

The composite utility function derived from ottawa International Airport data is:

$$U \text{ composite} = 99.10 + (-0.269) \text{ NSAPP} + (-8.657) \text{ WTIME} + 24.717 \\ \quad \quad \quad (-1.30) \quad \quad \quad (-4.77) \\ \quad \quad \quad (\text{STIME}) \\ \quad \quad \quad (1.76)$$

where

$$99.10 = \text{constant}$$

The other relevant statistics for this equation are:

$$\begin{aligned} R &= 0.651 \\ F &= 12.26 \\ \text{Sig of } F &= 0.000 \\ \text{DF} &= 50 \text{ for Residual} \\ \text{DF} &= 3 \text{ for Regression} \end{aligned}$$

The equation for above would explain the utility of that sub-system, as experienced by a passenger or a group of passengers.

It should be noted here that the Ridge Regression Analysis may help eliminate the opposite signs for NSAPP and STIME as the independent variables are correlated and survey data results are difficult to explain (i.e. they are counter-intuitive).

Appendix B contains the computer programme used for the determination of composite utilities for the PIL (Ottawa) area, along with the details of the equation and comprehensive analysis.

6.4.4.2 PIL Toronto

The variables selected for this sub-system were:

- i) space per person
- ii) waiting time in queue
- iii) service time at the counter

i) Space

This variable of space available per person was used to calculate the utility of space for the passengers in the PIL sub-system.

- a) NSAPP Net space per person.

Net space per person was calculated as the space occupied per person in the PIL at the time of interview. However, the allocation of the space per person is only the average of the space per person at the time of interview, the reason being that since the passengers were not allowed to be interviewed at the very minute they had gone through the PIL, therefore, it made it almost impossible to relate the actual net space available to that passenger. Hence, the average net space per person at the time of interview was allocated to each passenger.

- b) GSAPP Gross space available per person. This variable

was calculated the same way as the NSAPP.

The analysis of the correlations provided a better correlation of the rating of space and the NSAPP. Here the variable was used to calculate the utility of space in PIL sub-system (see Figure 6.12).

The simple regression equation for this performance measure would be

$$USPACE = 2.33 + (0.0773) NSAPP$$

Where 2.33 is a constant.

The other statistics for this equation are:

$$\begin{aligned} r &= 0.2571 \\ F &= 6.088 \\ \text{Sig of } F &= 0.0156 \\ \text{DF} &= 86 \text{ for Residual} \\ \text{DF} &= 1 \text{ for Regression} \end{aligned}$$

This equation can be used to find out the individual utility of space for PIL Toronto.

iii) Waiting Time: WTIME

For the same reasons as for the calculation of space, the waiting time per passenger is the average of the waiting time at the time of interview. This variable, therefore, was used to calculate the utility of waiting time in the PIL area (see Figure 6.13).

The simple regression equation for this performance measure would be

$$UWAIT = 59.658 + (-1.354) WTIME$$

Where 59.658 is a constant.

The other statistics for this equation are:

$r = 0.4349$
 $F = 20.059$
 $\text{Sig of } F = 0.000$
 $DF = 86 \text{ for Residual}$
 $DF = 1 \text{ for Regression}$

This equation can be used to find out the individual utility of waiting time.

iii) Service Time: STIMEM

Service time was allocated on the same basis as NSAPP and WTIME. Service time was calculated in seconds as well as minutes. Both gave the same correlations.

This variable was used to calculate the utility of service time in the PIL area (see Figure 6.14).

The simple regression equation for this performance measure would be

$$\text{USERV} = 34.156 + (-6.755) \text{ STIME}$$

Where 34.156 is a constant.

The other statistics for this equation are:

$R = 0.2173$
 $F = 4.262$
 $\text{Sig of } F = 0.042$
 $DF = 86 \text{ for Residual}$
 $DF = 1 \text{ for Regression}$

This equation can be used to find out the individual utility

PIL TORONTO Utility of Wait

Fig 6.13

PIL TORONTO Utility of Service

Fig 6.14

of service for every respondent as he or she goes through the PIL area.

The multiple regression of these variables with each other yielded the following equation for the composite utility of the PIL area in Toronto.

$$U \text{ composite} = 93.70 + 1.855 \text{ (NSAPP)} + (-22.38) \text{ STIMEM} + (-0.786) \text{ WTIME} \\ (2.61) \quad (-1.84) \quad (-1.4)$$

Where 93.70 is a constant.

The other relevant statistics for this equation are:

R = 0.51
F = 9.97
Sig of F = 0.000
DF = 84 for Residual
DF = 3 for Regression

This equation would yield the utility of the sub-system, as experienced by the passenger or a group of passengers in the PIL area of Toronto.

Appendix B contains the computer programme used for the determination of composite utilities for the PIL (Toronto) area, along with the details of the equation and comprehensive analysis.

This concludes the derivation of the composite utilities of each subsystem as perceived by the passengers, or users, consistent with the utility theories.

6.5 Application of the Utility Equations.

The utility equations for each sub-system can now be used to calculate the composite utilities of each sub-system . This can be achieved by assigning certain values to each of the individual utility function under ideal condition (LOS A) to the breakdown condition (LOS F).

The assignment of these values could be based on the recommended standards, space standards in the case of the utility of space, as practiced or followed by various airport authorities, or could be based on the individual judgment of an airport planner, or both. Where the standards for other performance measures , such as service time standards or waiting time standards, do not exist or are not very clear, then the level of service range from LOS A to LOS F could be defined based on the experimental evidence. For the purpose of illustration, utility functions for all the processors have been created here, so that this concept could be incorporated for their use in the planning and designing for the passenger terminals of an airport.

The composite utility functions for each sub-system were calculated by using the composite utility equations for each sub-system. The values for each performance measures level of service range (LOS A to LOSF) were calculated and then these values were incorporated in composite utility equations for each processor.

It must be noted here that the values for each performance measures' level of service range was either directly transplanted from the existing standards, followed by various airport authorities, where ever they were available. For certain

BAGGAGE CLAIM

Composite Utility

Fig 6 10

CHECKIN

Composite Utility

Fig 6 16

performance measure values, where there is no existing guideline or standards, the results from this research were used.

Explained below is an sample calculation for the computation of the composite utility function.

The composite utility function for check-in is

$$UCOMP = 75.49 + 1.43 \text{ SAPPN} - 0.86 \text{ WTIME} - 1.30 \text{ STIME}$$

The values for the performance measures are as follows:

Check-in: Ottawa and Toronto

	<u>SAPPN</u>	<u>STIME</u>	<u>WTIME</u>	<u>UTILITY</u>
LOS A	2.5 m	1.0 min	2.0 min	76.60
LOS B	2.0 m	3.0 min	5.0 min	70.15
LOS C	1.5 m	5.0 min	15.0 min	58.94
LOS D	1.0 m	7.0 min	30.0 min	42.02
LOS E	0.5 m	10.0 min	40.0 min	28.80

These values when computed according to the composite utility function would yield the utility for the check-in area. (see Figure 6.15)

The composite utility function for PIL Toronto is

$$UCOMP = 93.70 + 1.855 (\text{NSAPP}) - 22.38 (\text{STIME}) - 0.786 (\text{WITME})$$

PIL Toronto

	<u>NSAPP</u>	<u>STIME</u>	<u>WTIME</u>	<u>UTILITY</u>
LOS A	2.0 m	0.5 min	2.0 min	84.60
LOS B	1.5 m	1.0 min	5.0 min	70.17
LOS C	1.00 m	1.5 min	8.0 min	55.69
LOS D	0.75 m	2.0 min	12.0 min	40.89
LOS E	0.5 m	2.5 min	15.0 min	26.88

BOARDING LOUNGE Composite Utility

Fig 6 17

PIL TORONTO Composite Utility

Fig 6 18

These values produce a composite utility for the PIl Toronto area. (see Figure 6.18)

Similarly, composite utility functions for the baggage claim (see Figure 6.16) and boarding lounge processors have been developed. (see Figure 6.17).

