The effects of mode perceptions on intercity mode-choice behavior in Saudi Arabia

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Civil Engineering

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Abstract

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For the purpose of testing the effects of mode perceptions, multinomial logit mode choice models were calibrated for business trips as well as social/recreational trips. The data required for calibrating the models was obtained through a survey of all major intercity cooridors in the Kingdom considering air, bus and private auto modes. The perceptual scales were confirmed by subjecting the main survey data to factor analysis. The calibration process involved two stages. First, mode-choice models were calibrated, excluding the perceptual variables and next, perceptual variables were incorporated into the previously developed models to study their effect.

Among the four perceptual concepts used in the study, the perception of mode comfort was found to significantly affect the choice of the travellers for business as well as social/recreational trips. Perception of mode convenience was significant for business trips only.

It was concluded from the study that the inclusion of these variables resulted in a statistically significant but marginal improvement in the explanation of the mode choice behavior. Because of the difficulty and cost in obtaining the mode perceptions, it is therefore, recommended not to included these variables in planning stages. However, they could be quite useful in identifying deficiencies of the intercity modes as perceived by travelers and therefore could help operators in improving their services.

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THE EFFECTS OF MODE PERCEPTIONS ON INTERCITY MODE-CHOICE BEHAVIOR IN SAUDI ARABIA

BY

MOHAMMAD ALI AL-SUGHAIYER

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DOCTOR OF PHILOSOPHY

In

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DEDICATION

This dissertation is dedicated to my ***loving parents***,

my ***wife*** and ***children***.

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DISSERTATION ABSTRACT

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DOCTOR OF PHILOSOPHY DEGREE

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
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خلاصة الرسالة

اسم الطالـــــب : محمد علي حسين الصغير

عنوان الرســـالة : تأثير المتغيرات الحسية في سلوك المسافرين عند إختيـــار وسيلة السفر بين مدن المملكة العربية السعودية

التخصـــــــص : هندسة مدنية

تاريخ الشـهادة : اكتوبر ١٩٩٤م .

إن الطريقة التقليدية للتنبؤ بإختيار المسافر لوسيلة السفر تعتمد إعتماداً قوياً على زمن وتكلفة الرحلة . ورغم أن هذين المتغيرين مهمان إلا أنهما قد لايكونان كافيين لتمثيل سلوك المسافرين عند إختيار وسيلة السفر ولذا فقد يحتاج مخططو النقل إلى الأخذ بعين الإعتبار إنطباع المسافرين عن وسائل السفر عند تطوير النماذج الرياضية اللازمة للتنبؤ باختيار وسيلة السفر .

إن الهدف الرئيسي لهذا البحث هو التحقق من تأثير إدخال المتغيرات الحسية في بناء النماذج الرياضية المتعلقة بإختيار وسيلة السفر بين المدن في المملكة العربية السعودية . ولتحقيق هذا الهدف تم أولاً تطوير وإختيار مقاييس لقياس إدراكية المسافرين لخصوصية وسيلة السفر وملائمتها وراحتها وإمكانية الإعتماد عليها باستخدام طريقة العامل التحليلي من خلال مسح إستطلاعي . ومن أجل إختبار المتغيرات الحسية فقد تم تطوير نماذج رياضية لوغارثمية متعددة الحدود لكل من رحلات العمل والرحلات السياحية والإجتماعية ، وقد تم الحصول على المعلومات المطلوبه لتطوير النماذج الرياضية عن طريق إستبيانات صمّمت خصيصاً لهذا الغرض ووزعت على المسافرين بالطائرة وبالحافلة وبالسيارة الخاصة بين المدن الرئيسة في المملكة ، وقد تم مطابقة المقاييس الحسية وذلك بعرض معلومات المسح الرئيس للمعامل التحليلي . وتم إستخدام تلك المعلومات في تطوير نماذج إختيار وسيلة النقل على مرحلتين : في الأولى تم تطوير نماذج بدون المتغيرات الحسية أما في الثانيه فقد تم دراسة تأثير إدخال المتغيرات الإدراكية للنماذج المطورة .

من أهم نتائج هذه الدراسة أن لراحة المركبة أثر هام في إختيار المسافر

لوسيلة السفر في رحلات العمل والرحلات السياحية والإجتماعية وأما ملائمة وسيلة السفر فلها أثر هام في إختيار وسيلة السفر في رحلات العمل فقط . ومن نتائج هذا البحث أيضاً أن تضمن نماذج إختيار وسائل السفرلهذه المتغيرات كان مهماً إحصائياً ولكن التحسن في التنبؤ بإختيار المسافر لوسيلة السفر كان طفيفاً . ونظراً للمصاعب والتكاليف في إيجاد المتغيرات الحسية فقد أوصي بعدم إدخال هذه المتغيرات في الطور التخطيطي رغم أن هذه المتغيرات قد تكون مفيدة لمشغلي وسائل السفر من أجل تحسين خدماتهم وذلك بتحديد القصور في وسائل السفر كما يدركه المسافرون .

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Chapter 1

INTRODUCTION

1.1 OVERVIEW

The evolution of transportation engineering started before the Second World War when planners attempted to study travel patterns of inter-urban trips. During that period the focus of the researchers was on the improvement of the engineering characteristics of existing transportation systems, such as street capacity, traffic signals, etc. After the Second World War, until the 1950's, origin-destination surveys were conducted to gain information about urban activities, in order to understand travel patterns.

Since the 1950's rapid development in mathematical tools for the analysis of transportation demand has occurred and transportation planning has become a complex task that requires the joint effort of many parties: such as transportation planners, city planners, economists, system analysts, psychologists and sociologists.

During this period the conventional transportation planning process has been developed. This process represents the integration of many aspects of the urban environment. Main phases of this process include:

- Inventory of existing conditions

- Future public policy decisions and goals

- Estimation of future urban area growth

- Estimation of future travel

The last phase can be further sub-divided into trip generation, trip distribution, mode choice and trip assignment.

In the traditional method of forecasting mode choice, transportation planners rely heavily on travel time and travel cost to explain traveller's behavior. Although, these two variables are considered important in mode choice, they may be inadequate to explain people's behavior.

In addition to these quantitative variables, mode choice models may need to consider perceptions of transportation modes to be able to produce reasonable forecasts of mode choice.

1.2 STATEMENT OF THE PROBLEM

Mode choice is an essential step in transportation planning. In Saudi Arabia, people rely heavily on private cars for intracity trips as well as short intercity trips. This is due to many factors related to the availability of autos to almost all house-

hold members, mode characteristics and people's attitude towards public transportation systems. Only a small percentage of people rely on bus or taxi for their intracity trips. Most of these people do not have automobiles.

However, travellers consider a multitude of modes when they make their choice for intercity trips. This is due to the large area of the Kingdom (2,240,000 km^2) and long distances between cities which makes travel by automobile difficult and tiresome. For such trips, travellers can choose between air, bus, car, taxi, and train (the last is available on the only Dhahran-Riyadh corridor). Only few people rely on taxi, so this mode is excluded from the analysis.

The prediction of mode choice for intercity trips is important to balance the government spending on the development of transportation systems. During the last two decades millions of riyals have been spent on building a new highway network, airports, railway stations, etc. to meet the increase in travel demand. The investment on transportation projects should be balanced between different transportation systems based on the usage of each. To avoid the problems associated with under-design or over-design of the components of the transportation systems, it was considered necessary to study the behavior of travellers and to determine the factors influencing their mode choice.

The conventional mode choice models mostly consider quantitative variables in their model estimation. Such variables include travel time and cost as well as the socioeconomic characteristics of travellers. However, trip makers, in their mode choice may be affected by other perceived levels of service variables such as comfort, convenience, reliability and privacy of modes. Some of these variables may be as significant as travel cost or travel time or even more so.

This research will investigate the significance of introducing mode perceptions and in particular mode comfort, convenience, privacy and reliability on the intercity mode choice models. Privacy may be more important in Saudi Arabia due to cultural reasons.

1.3 GOALS AND OBJECTIVES

The main goal of this research was to study the effects of mode perceptions such as comfort, convenience, privacy and reliability on the intercity trips mode choice behavior in Saudi Arabia.

To achieve this goal, a number of objectives were identified which are summarized below:

- The collection of data for the construction of comfort, convenience, privacy and reliability attributes.

- Construction and testing of scales for measuring perceptions of comfort, convenience, privacy and reliability.

- The collection of data for the calibration of intercity mode-choice models.

- The development of mode choice models that will allow the determination of the share of each mode in intercity trips, and through these models test the effect of perceptual attributes.

1.4 RESEARCH HYPOTHESIS

The main hypothesis of this research is that the perceptual variables; comfort, convenience, privacy and reliability affect the mode choice behavior of the travellers for intercity trips. This research was designed to test this hypothesis. For this purpose, disaggregate intercity mode choice models were developed for passenger travel inside the Kingdom. The contribution of the perceptual attributes to the explanation of intercity trip behavior was tested through this model.

Chapter 2

LITERATURE REVIEW

In the first part of this chapter an overview of disaggregate mode choice models that have been developed for intercity trips is presented. Attitudinal studies that are related to mode choice are reviewed in the second part.