It has been clearly demonstrated above that these utility functions could be developed by obtain the individual utilities of the performance measures and then combining together to obtain a composite utility for each performance measures.

CONCLUSION AND RECOMMENDATIONS

7.1 Summary and Conclusions

Research on the level of service criteria and standards for the design and evaluation of existing and proposed landside facilities has so far lacked to consider and take into account one of the most relevant elements in landside design process i.e. the user perception of the criteria and standards.

The space /service standards applied so far in the planning and design process have usually arbitrarily been selected and applied, mainly due to the genuine lack of knowledge of user perception of these standards and criteria, and perhaps the simplicity of dealing with real numbers than dealing with human reactions. This approach is no longer valid nor recommended, especially when the users of these facilities also happen to be paying for these facilities too.

In this thesis research, level of service criteria based on the concept of utility of the performance measures, as perceived by the airport users, in conjunction with the existing space/service standards, have been calculated and established for each of the studied sub system of an airport, i.e. check-in, baggage claim, boarding lounge and preliminary inspection line area.

Various performance measures for each processor of an airport were analyzed, the user value (or utility) of these

performance measures directly assessed through attitudinal surveys, and the individual as well as composite utility equations have been calculated.

The conclusions of this research could be categorized as follows:

1. This thesis research has proposed a utility theoretic approach to the estimation and the calculation of the utility or the user perceived values for the level of service criteria and standards for the landside subsystem, and the establishment of corresponding density or volume indices and the space/service standards.

2. Using the utility theoretic approach, this thesis has clearly demonstrated that user perceptions of these facilities should be integral while planning and designing an existing or proposed landside facility, and must be taken into account.

3. The level of service framework, based on LOS A to LOS F as proposed and used by Transport Canada is the most appropriate to use for airport landside facilities, as it provides the most suitable gradations encompassing the best to the worst levels of facility operation. This research has provided a scientific basis for this framework by using the principles of utility theory.

4. The rationale, methodology and technique to obtain user perceptions of the performance measures at different sub systems have been described and have also been demonstrated in this

thesis. Also the practical, operational and the technical difficulties encountered at the various processors at Ottawa and Toronto airports have been documented.

5. The user value, or utility, for each subsystem has been calculated. This includes the individual utility of each performance measure, as perceived by a user, or a group of users, and also the composite utility of each processor as it serves the users. These utility equations could be used to determine the level of service of the existing facilities as well as to predict the level of service for the proposed facilities.

6. The individual and composite utility equations computed in this thesis for the four processors, i.e., check-in, baggage claim, boarding lounge and preliminary inspection line, are valid for these processors. Given all the logistics and otherwise operational difficulties, these equations are a true reflection of the user perceived values of these subsystems.

7. The data gathered in this thesis have been obtained by humans, about humans and of humans, hence the expectations of perfect relationship among numerous known and unknown variables may not be prudent. The margin of error in information gathering is human error.

8. The necessity to study the interrelationship of the level of service, density or volume indices and space/service standards has been established in this thesis. In response to the technological developments, operational innovations, world wide

trends towards deregulation of air transport industry, and the requirement to increase processing rates and throughput of the landside facilities, the estimation of level of service criteria based on the utility theoretic approach as proposed, demonstrated and proved in this thesis, is the next logical step in airport landside facilities design and planning.

7.3 Recommendations

Needless to say that this thesis research has practically demonstrated the necessity, methodology and the technique to estimate the landside level of service using the utility theoretic approach . However, this is just the first step in this new direction. Comprehensive data acquisition is required all around the world to substantiate the individual and composite utility curves for the various processors so that a data base could be established, which eventually may lead to an airport landside capacity manual, on lines of the Highway Capacity Manual, which is followed by the highway authorities in Canada. More specific recommendations are as follows:

1. The existing Level of Service criteria should be revised in light of what has been demonstrated in this thesis.
2. Level of Service A-F is most appropriate framework to be used in planning and design of airport facilities.
3. It is recommended that the provision of space must not be the only criterion while designing airport facilities.
4. The Airlines should be aware of the fact that

passengers are very sensitive towards service time at the counter and waiting time in the queue. Excess time spent on either of these activities may result in passenger dissatisfaction.

5. Airport planners should also consider a trade-off between various performance measures, which would result in an increased utility of a sub-system.

6. Further experimental studies are needed at both the Ottawa and Toronto International airports to verify the data obtained and the utility curves and equation drawn from the data.

7. Similar studies could be carried out at other international airports, especially in Canada, to obtain more information and data points for these utility equations and curves.

8. The survey questionnaire could be refined to obtain any perceptive information, which may have been neglected in the used survey questionnaire.

9. A detailed study in the survey design itself may provide a better set of data points for this kind of research.

10. The application of this methodology of utility theoretic estimation of levels of service for airport landside while developed in conjunction with the Artificial intelligence computer programmes might enable to measure and analyse this nature of data, more swiftly and efficiently.

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GLOSSARY

AIRCRAFT OPERATION. Aircraft departure from or arrival at an airport; takeoffs and landings. Airside facilities must serve all operations (including those of general aviation), whereas landside activity is typically related only to departures or arrivals of commercial service aircraft.

AIRSIDE. Airport facilities associated with aircraft movement to transport passengers and cargo, used primarily for landing and take-off, for example, runways, taxiways, and ATC facilities. The airside may overlap the airspace at ends of runways.

AIRSIDE CAPACITY. See Capacity (airside).

ANALYSIS PERIOD. Specified period of time, typically a peak period, used for analysis of landside capacity. Choice of period depends on functional components considered and demand characteristics.

BAGGAGE SERVICES. Processing of passengers' checked baggage. Included are destination tagging, movement to baggage room, sorting, movement to and from aircraft, loading and unloading, and delivery to baggage claim display device. Interline transfer, storage, and delivery may be included.

CAPACITY (LANDSIDE). As defined in this study, capability of the landside or its functional components to accommodate passengers, cargo, ground transport vehicles, and aircraft. Service volume is the principal indicator of landside capacity in this report.

CHECK-IN. Initial step in passenger processing, involving passenger contact with the airline immediately before flight departure. It may include ticket inspection, issuance of boarding pass and seat assignment, baggage checking, ticketing, and preliminary inspection of immigration documents and may occur at ticket counter or gate area. To speed processing, some steps may be completed in advance of passenger arrival at the airport.

CROWDING. Density of people in airport waiting areas, or number of people per unit area. Those accompanying departing passengers or greeting arrivals may be included as well as passenger themselves.

DELAY. For the airside, added time spent in accomplishing an aircraft operation because of airport congestion, or the difference between time required under constrained conditions caused by simultaneous demands on the facility and time required under unconstrained conditions. Landside delay is the added time required for a passenger to complete processing at a functional component because of limits to capacity. Wait time and processing time are included. Acceptable delay depends on type of service being delivered, demand characteristics, and local conditions at an airport.

DEMAND CHARACTERISTIC. Number of air passengers and aspects of their behavior that materially affect the ability of a functional component or group of components to accommodate them. Such factors as the timing of passenger arrivals at the airport, age,

trip purpose, fare paid, baggage carried or checked, and whether passenger has a ticket and boarding pass are often important. Airlines often try to tailor their services to their passengers' demand characteristics.

FUNCTIONAL COMPONENT. Element of the landside such as a gate or ticket counter that provides specific service to air passengers or cargo. Functional components unable to meet demand characteristics and maintain adequate service levels may become limits to capacity.

GATE. Terminal portal for passengers to enter and exit aircraft. The term is commonly used to mean a loading bridge-equipped entry adjacent to a holdroom, but may include entry to a transporter or directly onto an apron. It sometimes includes the hardstand.