2.1 OVERVIEW OF INTERCITY MODE CHOICE MODELS

Intercity travel has received comparatively less attention than urban travel. Since mid-1960's some mode choice models have been calibrated for intercity trips. In the USA, most of the intercity models were developed in conjunction with the Northeast corridor project [1]. They were developed to predict the share of potential new models as well as existing models. However, most of these models were calibrated using aggregate data and few have employed disaggregate data.

In the mid-1960's, it was recognized that population and economic growth would increase travel demand on the Northeast corridor and congestion problems would occur if no improvements on travel services were made.

The aggregate models were developed using variables

which describe the demographic and economic characteristics of the city pair as well as the level of service provided by intercity travel modes.

The aggregate intercity travel demand models can be classified into five groups. Table 2.1 shows a list of these aggregate models [1]. The first group includes models which predict travel demand between city pairs for each mode separately, using one or a set of equations. In the second group, city pair travel demand is combined over all modes in the corridor. So the total demand between origin and destination, not modal split, is predicted using a single equation. The third group of models are mode-share models, used to predict the modal split of known intercity travel volume. These models may be used in conjunction with total origin-destination demand models. The fourth group of models are sequential models; in which both intercity demand, as well as modal splits are predicted by combining both total city pair demand models with mode share models. The last group includes direct single mode demand models, in which the city pair demand is predicted for a single mode.

Besides aggregate intercity mode choice models, a number of disaggregate models were developed. The development of such models requires a data set that describes the behavior of an individual, his individual characteristics, and his attitudes towards the

Table 2.1: Aggregate Models of Intercity Demand

Group I: Direct Origin - Destination - Mode Volume	
	Kraft-SARC (1963)
	Quandt and Baumol (1966)
	Mayberry (1968)
Group II: Total Origin - Destination Volume - All Modes	
	Alcaly (1967)
Group III: Modal Share	
	Ellis et al (1971)
	Walmsley (1979)ol (1966)
	Bennet et al (1974) - Review
Group IV: Sequential Models	
	McLynn and Woronka (1969)
	Monsod (1969)
	New York State DOT (Cohen et al, 1977, 1978)
	Ohio High Speed Rail Study (PMM, 1979)
	Aerospace Corporation (1977, 1978, 1979, 1981)
Group V: Direct Single Mode Demand	
	Simple Gravity Models
	Modified Gravity Models
	Intrinsically Linear Models
	Judgemental Models

Source: Koppleman et al. (1)

travel services provided by each mode. The first disaggregate intercity mode choice model was developed by Watson in 1972 and 1974 [2]. The model was a binary-choice model since it was developed to forecast the share of rail and car in the Edinburgh-Glasgow, Scotland corridor. Line haul time, access and egress time, cost and convenience were the variables included in his model. He used the number of travel activities: walk, wait, ride or transfer necessary to complete the journey as a measure of travel convenience. Table 2.2 shows Watson's model.

Another set of binary disaggregate models was developed by Leak and Underwood in 1978 [3]. Seven binary mode choice models were formulated and evaluated for rail versus air travel, for travellers in the London-Manchester and London-Glasgow corridors. The selected model included measures of travel time and cost for each mode. It was calibrated for work and non-work trips for each corridor. Their preferred models are:

$$\ln \frac{P_{rail}}{P_{air}} = \alpha_o + \alpha_1 \left(\ln W_{air} - \ln W_{rail}\right)$$

$$W_k = \left(C_k^{\beta} + \gamma \left(T_k + \lambda E_k\right)^{\beta}\right)^{1/\beta}$$

where:

P = Probability choosing the alternative indicated

Table 2.2: Watson Intercity Mode-Choice Disaggregate Model

Variable	Coefficient Estimate	t-statistics
Relative travel time difference	-1.05	-6.48
Relative cost difference	-0.667	-8.95
Difference in waiting time	-0.002	-9.45
Difference in number of journey segments (Ns)	-0.132	-5.95

$$P_{rail} = \{1 + EXP\{Td(T_{car} - T_{rail}) + Cd(C_{car} - C_{rail}) + Wd(W_{car} - W_{rail}) + Ns(N_{car} - N_{rail})\}\}$$

W_k = Composite measure of utility for mode k.

T_k = Travel time for for mode k.

C_k = Travel cost for mode k.

E_k = Access plus egress time for model k.

α_o, α_1, γ, β = are representative parameters.