HOLDROOM. Passenger waiting area adjacent to gate. The term is also used to refer to other passenger waiting areas such as that for immigration or baggage claim devices.

LANDSIDE. Facilities and services associated with air passengers or cargo movement between aircraft and trip origin or destination. The landside includes aprons, gates, terminals, cargo storage areas, parking, and ground access.

LANDSIDE CAPACITY. See Capacity (landside).

MAXIMUM THROUGHPUT. Maximum rate at which passengers (or aircraft, ground transport vehicles, pieces of baggage, tons of cargo, etc.) can be processed by a functional component or group

of components. In practice this rate is observed only when demand equals or exceeds a component's processing capability, and is typically sustained only for brief periods, because excess demand usually produces significant delays and crowding.

PASSENGER CIRCULATION AREA. Corridor, stairway, escalator, or moving walkway connecting processing components, generally only in a terminal.

PEAK PERIOD. Time period, which may be one hour, several hours, or one day, representative of busy conditions within a functional component. It is typically defined from historical records by frequency of occurrence.

RAMP. Aircraft parking position, often used to refer to gate parking positions.

SERVICE LEVEL. The quality and conditions of service of a functional component or group of components as experienced by passengers. Such factors as delay, crowding, and availability of passenger amenities for comfort and convenience measure service level.

SERVICE-LEVEL TARGET. Minimum or maximum tolerable service level during a particular analysis period established by airport operator, airlines, the FAA, and the community to guide decision making.

SERVICE TIME. Time required, excluding waiting time, to process a passenger at a functional component such as a ticket counter or

passenger security screening facility.

SERVICE VOLUME. Number of passengers (or aircraft, ground transport vehicles, etc.) with particular demand characteristics that can be accommodated by a functional component or group of components during an analysis period at a given service level.

TERMINAL. Building with facilities for passenger processing and boarding of aircraft or groups of such buildings (unit terminals, often used by a single airline) within a terminal area. Terminals are often classified into four configurations by the system used for horizontal movement of passengers: linear, pier, satellite, and transporter.

USER. Broadly understood to include passengers, airlines, cargo shippers, concessionaires, and others who use airport landside facilities and services. In this report, passengers are the principal users, and are served by airlines and airport operations.

APPENDIX A

CARLETON UNIVERSITY

Passenger Survey at Airport Terminal Building: Check-in Area

Sir/Madam:

We are conducting a survey of level of service. Could you please answer a few questions?

What is the purpose of this trip? * Are you travelling alone? If not,
 * number of persons in your party?
 Business _____ Non-business _____
 Combined _____ * Alone _____ Party size _____
 *

Flight number? _____ * Male _____ Female _____
 *

On a scale of 1 to 7, one being extremely dissatisfied and 7 being extremely satisfied, how do you rate the amount of space available to you in the check-in area?

	1	2	3	4	5	6	7
Extremely							Extremely
dissatisfied							satisfied

On a scale of 1 to 7, how do you rate waiting time before reaching the service counter? One being waiting too long in the queue and 7 being no waiting at all.

	1	2	3	4	5	6	7
Waiting time too long							No waiting at all

Once you reached the counter, how quick was the service on a scale of 1 to 7? One being extremely slow and 7 being extremely quick.

	1	2	3	4	5	6	7
Extremely slow							Extremely quick

Among the following three service factors, please tell me which is the most important and which is the second?

Space available to you _____ Short waiting time in the queue _____

Quick service at the counter _____

Time: _____ Date: _____ Airport _____ No. _____

CARLETON UNIVERSITY

Passenger Survey at Airport Terminal Building: Baggage Collection Area

Sir/Madam:

We are conducting a survey of level of service. Could you please answer a few questions?

What is the purpose of this trip? * Are you travelling alone? If not,
 * number of persons in your party?
 Business ____ Non-business ____
 *
 Combined ____ Alone ____ Party size ____
 *

Flight number? _____ * Male _____ Female _____
 *

On a scale of 1 to 7, one being extremely dissatisfied and 7 being extremely satisfied, how do rate the amount of space available to you in the baggage claim area?

1	2	3	4	5	6	7
Extremely						Extremely
dissatisfied						satisfied

On a scale of 1 to 7, how do you rate the amount of time spent in collecting your baggage? One being too much time and 7 being very little time.

1	2	3	4	5	6	7
Too much time						Very little time

Between the following two service factors, please tell me which is most important?

Space available to you _____ Short time in collecting bags _____

Time: _____ Date: _____ Airport _____

Questionnaire No. _____

CARLETON UNIVERSITY

Passenger Survey at Airport Terminal Building: Boarding Lounge Area

Sir/Madam:

We are conducting a survey of level of service. Could you please answer a few questions?

What is the purpose of this trip? * Are you travelling alone? If not,
* number of persons in your party?

Business ____ Non-business ____
Combined ____ Alone ____ Party size ____

Flight number? ____ * Male ____ Female ____

On a scale of 1 to 7, one being extremely dissatisfied and 7 being
extremely satisfied, how do you rate the amount of space available to you
in the boarding lounge area?

1	2	3	4	5	6	7
Extremely dissatisfied						Extremely satisfied

On a scale of 1 to 7, how do you rate the availability of a seat in the
boarding lounge area? One being extremely dissatisfied and 7 being
extremely satisfied.

1	2	3	4	5	6	7
Extremely dissatisfied						Extremely satisfied

On a scale of 1 to 7, how do you rate the availability of concessions type
of services, one being extremely dissatisfied and 7 being extremely
satisfied?

1	2	3	4	5	6	7
Extremely dissatisfied						Extremely satisfied

What additional concession type of services would you like to see?

Among the following three service factors, please tell me which is the most
important and which is the second?

Space available to you ____ Seat available to you ____

Concession type of services ____

Time: ____ Date: ____ Airport ____ No. ____

Passenger Survey at Airport Terminal Building: PIL Area

Sir/Madam:

We are conducting a survey of level of service. Could you please answer a few questions?

What is the purpose of this trip? * Are you travelling alone? If not,
* number of persons in your party?
Business _____ Non-business _____
*
Combined _____ * Alone _____ Party size _____
*

Flight number? _____ * Male _____ Female _____
*

On a scale of 1 to 7, one being extremely dissatisfied and 7 being extremely satisfied, how do you rate the amount of space available to you in the immigration/customs (PIL) area?

1	2	3	4	5	6	7
Extremely						Extremely
dissatisfied						satisfied

On a scale of 1 to 7, how do you rate waiting time before reaching the service counter? One being waiting too long in the queue and 7 being no waiting at all.

1	2	3	4	5	6	7
Waiting time too long						No waiting at all

Once you reached the counter, how quick was the service on a scale of 1 to 7? One being extremely slow and 7 being extremely quick.

1	2	3	4	5	6	7
Extremely slow						Extremely quick

Among the following three service factors, please tell me which is the most important and which is the second?

Space available to you _____ Short waiting time in the queue _____

Quick service at the counter _____

Time: _____ Date: _____ Airport _____ No. _____

APPENDIX B

Appendix B contains the the computer programs developed for the detailed and comprehensive analysis of all the four sub-systems studied for this research. This Appendix also Contains the the complete description of all the variables as they were used in the analysis. Since the volume of the thesis does not permit to include all the analysis for all the four processors studied for this theis, therefore, the detailed analysis for the Check-in sub-system have been included in this appendix for the purpose of illustration. For the rest of the three processors, only the final outputs for the individual and composite utilites are included.

Check-in**Description of Variables used in the Computer Analysis.**

VARIABLES	DESCRIPTION
ID	Identification Number
DATE	Date of Survey
APOINT	Name of Airport
TIME	Time of Interview
FLIGHT	Flight Number
TRIP	Trip Purpose
SIZE	Size of Party
SEX	Sex of Respondant
SPACE	Rating of Space
WAIT	Rating of Wait in Queue
SERV	Rating of Service at Counter
RSPACE	Ranking of Space
RWAIT	Ranking of Wait
RSERV	Ranking of Service
NPER	No. of Persons in queue at Interview Time
TNPER	Net Space Available per Person
TGSAPP	Total Gross Space Available per Person
TNSAPP	Total Net Space Available per Person
STIME	Time Spent at Service Counter
WTIME	Time Spent Waiting in Queue

 REGRESSION *****
 Equation Number 1 Dependent Variable.. USACE

Variables in the Equation									
Variable	B	CI B	95% Confidence Interval B	Beta	CI Beta	Correl Part Cor	Partial	Tolerance	
SAPPN	.153202	.023171	.108491	.431412	.072854	.421489	.431489	1.000000	4.845
(Constant)	-.44312		-.161463						16.949

 Variable 'SAPPN'
 SAPPN .0000
 (Constant) .0000

End Block Number 1 All requested variables entered.

Summary Table

Step	Multiple R	Adjusted R Square	F	df1	df2	Sig.	Variable	Partial Correl	Change in R Square
1	.4315	.1863	4.118	1	106	.0431	SAPPN	.4314	.1863

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*** MULTIPLE REGRESSION ***

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. UNAIT

Designated Block Number 1. Method: Enter WTIME

Variable(s) Entered on Step Number 1.. WTIME WAITING TIME IN QUEUE IN MINUTES

Multiple R .5547
R Square .30773
Adjusted R Square .28428
Standard Error 22.6471

R Square Change .30773
F Change 81.1197
Signif F Change .0000

Analysis of Variance
Regression 1 207 106068.75054
Residual 1 106068.75054
Total 2 207 212137.50108

Mean Square
47618.19442
512.40701

Condition Number: 1.000 1.000

Var Covar Matrix of Regression Coefficients (b)
Below Diagonal: Covariance Above: Correlation

WTIME
WTIME .01590

XIX Matrix:

	WTIME	UNAIT
WTIME	1.00000	.5547
UNAIT	.5547	.7132

22 AUG 89 00:49:21 22 AUG 89 00:49:21 Release 2.1 for Honeywell CP-6
 Calculation: HONEYWELL

Equation Number 1 Dependent Variable.. UVAL

Variable	B	CI B	95% Confidence Interval B	Std. Err. of Beta	Control Part for	Partial Tolerance	P
UVAL	1.078572	.118730	1.311677	.053476	.535470	1.000000	9.122
(Constant)	50.044606	2.379076	55.454460	64.744913			25.239

10
 Variable C14
 UVAL
 (Constant) .0000
 .0000

End Block Number 1 All requested variables entered.

Summary Table

Step	Multi	R-sq	Adjusted R-sq	F Value	Prob > F	R-sqch	Fth	Prob > Fth	Variable	Partial Tolerance	Control	Waiting Time in Hour in MINU
1	.5355	.2867	.2813	83.212	.000	.2867	83.212	.000	UVAL	.5355	.5355	

22 AUG 89 09:59 X Release 2.1 for Moneyswell CP-6 CP-6
00:49:21 Carleton University Moneyswell 1.54 SECONDS ELAPSED.

PRECALCULATED RESULTS .54 SECONDS CPU TIME:
14.000 16 0 REGRESSION VARIABLES=USERV STIME/
14.100 17 8 STALLS=0.000/
14.200 18 0 STALLS=0.000/
14.300 19 0 ENTER STIME/
THERE ARE 19976 WORDS OF MEMORY AVAILABLE.
THE TASKS:1 (LIMITED) AREA HAS 19844 WORDS.
387 words of memory requested for REGRESSION plots.
0 extra words can be needed for Residuals plots.

AUG 89 SF55-X Release 2.1 for Honeywell (P-6
47172 Carleton University Honeywell P-6

***** MULTIPLE REGRESSION *****

twice deletion of Missing Data

ation Number 1 Dependent Variable.. USERV

ation Number 1. Method: Inter STIME

table(s) entered on Star Number 1.. STIME SERVICE TIME AT COUNTER IN MINUTES.

Multiple R	.99000	Adjusted R Square	.94516	Sum of Squares	Mean Square
Adjusted R Square	.94516	Standard Error	7.45063	Regression	127.75648
Standard Error	3.67677		.0074	Residual	13.51831
				Total	140.27480

dition: number bounds: 1.000, 1.000

Cover Matrix of Regression Coefficients, (b)
on Diagonal: Covariance Above: Correlation

STIME

MS .19235

Matrix

	STIME	USERV
ME	1.00000	.20000
KV	.20000	.71174

2, AUG 89 SPSS X Release 2.1 for Honeywell CP-6
 00:49:33 California University CP 6

***** MULTIPLE REGRESSION *****
 Equation Number 1 Dependent Variable: USFRV

----- Variables in the Equation

Variable	B	SE B	95% Confidence Interval	Beta	SE Beta	Current Part for	Partial Tolerance	T
TIME	1.340265	.438576	2.212865	.207995	.067657	.207995	.207995	3.074
(Constant)	11.640117	1.106451	19.467003					19.565

Variable	Size
TIME	.0024
(Constant)	.0000

Model Number 1 All requested variables entered.

Summary Table

Step	Model	R	Adjusted R	F	df1	df2	Prob > F	Variable	Retain	Current	Service Time at Counter in MI
1	1	.2080	.0433	9.451	1	99	.003	TIME	.2080	.2080	

11 AUG 69 2155 X Release 2.1 for Honeywell CP 6
17:01:00 6.01 Com. Utilities CP 6

***** H U L T I P L E R E G R E S S I O N * * * * *

Equation Number 1 Dependent Variable: UCONE

Variable	B	SE B	75% Confidence Interval	Ratio of Prob.	Partial Cor	Partial Tolerance
CAFFN	2.852300	.375300	2.112553	.000001	.000001	.000000
(Constant)	24.41064	2.412064	18.045017	.000001	.000001	.000000

Variables not in the Equation

Variable	Ratio	Partial Tolerance	Min. Toler	F Stat
UTIME	.492187	.378223	.000001	.0000
(Constant)	.194289	.000000	.000000	.0000

Eq. Plot Number 1 All requested variables entered.

Dependent Plot Number 2. R Ratio: Enter UTIME

Variable(s) Entered on Step Number 2. UTIME WAITING TIME IN QUEUE IN MINUTES

Multiple R	R Square Change	Adjusted R Square	Standard Error
.57210	.32730	.32730	.375300
.57210	.32730	.32730	.375300
.57210	.32730	.32730	.375300

Condition number: 1.507, 4.030

Var. Covar Matrix of Regression Coefficients (E)
Below Diagonal: Covariance Above: Correlation

CAFFN	UTIME
.10430	.50075
.03924	.02474

Analysis of Variance	Sum of Squares
Regression	57155.43078
Residual	101523.57067
Total	158679.00145

49883.5713
595.850

11 AUG 67 SPSS X Release 2.1 for Honeywell CP 6 CP 6
17:01:58 2.1.1 Com. Univ. of Ill. Honeywell

*** MULTIPLE REGRESSION ***

Equation Number 1 Dependent Variable.. UCORP

XIX Matrix..

	CAPFN	WTIME	UCORP	CTIME
CAPFN	1.00000	.00000	.00000	.00000
WTIME	.00000	1.00000	.00000	.00000
UCORP	.00000	.00000	1.00000	.00000
CTIME	.00000	.00000	.00000	1.00000

Statistics on the Function

Variable	R	SE B	95% Confidence Interval	Beta	SE Beta	Entered Part Cor	Partial	Tolerance	F
CAPFN	1.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	1.00000
WTIME	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	1.00000
(Constant)	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	1.00000

in

Statistics on the Equation

Variable	Sum of Squares	df	Mean Square	F	Sig.
CAPFN	.00000	1	.00000	.00000	.00000
WTIME	.00000	1	.00000	.00000	.00000
(Constant)	.00000	1	.00000	.00000	.00000

End Block Number 2 All computed variables entered.