Besides the binary models, a number of multinomial models have been developed. In 1976, Stopher and Prashkar used 2035 observations from the 1972 National Travel Survey to develop multinomial logit models [4]. The models were used to predict the share of car, rail, bus and air for intercity travel. From various formulated models, the best was calibrated for business and non-business intercity trips (see Tables 2.3 and 2.4). The models included variables such as travel distance, line-haul travel time, travel cost, estimated access/egress time, and the frequency of services for each mode. The average values for travel time, travel cost, service frequencies and access-egress times for each mode were used, hence these models are not considered truly disaggregate models. The calibration of the models produced satisfactory results with respect to signs of parameters and significance.

A similar approach has been followed by Grayson in 1981,

Table 2.3: Stopher Intercity Mode-Choice Disaggregate Model for Business Trip

Variable	Coefficient Estimate	t-statistics
Line-haul travel time	-0.62	-2.1
Line-haul travel cost	-3.96	-9.79
Service frequency	0.01	3.44
Line-haul distance	-10.64	-5.78
Access-egress travel time	-0.52	-3.13
Bus constant	-1.65	-4.31
Rail constant	-0.40	-0.93
Air constant	3.13	0.10
X^2 (d.f)	1016(8)	
% Predicted correctly	63.1	

$$P_{ki} = \frac{EXP\ (V_{ki})}{\sum_j EXP\ (V_{ji})}$$

where:

P_{ki} = The probability of traveller i choosing mode k

V_{ki} = The systematic component of utility function of mode k to traveller i.

Table 2.4: Stopher Intercity Mode-Choice Disaggregate Model for Non-Business Trip

Variable	Coefficient Estimate	t-statistics
Line-haul travel time	-1.69	-5.65
Line-haul travel cost	-4.25	-7.95
Service frequency	0.012	4.48
Line-haul distance	-0.523	-0.29
Acess-egress travel time	-0.196	-1.6
Bus constant	-1.41	-4.42
Rail constant	-0.365	-0.96
Air constant	2.476	4.08
X^2 (d.f)	1561(8)	
% Predicted correctly	77.8	

wherein, he formulated a multinomial intercity logit model for car, bus, rail and air travel [5]. Grayson replaced the access time used by Stopher in the earlier model by the access distance to a terminal. In addition, he included family income as a multiplier of time, access distance and frequency. The 1977 National Travel Survey data supplemented with service data from industry guides and round maps were used to calibrate his model. The utility function of the model was:

$$U_m = aC_m + bYT_m + CY/2F + dYA_m + e_m$$

where:

U_m = utility function for model m

C_m = travel cost

T_m = travel time

A_m = Access of mode m

Y = family income/2000

e_m = alternative specific constant

a, b, c, d = coefficients

The Grayson model presented in Table 2.5 shows that all

Table 2.5: Grayson Intercity Mode-Choice Disaggregate Model

Variable	Coefficient Estimate	t-statistics
Travel Cost	-0.0161	-5.65
Travel Time	-0.024	12.66
Service Frequency	-0.0055	-1.81
Access Time	-0.0007	-1.66
Bus constant	-2.552	-14.32
Rail constant	-3.027	-16.89
Air constant	-2.7	-14.6
ρ^2	0.303	
% Predicted correctly	82.7	

variables have the expected sign and are statistically significant. In addition, the likelihood ratio of 0.303 indicates that the model has a satisfactory goodness of fit. The improvement in the Grayson model compared with theStopher and Prashkar model may be attributed to the inclusion of access distance in the 1977 Survey data also more accurate road mileage estimates and improved model specification.

Stephendes, et. al. [6] recently calibrated multinomial choice models for business travel in the Twin Cities-Duluth, Minnesota corridor The models were calibrated to predict the percentage of bus, plane and auto in traveller's choice. Although train was an available alternative, it was excluded from the analysis. The responses of 90 travellers were selected for a random sample including 300 travellers to calibrate the models. The intercity mode choice models included: out of pocket cost, household income, total travel time, out of vehicle time, in-vehicle travel time, distance and waiting time for bus only, household income for auto and mode specific constants for bus and plane; as variables. The result of the analysis showed that all variables, excluding the airplane mode specific constant, were significant at a level of 10 percent (see Table 2.6).