11 AUG 68
1730153
Cable from Dallas, TX
Re: Release 2.1 for Howell Cr 2
Howell

[illegible]

CONTRACT NUMBER: 1
PERIODICITY: Quarterly
PAYMENT METHOD: By check

THIS STATE TIME AT COUNT IN MINUTES

Multiple R	Adjusted R Square	Standard Error	Mean Square	Sum of Squares	df	F	Significance
.770	.730	1.170	1.369	1.369	1	13.010	.000

1400 1511 1512

Year Cows: H-1-1: of Reservoir Cut Effects (F)
Bottom Water: C-1: same Abol. Correlation.

SAPPH	WTIME	CTIME
.18528	.19979	.02494
.01001	.03116	.19248
.03995	.15671	12.16688

XLX Mat: i:

	CATH	WTMC	CTMC	WOMP
CATH	1.51027	.55518	.92708	.34893
WTMC	.65518	2.01103	.91546	.36363
CTMC	.03708	.01773	1.00000	.03333
WOMP	.34893	.36363	.03333	1.00000

ID	1.0000 (.0)	.8473 (.0)	.8292 (.0)	.3334 (.0)	.3084 (.0)	.314
DATE	.8473 (.0)	1.0000 (.0)	.8111 (.0)	.3243 (.0)	.3257 (.0)	.314
APORT	.8202 (.0)	.8111 (.0)	.8000 (.0)	.3143 (.0)	.3143 (.0)	.314
TIME	.3143 (.0)	.3143 (.0)	.3143 (.0)	.3143 (.0)	.3143 (.0)	.314
FLIGHT	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.000
TRIP	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.000
SIZE	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.0000 (.0)	.000

254

SEX	.0000 (.0)	.2450 (.0)	.1944 (.0)	.0132 (.0)	.1005 (.0)	.000
SPACE	.0000 (.0)	.1157 (.0)	.0578 (.0)	.0489 (.0)	.0214 (.0)	.000
WAIT	.0000 (.0)	.1356 (.0)	.0576 (.0)	.0393 (.0)	.0058 (.0)	.000
RESV	.0000 (.0)	.0276 (.0)	.1211 (.0)	.0144 (.0)	.1060 (.0)	.000
RSPACE	.0000 (.0)	.0984 (.0)	.1104 (.0)	.0187 (.0)	.0160 (.0)	.000
RWAIT	.0000 (.0)	.0155 (.0)	.0151 (.0)	.0039 (.0)	.0174 (.0)	.000
RRESV	.0000 (.0)	.0773 (.0)	.1264 (.0)	.0446 (.0)	.0105 (.0)	.000
NPER	.7107 (.0)	.4940 (.0)	.8244 (.0)	.2500 (.0)	.0174 (.0)	.000
SAPPN	.3745 (.0)	.1938 (.0)	.0040 (.0)	.1000 (.0)	.0250 (.0)	.000
TNPER	.6677 (.0)	.4228 (.0)	.9106 (.0)	.0284 (.0)	.0003 (.0)	.000
TGSAPP	.1930 (.0)	.0215 (.0)	.4584 (.0)	.3015 (.0)	.1208 (.0)	.000
TNSAPP	.1902 (.0)	.0228 (.0)	.4553 (.0)	.3006 (.0)	.1250 (.0)	.000
WTIME	.3457 (.0)	.6673 (.0)	.7531 (.0)	.1117 (.0)	.0007 (.0)	.000
STIME	.0000 (.0)	.3473 (.0)	.5074 (.0)	.0773 (.0)	.0106 (.0)	.000

(COEFFICIENT / (CASES) / 1-TAILED 910)

* * * IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED

ID	-1.1902 (.212) P=.000	.8457 (.212) P=.000	.4594 (.212) P=.000
DATE	.0228 (.212) P=.000	.0573 (.212) P=.000	.5473 (.212) P=.000
APORT	-.4753 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
TIME	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
CLIGHT	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
TEMP	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
CEFF	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
CEV	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000

TEMP	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
WAVE	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
SEFF	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
SPACE	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
RWAIT	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
RSERV	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
NPER	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
SAPPN	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
TNFER	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
TGAPP	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
TNSAPP	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
WTIME	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000
ETIME	.0000 (.212) P=.000	.0000 (.212) P=.000	.0000 (.212) P=.000

COEFFICIENT (RATED) IS RATED 1.0

IF A COEFFICIENT CANNOT BE COMPUTED

BAGGAGE CLAIM**Description of Variables used in the Computer Analysis.**

VARIABLES	DESCRIPTION
ID	Identification Number
DATE	Date of Survey
APORT	Name of Airport
TIME	Time of Interview
FLIGHT	Flight Number
TRIP	Trip Purpose
SIZE	Size of Party
SEX	Sex of Respondant
SPACE	Rating of Space
WAIT	Rating of Wait in Queue
RSPACE	Ranking of Space
NPER	No. of Persons in Baggage Claim at Interview Time
GSAPP	Gross Space Available per Person
NSAPP	Net Space Available per Person
NPER2	No. of Persons in Baggage Claim 2 Minutes before Interview Time
GSAPP2	Gross Space per Person 2 Minutes before Interview
NSAPP2	Net Space per Person 2 Minutes before Interview

[illegible]

***** MULTIPLE REGRESSION *****

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. UCOMP
 Beginning Block Number 1. Method: Enter NSAPP

Variable(s) Entered on Step Number 1.. NSAPP NET SPACE AVAILABLE PER PERSON

Multiple R	.10447	R Square Change	.01091	Analysis of Variance	DF	Sum of Squares	Mean Square
R Square	.01091	F Change	1.89806	Regression	1	1683.29162	1683.29162
Adjusted R Square	.00516	Signif F Change	.1701	Residual	172	152537.75257	886.84740
Standard Error	29.77998			F		Signif F	.1701

Condition number bounds: 1.000, 1.000

Var-Covar Matrix of Regression Coefficients (B)
 Below Diagonal: Covariance Above: Correlation
 NSAPP

NSAPP .09275

XTX Matrix

	NSAPP	UCOMP	CTIME
NSAPP	1.00000	-.10447	.23577
UCOMP	.10447	.98909	-.41603
CTIME	-.23577	-.41603	.94441

11 AUG 89 SPSS-X Release 2.1 for Honeywell CP-6 CP-6
 16:57:30 Carleton University
 *** MULTIPLE REGRESSION ***
 Equation Number 1 Dependent Variable.. UCOMP

Variables in the Equation									
Variable	B	SE B	95% Confidence Interval B	Beta	SE Beta	Correl Part	Part Cor	Partial	Tolerance
NSAFF	.419576	.304547	-181556 1.020707	.104474	.075832	.104474	.104474	.104474	1.000000
(Constant)	63.417300	2.764242	57.961095 68.873505						

Variables not in the Equation									
Variable	Sig T	Variable	Beta In	Partial Tolerance	Min Toler	T	Sig T		
NSAFF	.1701	CTIME	-.440521	-.430457	.944411	-.6.236	.0000		
(Constant)	.0000								

End Block Number 1 All requested variables entered.

Beginning Block Number 2. Method: Enter CTIME

Variables Entered on Step Number 2.. CTIME									
TIME SPENT IN DATABASE COLLECTION IN MINU									
Multiple R	.44047	R Square Change	.18327	Analysis of Variance	DF	Sum of Squares	Mean Square		
R Square	.19419	F Change	38.89155	Regression	2	29947.55540	14973.77770		
Adjusted R Square	.18474	Sig. Change	.0000	Residual	171	124273.49099	726.74556		
Standard Error	24.95022			F		20.60388	Sig. F	.0000	

Condition number bounds: 1.059, 4.235

Var-Covar Matrix of Regression Coefficients (B)
 Below Diagonal: Covariance Above: Correlation
 NSAFF CTIME

11 AUG 89 SPSS-X Release 2.1 for Honeywell CP-6 CP-6
 16:57:38 Carleton University Honeywell

*** MULTIPLE REGRESSION ***

Equation Number 1 Dependent Variable.. UCOMP

XIX Matrix

	MSAPP	CTIME	UCOMP
MSAPP	1.05884	.24965	-6.11E-04
CTIME	.24965	1.05884	.44052
UCOMP	6.105E-04	.44052	.80581

--- Variables in the Equation ---

Variable	B	SE B	95% Confidence Interval	Beta	SE Beta	Correl Part	Partial Cor	Partial Tolerance	T
MSAPP	.002452	.283488	-.557530	6.105E-04	.070638	.104474	.000593	.000661	.944411
CTIME	-3.732944	.598582	-4.914504	-.440521	.070638	-.440665	-.428102	.430457	.944411
(Constant)	102.116174	6.690946	88.908689	115.323659					
									.009
									-6.236
									15.262

--- in ---

Variable Sig F

MSAPP .9931

CTIME .0000

(Constant) .0000

End Block Number 2 All requested variables entered.

11 AUG 89 SPSS-X Release 2.1 for Honeywell CP-6 CP-6
14127130 Carleton University Honeywell

*** MULTIPLE REGRESSION ***

Equation Number 1 Dependent Variable.. UCOMP

Summary Table

Step	MultiR	Rsq	AdjRsq	F(Eqn)	SigF	RsqCh	FCh	SigCh	In:	Variable	Deteln	Correl	NET SPACE AVAILABLE PER PERSON TIME SPENT IN BAGGAGE COLLECT
1	.1045	.0109	.0052	1.898	.170	.0109	1.898	.170	In:	NSAPP	.1045	.1045	
2	.4407	.1942	.1848	20.404	.000	.1833	38.892	.000	In:	CTIME	.4403	-.4407	

[illegible]

22 AUG 89 5P55 X Release 2.1 for Honeywell CP-6
 00:40:30 Carleton University Honeywell CP-6

* * * * * M U L T I P L E R E G R E S S I O N * * * * *

Equation Number 1 Dependent Variable.. USACE

Variables in the Equation				
Variable	B	SE B	95% Confidence Interval B	Initial Tolerance
MSAPP	.076137	.020403	.035864	.273669
(Constant)	.001052	.185192	-.185192	.273669
				.073330
				.273669
				1.000000
				3.732
				32.404

Variable Sig 1
 MSAPP .0003
 (Constant) .0000

End Block Number 1 All requested variables entered.

* * * * *

Summary table

Step	Multiple R	Rsq	Adjusted Rsq	F (lon)	Sig	RsqCh	FCh SigCh	Variable In: MSAPP	Variable Out: MSAPP	Corrected Total	Corrected Total	Net Change Available for Person
1	.2737	.0749	.0695	13.925	.000	.0749	13.925	.000		.2737	.2737	

22 AUG 89 SFSS X Release 2.1 for Huneyswell CP-6
 00:48:10 Carleton University Huneyswell CP-6

***** MULTIPLE REGRESSION *****

Equation Number 1 Dependent Variable.. UNAI

End Block Number 1 All requested variables entered.

Summary table

Step	MultiR	Rsq	AdjRsq	F(Eqn)	SigF	RsqCh	FCh SigCh	In: Variable	Ret:Ln	Correl	TIME SPENT IN PACKAGE COLLECT
1	.4329	.1874	.1827	39.660	.000	.1874	39.660 .000	TIME	.4329	-.4329	

Description of Variables used in the Computer Analysis.

VARIABLES	DESCRIPTION
ID	Identification Number
DATE	Date of Survey
APOINT	Name of Airport
TIME	Time of Interview
FLIGHT	Flight Number
TRIP	Trip Purpose
SIZE	Size of Party
SEX	Sex of Respondant
SPACE	Rating of Space
SEAT	Rating of Availability of Seats
CONCESS	Rating of Availabilty of Concessions
RSPACE	Ranking of Space
RSEAT	Ranking of Seat
RCON	Ranking of Concessions
NSEAT	NO. of Seats in Boarding Lounge
NPER	No. of Persons in Boarding Lounge at Interview Time
SPAPER	Space Available per Person
SEAPER	No. of Seats Available per Person
ADDCON	Desire for Additional Concessions
SERTIME	Dwell time in Boarding Lounge
AVACON	Available Concessions


```

11 AUG 89 SPSS-X Release 2.1 for Honeywell CP-6      Honeywell
14:59:05 Carleton University

SSSSSS PPPPPPPP SSSSSS SSSSSS XX XX 1
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 11
SS SS PP PP SS SSSSSSSS XX XX 111
SSSSSSSSSS PPPPPPPP SS SSSSSSSS == == 111
SSSSSSSSSS PPPPPPPP SS SSSSSSSS == == 111
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 11
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 11
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 111
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 111
SSSSSSSSSS PPPPPPPP SS SSSSSSSS XX XX 111

SPSS-X for CP-6 Carleton University License Number 332

2.000 1 0 GET FILE=SYSNOR
FILE CALLED SYSNOR.PA080395 :
LABEL:
CREATED 07 AUG 89 22:27:09 21 VARIABLES

3.000 2 0 RECODE SPACE (1=0.00)(2=0.17)(3=0.33)(4=0.50)(5=0.67)(6=0.83)(7=1.00) INTO USPACE
4.000 3 0 RECODE SEAT (1=0.00)(2=0.17)(3=0.33)(4=0.50)(5=0.67)(6=0.83)(7=1.00) INTO USEAT
5.000 4 0 RECODE COMESS (1=0.00)(2=0.17)(3=0.33)(4=0.50)(5=0.67)(6=0.83)(7=1.00) INTO UCOMESS
6.000 5 0 COMPUTE UCONF=(UCON * 6.4) + (USEAT * 76.6) + (USPACE * 17.0)
7.000 6 0 REGRESSION VARIABLES=UCONF SEAPER AVACOM SPATER/STATISTICS ALL/DEPENDENT=UCONF/
8.000 7 0
9.000 8 0
10.000 9 0 ENTER AVACOM/ENTER SEAPER/ENTER SPATER/
11.000 10 0
12.000 11 0
13.000 12 0
13.000 13 0

THERE ARE 19660 WORDS OF MEMORY AVAILABLE.
THE LARGEST CONTIGUOUS AREA HAS 19594 WORDS.

533 words of memory required for REGRESSION procedure.
0 more words may be needed for Residuals plots.
```

Question Number 1 Dependent Variable.. UCOMP
 * * * * * M U L T I P L E R E G R E S S I O N * * * * *

Variables in the Equation									
Variable	B	SE B	95% Confidence Interval B	Beta	SE Beta	Correl Part	Cor	Partial	Tolerance
UCOM	14.389698	2.496464	8.955332 19.824064	.690835	.129454	.485691	.613485	.626835	.788605
AVCOM	.493063	1.432679	-2.394311 3.380437	.093482	.271628	.125668	.09564	.051814	.179120
APER	.033513	.576384	-.316025 1.983051	.00020	.265528	.183558	.167991	.215142	.187444
constant)	10.801625	12.259968	-13.904717 35.511968						

----- in -----

Variable	Sig F
UCOM	.0000
APER	.7324
APER	.1510
constant)	.1830

Block Number 3 All requested variables entered.