In Canada, the Transportation Development Agency (TDA) employed disaggregate logit analysis in modelling intercity passen-

Table 2.6: Stophanedes et al. Intercity Travel Mode-Choice Disaggregate Models

Variable*	Coefficient Estimate (t-statistics) for		
	Minnesota 1	Minnesota 2	Minnesota 3
OPTC/HINC	-3.43(-2.74)	--	-7.75(-5.07)
OPTC	-	-0.69(-5.10)	-
OVIT/DIST	-	-30.90(-3.50)	-23.20(-3.13)
IVTT	-0.01(-2.03)	-0.08(-1.41)	-0.08(-1.81)
TTT	-0.06(-4.38)	-	-
WT	-	-	-0.20(-1.90)
$HINC_a$	-	-0.24(2.13)	-
C_b	4.80(2.10)	4.68(2.65)	3.82(2.95)
C_p	-12.13	24.80(2.56)	7.62(1.20)
ρ^2	0.61	0.64	0.50
% Predicted correctly	73	78	69

*

OPTC	One-way out-of-pocket cost
TTT	One-way total travel time, min;
TTT	= IVTT + OVTT
OVTT	One-way out-of-vehicle time, min
OVTT	= AT + WT + ET-vehicle time, min
IVTT	One-way in-vehicle travel time, min
WT	One-way wait time, min.
HINC	Household income, 000$
$HINC_a$	Household income for auto, 000$
C_b	1 for bus, 0 else
C_p	1 for plane, 0 else

ger mode choice, as part of the Intercity Passenger Travel Forecasting Project in 1971 [7]. Disaggregate data were used to calibrate the models for bus, rail, air and car modes. Modal split models for business and recreation trips were developed for the Montreal-Ottawa corridor. During the calibration of the models eighteen variables were tested; none of which is related to socioeconomic characteristics of the traveller. Models reported counter intuitive coefficients, for instance the coefficient of travel time is positive and the cost of travel does not influence business model choice significantly. However, the authors reported that the models can successfully predict actual modal shares.

In another study in Canada, Ridout [7,8] developed disaggregate intercity mode choice models using data from the 1969 Canadian Transport Commission (CTC) Windsor-Quebec City corridor survey. The models were developed for three intercity modes: air, rail and bus; excluding the car mode. The models were calibrated for business, pleasure and personal trips.

One of the weaknesses of the Ridout models was his elimination of the car mode since about 90% of total intercity personal trips were made by car in 1980. Both Canadian disaggregate intercity mode choice models are presented in Tables 2.7 and 2.8, for business and non-business trips respectively.

Recently, in 1988, Damodaran calibrated disaggregate

Table 2.7: Canadian Disaggregate Mode Choice Models for Intercity Passenger Business Travel

Category	Variable	Disaggregate Logit Models*	
		Transport Canada (1976)	Ridout (1982) (Model(1)*
Level of Service	Time		
	Perceived door-to-door Travelling	$0.36_{b,r,a}$ (—)	
		0.261_{c}(—)	
	Travel time		-0.1232_{a}(-7.587)
			-0.0369_{r}(-11.95)
			-0.0426_{b}(-13.47)
	Cost		
	Fare/Income	--	-0.3012 (-7.080)
	Access/Egress		
	Access distance/distance		-0.9449 (-0.9991)
	Egress/distance/distance		-0.921_{a} (-5.66)
			-0.7128_{r}(-0.5439)
			0.7030_{b}(3.359)
	Objective access + egress	$-1388_{b,a,r}$(—)	
	Frequency		
	Perceived convenience of schedule	$0.355_{b,a,r}$(—)	——
Socioeconomic Variables	Income	--	Incorporated with Cost
Model Constants	Bus	-3.363(—)	-0.7302 (-2.336)
	Rail	-2.673(—)	-0.0842 (-0.1774)
	Air	-2.693	
	Dummy variables		0.9315_{a1}(6,916)
			0.2079_{a2}(1.6)
			0.8159_{r}(5.789)
Major Drawbacks‡		No information about unchosen modes in the data	
		The time coefficients sign is counter-intuitive	Absence of the auto mode
		Absence of socioeconomic variables	Frequency is omitted
		Estimation of a cost	Counter-intuitive values of the constants

Notes: Subscript a refers to the air mode, b the bus mode, c the car mode, and r the rail mode. Dash denotes not applicable. Values in parentheses are t-statistic values and (—) denotes value of the t-statistic not available.

*Model selected for including the maximum number of variables.

‡Independent of what model is selected here, in the case where several models were developed.

Source: Ghoneim and Sargious [7].