* * * * *

Summary table

Dep	NullR	Rsq	Adj.Rsq	F(Fnn)	SigF	RsqCh	FCh	SigCh	Variable	Detail	Correl
1	.4857	.2359	.2193	14.701	.000	.2359	14.201	.000	AVACOM	.4857	.4857
2	.6247	.3903	.3632	14.402	.000	.1544	11.394	.002	SEAPER	.4424	.1257
3	.6449	.4185	.3789	10.556	.000	.0282	2.135	.151	SPAPER	.3880	.1836

SEAT AVAILABLE PER PERSON
 SPACER AVAILABLE PER PERSON

11 AUG 87 0900 Release 2.1 for Honeywell CP 6
 17:01:58 Simulation Statistics Honeywell CP 6

*** MULTIPLE REGRESSION ***
 Caution Number 1 Dependent Variable... UCONF

Variables in the Equation									
Variable	B	SE B	95% Confidence Interval	Beta	St Beta	Correl Part	Cor	Partial	Tolerance
CAPPN	1.430331	.430447	1.501610	.234952	.020712	.498201	.181210	.222126	.662089
WTIME	.824032	.181740	1.222770	.337732	.001602	.539082	.273274	.316213	.497250
STIME	1.305771	3.420410	0.420408	.025524	.071120	.332201	.020707	.025249	.654555
(Constant)	75.497147	31.571032	53.306370						

170

Variable	Std F
CAPPN	.0011
WTIME	.0000
STIME	.7192
(Constant)	.0000

End Block Number 3 All requested variables entered.

Summary table

Step	Model R	Adj R	Delta R	F (Full)	Std F	R-sqCh	FCh	StdCh	Int	Variable	Retain	Correl
1	.4693	.3274	.3124	27.872	.600	.000	22.892	.000	.4693	CAPPN	.4693	.3373
2	.5722	.3273	.3208	49.747	.000	.000	22.504	.000	.4622	WTIME	.4622	.3373
3	.5722	.3273	.3179	33.601	.000	.0004	.120	.719	.0252	STIME	.0252	

STAFF AVAILABLE PER PERSON
 WAITING TIME IN QUEUE IN HOURS
 SERVICE TIME AT COUNTER IN MI

4

OF/DE

4

METRO

PRELIMINARY INSPECTION LINE (PIL), OTTAWA

Description of Variables used in the Computer Analysis.

VARIABLES	DESCRIPTION
ID	Identification Number
DATE	Date of Survey
APOINT	Name of Airport
TIME	Time of Interview
FLIGHT	Flight Number
TRIP	Trip Purpose
SIZE	Size of Party
SEX	Sex of Respondent
SPACE	Rating of Space
WAIT	Rating of Wait in Queue
SERV	Rating of Service at Counter
RSPACE	Ranking of Space
RWAIT	Ranking of Wait
RSERV	Ranking of Service
NPER	No. of Persons in queue at Interview Time
NPER2	No. of Persons in queue 2 Minutes before Interview Time
GSAPP	Gross Space Available per Person
NSAPP	Net Space Available per Person
STIME	Time Spent at Service Counter
WTIME	Time Spent Waiting in Queue
NSPRL	Net Space per Person at Red Line

[illegible]

22 AUG 89 SPSS X Release 2.1 for Honeywell CP-6 CP-6
00:50:11 Hamilton University Honeywell

***** MULTIPLE REGRESSION *****
 Equation Number 1 Dependent Variable.. USACE

Variable	B	SE B	95% Confidence Interval B	Beta	% Beta	Tol	F	Partial	Interance
MSAPP	-.005115	.002728	-.010579 3.47725E-04	-.241029	.128540	.241029	.241029	.241029	1.000000
(Constant)	1.517246	.044524	1.428404 1.606807						

----- in -----
 Variable Sig 1
 MSAPP .0659
 (Constant) .0000

End Block Number 1 All requested variables entered.

***** SUMMARY TABLE *****

Step	Model	R	Adjusted R	F (Egn)	Std	RsqCh	1th SigCh	Variable	Retain	Correl
1	.2410	.0581	.0416	3.516	.066	.0581	3.516 .066	MSAPP	.2410	-.2410

CP 2

CP 2

CP 2

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CP 2

22 AUG 68 0900 A RELEASE 2.1 FOR HOMER, 11 CP 2
 00150134 Corleton University Homestead EP 6
 RECEIVING 100. 8100110 100 SECONDS CPU TIME 1.15 SECONDS ELAPSED
 14.000 14 0 REGRESSION VARIABLES-USERV STIMUL
 14.100 14 0 STATISTICS ALL
 14.200 14 0 DEPENDENT-USERV
 14.300 14 0 ENTER STIMUL
 THERE ARE 10000 WORDS OF MEMORY AVAILABLE.
 THE TARGET CONTINUOUS AREA HAS 10044 WORDS.
 200 words of memory required for REGRESSION procedure.
 0 more words may be needed for residuals plots.

CP 2
 CP 2
 CP 2

***** MULTIPLE REGRESSION *****

Constant Number 1 Dependent Variable: USGDP

Variables in the Equation

Variable	B	df	SS	Mean Square	F	df1	df2	Significance	Partial	Tolerance
USGDP	.122410	1	.000431	.000431	2.000000	1	1	.1574	.012410	1.000000
(Constant)	12.311177	1	.000754	.000754	17.931200	1	1	.0000		

in

Variable

USGDP

(Constant)

End Block Number 1 All requested variables entered.

Summary Table

Step	Model	R	Adjusted R	Sum of Squares	Mean Square	F	df1	df2	Significance	Variable	Partial	Correlation	Service Time in Minutes
1	.0124	.0003	.0003	.0124	.0124	2.0000	1	1	.1574	USGDP	.0124	.0124	

PRELIMINARY INSPECTION LINE (PIL), TORONTO**Description of Variables used in the Computer Analysis.**

VARIABLES	DESCRIPTION
ID	Identification Number
DATE	Date of Survey
APORT	Name of Airport
TIME	Time of Interview
FLIGHT	Flight Number
TRIP	Trip Purpose
SIZE	Size of Party
SEX	Sex of Respondent
SPACE	Rating of Space
WAIT	Rating of Wait in Queue
SERV	Rating of Service at Counter
RSPACE	Ranking of Space
RWAIT	Ranking of Wait
RSERV	Ranking of Service
NPER	No. of Persons in queue at Interview Time
NSAPP	Net Space Available per Person
GSAPP	Total Gross Space Available per Person
STIME	Time Spent at Service Counter
WTIME	Time Spent Waiting in Queue

22 AUG 69 1055 A Release 2.1 for Homosapien CP 3
00:17:15 (Con) Con Rate Data Homosapien 11

* * * * * H U L T I P L I F I C A T I O N S * * * * *

Function Name : 1 Constant Variables: USPACE

Variables in the function

Variable	B	CC B	95% Confidence Interval B	Beta	SE Beta	Corrected Part Var	Partial	Tolerance	F
MSAFF	.077152	.031350	.015013	.139278	.057107	.001122	.001122	1.000000	13.482
(Constant)	.130528	.142120	2.010071	.6221042	.104267	.001122	.001122	1.000000	13.482

20

Variable Std 1
MSAFF .0152
(Constant) .0000

End Block Number 1 All requested variables entered.

* *

Summary Table

Step	Multiple	R ²	Adjusted R ²	F (full)	Std F	K-Sch	FCh S-Kch	Int	MSAFF	Variable Beta	Correl
1	.2571	.0241	.0553	2.600	.012	.0241	2.088	.012	MSAFF	.0011	.0571

22 APR 69 SPSS X Release 2.1 for Honeywell CP-6 CP-6
00:49:14 Calculation: Honeywell

***** B U L T I P L E R E G R E S S I O N *****
Equation Number: 1 Dependent Variable: URA11

Variables in the Equation									
Variable	B	SE B	75% Confidence Interval	Beta	GL Beta	Correl Part	Partial	Tolerance	F
UTIME	1.354616	.302459	1.855804	.434092	.097102	.434092	.434092	1.000000	4.428
(Constant)	57.650240	3.429977	52.039479	62.474817					17.393

16
Variable Size
UTIME .02
(Constant) .000

End Block Number: 1 All requested variables entered.