Table 2.8: Canadian Disaggregate Models of Mode Choice for Nonbusiness Intercity Passenger Travel

Category	Variable	*Disaggregate Logit Model		
		Transport Canada (1976)	Ridout (1976)	
		Pleasure	Personal (personal, business, Other)	Pleasure (vacation, visiting, shopping, entertainment)
Level of Service Variable	Time			
	Travel Time		-0.0108(-6.593)	-0.009512(-8.032)
	Perceived door-to-door travel time	$0.278_{a,r,b}$(—) 0.186_{c}(—)		
	Cost			
	Fare/income			-0.3731(-11.29)
	Fare		-0.2568(-9.061)	
	Objective door-to-door travel cost	$-0.708_{a,r,b}$(—) -0.817_{c}(—)		
	Access/egress + egress time	$-1.564_{a,r,b}$(—)		
	Egress dist/dist			-2.401(-2.49)
	Access dist/dist		-4.49(-3.776)	-6.773_{a}(-3.625) -3.413_{r}(-3.625) -9.29_{b} (-7.277)
	Frequency			
	Log frequency		1.959(5.282)	2.009(7.116)
	Perceived convenience of schedule	$0.381_{a,r,b}$(—)		
Socioeconomic Variables	Income	--	--	Incorporated with fare
Model Constants	Bus	-1.464(—)		
	Rail	-1.086(—)	0.4852(2.501)	0.4638(3.202)
	Air	5.661(—)	-1.980 (-6.34)	-1.843 (-5.697)

* Notes: Subscript a refers to air mode, b the bus mode, c the car mode and r the rail mode.
— denotes not applicable, (—) denotes available. Values in parentheses are values of a t-statistic.

Source: Ghoneim and Sargious [7].

models to predict the intercity travel demand in Canada [9,10]. Nested multinomial logit models that combine both trip generation and mode choice were developed. The researcher used the Canadian Travel Survey as a source for his data. This survey, which was carried out during the third quarter of 1984, included socio-economic variables of the individuals and information about the intercity trips taken by them. Level of service variables were obtained from other sources. For model calibration, the researcher used 4963 observations with 1624 trips between 144 city pairs in Canada.

Mode choice and trip generation models were calibrated for auto, bus, rail and air travel. Inclusive value variables were used to link both mode choice and trip generation models. The data were segmented based on two criteria, namely trip purpose (business and non-business) and geographic region (eastern and western regions of Canada). The models included travel time as well as travel cost and frequency as level of servic variables. Travel time was converted to speed and travel cost was transferred to unit cost by dividing both variables by distance. The only socio-economic variable used was household income, which was introduced into the models as an alternative specific variable.

The calibrated models produced goodness of fit measures with likelihood ratio index values ranging between 0.282 and 0.436.

All variables had expected signs with significant values for coefficient estimated.

The major deficiency in the Damodaran models was the lack of access and egress information due to data limitations in the main survey. Also, for the same reason the destination choice was not included.

In Saudi Arabia, there is only one study to be found in literature related to intercity mode choice. In this study, which was conducted by Al-Ahmadi [11], disaggregate mode choice models were developed for two major corridors in the Kingdom: the Dhahran-Riyadh corridor and the Riyadh-Jeddah corridor. Multinomial logit models were formulated to forecast modal split among car, bus, air and rail (the last mode is available for the Dhahran-Riyadh corridor only). The data were collected through self-administered questionnaires which were distributed to travellers at terminals and gas stations. A total of 1338 responses were analysed to formulate a number of intercity mode choice models out of which the best were selected to represent intercity traveller behavior. The calibrated models for the Dhahran-Riyadh corridor with and without train and for the Riyadh-Jeddah corridor are given in Tables 2.9, 2.10 and 2.11 respectively. Variables used to calibrate these models were: out of pocket cost (OPTC), in vehicle travel time (IVTT), monthly household income (HINC), duration of

Table 2.9: Dhahran-Riyadh Corridor Mode-Choice Model for Non-Business Trips (Train Included)

Independent Variables	Coefficient Estimate	t-stat	Standard Error
ASC-AIR	42.00	3.26	12.9
ASC-BUS	4.08	9.50	0.42
ASC-TRAIN	0.44	1.80	0.25
IVTT (specific to train, car and bus)	-0.84	-2.44	0.34
IVTT (speciific to air)	-47.79	-3.70	12.92
OPTC (generic)	-0.013	-5.94	0.0022
HINC (specific to air)	0.236	1.65	0.142
HINC (specific to bus)	-0.58	-6.33	0.092
COMFORT (generic)	0.61	8.00	0.076
SAFETY (generic)	0.39	4.82	0.082
DUR (specific to air)	1.88	3.45	0.55

LOG LIKELIHOOD L(B) = -307.2
LOG LIKELIHOOD L(0) = -665.4
-2[L(0)-L(B)] = 716.2
Rho sq. (ρ^2) = 0.538
Rho bar sq. ($\bar{\rho}^2$) = 0.535

ASC-AIR = Mode-specific for air
ASC-BUS = Mode-specific for bus
ASC- TRAIN = Mode-specific constant for train
OVTT = In-vehicle time in hours
OPTC = Out-of-pocket cost
HINC = Monthly household income
COMFORT = Qualitative variable
SAFETY = Qualitative variable
DUR = Duration of stay

Table 2.10: Dhahran-Riyadh Corridor Mode-Choice Model for Non-Business Trips (Train is not Included)

Independent Variables	Coefficient Estimate	t-stat	Standard Error
ASC-AIR	40.34	3.8	10.4
ASC-BUS	5.33	6.45	0.83
IVTT (specific to train, car and bus)	-0.56	-1.04	0.539
IVTT (speciific to air)	-43.45	-4.21	10.33
OPTC (generic)	-0.031	-6.17	0.0052
HINC (specific to air)	0.39	2.0	0.191
HINC (specific to bus)	-0.716	-5.54	0.129
COMFORT (generic)	0.670	4.5	0.147
SAFETY (generic)	0.492	3.3	0.149
DUR (specific to air)	2.1	3.1	0.68

LOG LIKELIHOOD L(B)	= -100.2
LOG LIKELIHOOD L(0)	= -395.5
-2[L(0)-L(B)]	= 590.6
Rho sq. (ρ^2)	= 0.746
Rho bar sq. ($\bar{\rho}^2$)	= 0.743

ASC-AIR	= Mode-specific for air
ASC-BUS	= Mode-specific for bus
ASC- TRAIN	= Mode-specific constant for train
OVTT	= In-vehicle time in hours
OPTC	= Out-of-pocket cost
HINC	= Monthly household income
COMFORT	= Qualitative variable
SAFETY	= Qualitative variable
DUR	= Duration of stay

Table 2.11: Jeddah-Riyadh Corridor Mode-Choice Model for Non-Business Trips

Independent Variables	Coefficient Estimate	t-stat	Standard Error
ASC-AIR	-0.5486	-0.15	3.754
ASC-BUS	7.6891	7.797	0.986
IVTT (specific to train, car and bus)	-0.4263	-3.05	0.1398
IVTT (speciific to air)	-2.795	-1.14	2.439
OPTC (generic)	-0.0088	-7.43	0.0012
HINC (specific to air)	0.530	3.36	0.158
HINC (specific to bus)	-1.646	-6.79	0.242
COMFORT (generic)	0.416	3.88	0.107
SAFETY (generic)	0.430	3.77	0.114
DUR (specific to air)	3.3	2.69	1.225

LOG LIKELIHOOD L(B)	= -140.3
LOG LIKELIHOOD L(0)	= -395.5
-2[L(0)-L(B)]	= 510.4
Rho sq. (ρ^2)	= 0.645
Rho bar sq. ($\bar{\rho}^2$)	= 0.641

ASC-AIR	= Mode-specific for air
ASC-BUS	= Mode-specific for bus
ASC- TRAIN	= Mode-specific constant for train
OVTT	= In-vehicle time in hours
OPTC	= Out-of-pocket cost
HINC	= Monthly household income
COMFORT	= Qualitative variable
SAFETY	= Qualitative variable
DUR	= Duration of stay

stay (DUR), in addition to two qualitative variables; comfort and safety. The goodness of fit measure rho-square for the Jeddah-Riyadh corridor and the Dhahran-Riyadh corridor models, with and without train are 0.645, 0.534 and 0.746 respectively, which represent a very good fit. The transferablity of the models were tested to find their feasibility. It was concluded that transferring models across corridors in the Kingdom was feasible and gave acceptable goodness of fit only when a modified approach was used. In addition, a general model was calibrated using the data set for both corridors. The general model as shown in Table 2.12 explained the behavior of the travellers in both corridors with goodness of fit measure value, ρ^2, of 0.568. The general modal split model gave more accurate predictions than transferring a specific model from one corridor to another. Finally, Al-Ahmadi that additional corridors should be studied.

Al-Ahmadi's study was performed on two major corridors only. These two corridors connect the Eastern coast of the Kingdom to the Western coast. There are other important corridors that need to be considered. In addition, mode perceptions of comfort, convenience, privacy and safety were incorporated using a single direct statement, to compare between different modes for each of the perceptual variables.

Table 2.12: General Model for the Two Corridors

Variable Name	Coefficient Estimate	t-stat
ASC-AIR	4.54	5.08
ASC-BUS	6.18	13.63
OPTC	-0.01	-8.82
$IVTT_{B,C}$	-0.70	-10.00
$IVTT_A$	-8.24	-7.87
COMFORT	0.65	8.68
SAFETY	0.36	5.17
$MHINC_A$	0.27	3.34
$MHINC_B$	-1.01	-9.71
DUR_A	1.23	3.75
$\rho 2$ = 0.568		
L(0) = -790.0		
L(B) = -341.7		

Notes:

L(B) The log likelihood for the general model estiamted from the data set for both corridors.