Summary table									
Step	Multiple R	Adjusted R	F (F _{max})	Sig F	R _{adj} Ch	F Ch Sig Ch	Variable	Partial Correl	
1	.4349	.1091	.1797	.000	.1091	.20.059	UTIME	.4349	.4349

23 AUG 69 1969 X Release 2-1 for Homewell CP 2
00:47:10 Prediction Homewell

CP 2

*** MULTIPLE REGRESSION ***

Equation Number: 1 Dependent Variable: USFRV

Variables in the Equation

Variable	B	SE B	75% Confidence Interval B	SE Beta	Beta	SE Beta	Correl Part	Cor	Partial	Tolerance	F
STIMEH	5.75082	3.272342	13.221200	.250779	.217300	.105254	.217300	.217300	.217300	1.000000	13.923
(Constant)	44.15092	2.041002	30.057210	38.251983							13.523

16

Variable: STIMEH
STIMEH
(Constant) .0000

End Block Number: 1 All requested variables entered.

Summary Table

Step	Multiple R	R Sq	Adjusted R Sq	F (F-Test)	Prob	R-adj	FCH	SumCh	In1	Variable	Partial	Correl	SERVICE TIME IN MINUTES
1	.2173	.0472	.0341	4.222	.042	.0472	4.222	.042		STIMEH	.2173	.2173	

APPENDIX C

Appendix C contains the correlation of the variables which were found not to be significant or their relationship to each other was not used in the calculation of the individual or the composite utilites. These variables are explained for each subsystem.

Check-in

i) TRIP: Purpose of the Trip

- Trip and Size. The purpose of the Trip had no significant correlation with the Size of the party.

- Trip and Sex. Trip purpose had no significant correlation with the Sex of the respondent.

- Trip and Space. The purpose of the Trip had no significant correlation with the rating of Space.

- Trip and Wait. Trip purpose had no significant correlation with the rate of Wait.

- Trip and Serv. Trip purpose had no correlation with the rate of Service.

- Trip and RSpace. Trip purpose had no effect on the ranking of Space.

- Trip and RWait. Trip purpose had no effect on the ranking of Wait.

- Trip and RServ. Trip purpose had no effect on the

ranking of service.

(ii) SIZE: Size of the Party

- Size and Trip. Size of the party had no relation to the Trip.

- Size and Sex. Size of the party had no relation to the Sex of the respondent.

- Size and Space. Size of the party had no effect on the rating of Space.

- Size and Wait. Size of the party had no effect on rating of Wait.

- Size and Service. Size of the party had no effect on the rating of Service.

- Size and RSpace. Size of the party had no effect at all on the ranking of Space.

- Size and RWait. Size of the party had no effect on the ranking of Waiting.

- Size and RServ. Size of the party had no effect on the ranking of Service.

(iii) SEX: Sex of the Respondent

- Sex and Space. Sex of the respondent had no effect on the rating of Space.

- Sex and Wait. Sex of the respondent had no effect on the rating of Wait.

- Sex and Service. Sex of the respondent had no effect on the rating of Service.

- Sex and RSpace. Sex of the respondent had no effect on the ranking of Space.

- Sex and RWait. Sex of the respondent had no effect on the ranking of Wait.

- Sex and RServ. Sex of the respondent had no effect on the ranking of service.

Baggage Claim

i) TRIP: Purpose of Trip

- Trip and Sex. There was no relation between the Trip purpose and the Sex of the respondent.

- Trip and Size. There was no relation between the Trip purpose and the rating of Size.

- Trip and Space. There was no relation between the Trip purpose and the rating of Space.

- Trip and Wait. There was no relation between the Trip purpose and the rating of Wait.

- Trip and RSpace. There is no relation between the

purpose of the Trip and the ranking of Space. This means that the ranking of Space or the ranking of Wait was independent of the purpose of the Trip.

Boarding Lounge

i) SEX: Sex of the Respondent

- Sex and Size. There was no relation between the Sex of the respondent and the rating of Size.

- Sex and Space. There was no relation between the Sex of the respondent and the rating of Space.

- Sex and Wait. The rate of Wait was independent of the Sex of the respondent.

- Sex and RSpace. The ranking of Space and the ranking of Wait was independent of the Sex of the respondent.

ii) SIZE: Size of the Party

- Size and Space. The Size of the party does not have any correlation with rating of space.

- Size and Seat. There is no correlation between the Size of the party and the rating of Seat.

- Size and Concessions. There is no correlation between the Size of the party and the rating of Concessions.

- Size and RCON. There is a very weak relationship between the Size of the party and the ranking of Concessions. Single travelers ranked Concessions lower than that of people traveling in a group of two or more.

- Size and RSEAT. There is a weak relationship between the Size of the party and the Ranking of Seat. People traveling alone ranked the availability of Seat higher than the people traveling in a group.

- Size and RSPACE. There is absolutely no significance and relationship between the Size of the party and the ranking of Space.

- Size and ADDCON. There is no relationship between the Size of the party and additional Concessions.

iii) WAIT: Rate of Wait

- Space and Wait. This relationship has been explained earlier.

- Wait and Service. There is a very weak correlation between the rate of Wait and the rate of Service.

- Wait and RSPACE. There is no correlation between rate of Waiting Time and rank of Space.

- Wait and RWAIT. There is a correlation between the rating of Wait and the ranking of Waiting Time. To those who were extremely satisfied, or close to it, with Wait RWAIT was second. For others, it was most important.

- Wait and RSERV. There is no correlation between the rating of Wait and the ranking of Service.

iv) SERV: Rate of Service

- Service and Space. This relationship has been described already.

- Service and Wait. This relationship has been described already.

- Service and RSPACE. There is no correlation between the rating of Service and ranking of Space.

- Service and RWAIT. There is no correlation between the rating of Service and ranking of Waiting Time.

- Service and RSERV. The rate of Service was totally independent of the rank of Service.

PIL

i) TRIP: Purpose of Trip

- Trip and Size. There is no significant relationship between purpose of Trip and Size of party.

- Trip and Sex. There is a weak relationship between Trip purpose and Sex of the respondent. Almost all of the people traveling on business were male.

- Trip and Space. There is no relationship between Trip purpose and the rate of Space.

- Trip and Wait. Business travelers rated Wait higher than

the non-business or combined trips.

- Trip and Service. There is no relation between purpose of Trip and the rating of Service.

- Trip and RSPACE. There is no relation between purpose of Trip and the ranking of Space.

- Trip and RWAIT. The purpose of the Trip is not related at all to the rank of Waiting Time.

- Trip RSERV. There is no correlation between purpose of Trip and ranking of Service.

ii) SIZE: Size of Party

- Size and Space. There is a very weak relationship between party size and the rate of Space. The people traveling alone rated space higher than the people traveling in the group.

- Size and Wait. There is a relationship between party Size and the rate of Wait. People traveling alone rate Waiting Time higher than people traveling in a group of 2 or more.

- Size and Service. There is a weak correlation between Size and the rate of Service. People traveling alone rated Service higher than those who traveled in a group of 2 or more.

- Size and RSPACE. There is no relationship between Size of party and rank of Space.

- Size and RSERV. There is no relationship between Size of party and the rank of Service.

- Size and RWAIT. There is no relationship between Size of party and the rank of Waiting Time.

END

1 9/0 2/9 1

FIN