ρ^2 Goodness of fit measure

Subscript A for air, B for bus, C for car

2.2 ATTITUDINAL STUDIES AND MODE CHOICE MODELS

In this section, a review of some transportation mode choice models that have included psychological factors influencing the choice of the traveller is presented. In this regard Transportation planners search outside the traditional boundaries of their discipline looking for psychological factors to help understand transportation mode choice.

A number of studies have measured general attitudes towards a variety of transportation aspects. Several of these studies have applied attitudes to a wider scope than mode choice. These works have been more descriptive than analytical and have attempted to outline the attitudes of Americans towards mobility, their feelings concerning the automobile's role in society, their basic motivations for driving, and their preferences for transportation innovations [12,13, 14, 15, 16, 17]. In 1967 the most comprehensive review of American attitudes was conducted and reported in The National Survey of Transportation Attitudes and Behavior [18, 19]. The main purpose of this research was to determine the sensitivity of allocation procedures for highway funding to public attitudes to find the relationship between transportation attitudes and mode choice and to investigate factors affecting public attitudes and behaviors.

As an outcome of this research, attitudes, opinions and

values were registered regarding automobiles (95% considered auto as an ideal mode for social trips). On the other hand, public transit was generally regarded negatively. Another large scale transportation survey conducted by Lansing and Hendricks, [20] at the University of Michigan Survey Research Center, also reported negative reactions to public transportation and a high preference for auto travel. In their survey of Residential Location and Urban Mobility, they indicated various reasons and motivations for car and transit mode. Convenience was strongly related to auto use for work trips. A significant finding of this study was that mode choice was not sensitive to cost (75% indicated that they had never calculated the cost of driving to work).

One of the earliest attempts to relate traveller attitudes to mode choice was undertaken by Ackoff [21]. He formulated and tested a modal-split model which was based on an individual's relative evaluation of four attributes: cost, travel time, comfort and convenience. The model consists of four vectors describing the effect of change of the service characteristics to preferred mode. These calculated vector components were considered to represent equal utilities in their effect on mode choice behavior. Ackoff's exploratory effort in 1965 is considered to be a pioneer in considering psychological factors in mode choice.

Few studies in literature have attempted to integrate atti-

tude variables with disaggregate choice models. Allen (1971, 1972) included socioeconomic characteristics of individuals as well as their attitudes towards transportation attributes in mode choice models [22]. Using linear regression, linear and discriminant models were used to analyze collected data for the two samples. Individuals' satisfaction towards auto and transit together with attribute importance were used as attitudes in this research. Dummy variables representing socioeconomic characteristics of the respondent were used in conjunction with several combinations of the respondent perceptions. Allen reported a greater predictive success using a discriminant model. The model was able to classify between 70-90% of respondents correctly in the two samples.

A number of researchers have employed various multidimensional techniques to quantify attitudinal variables such as: convenience, comfort and reliability for use in the development of mode-choice models. Spear [23] investigated the effect of a generalized convenience variable in mode choice for work trips. Convenience was measured using the following fourteen individual attributes:

- arrive at the intended time
- avoid leaving early to be on time for work
- have a choice of departure times
- have the station easily accessible from home

- arrive in the shortest time
- pay as little as possible for the trip
- avoid a long wait for the vehicle
- avoid paying daily for the trip
- have understandable schedules and routes
- be able to travel in all weathers
- avoid a long walk
- avoid making numerous stops
- avoid travelling in undesirable areas
- avoid changing vehicles

A questionnaire was designed to produce comparative judgement data in conjunction with person and trip data. A total of 397 responses were obtained from two major cities, Boston and Chicago. A convenience index was constructed using indicated respondent satisfaction to a preselected subset of ten attributes. This idea was incorporated in a mode-choice model, in addition to travel cost and travel time using a binary logit choice model. The result of the analysis (as shown in Table 2.13) revealed that the inclusion of a convenience index not only improved the fit of the model but also caused a major decline in the alternative specific constant and its significance. This decline is desirable since it indicates a reduction in unexplained bias for a particular mode.

A similar study was performed by Nicolaidis [24] to investi-

Table 2.13: Results of Convenience Index Used in Mode-Choice Model

Model Number	Coefficient (t-scores)				rho sq. ρ^2
	Time Diff.	Cost Diff.	Conv. Diff.	Constant	
1	-0.0058 (-0.53)	1.595 (5.37)	----	-1.083 (-3.09)	0.42
2	-0.047 (-2.85)	-1.41 (-3.83)	-1.19 (-4.93)	0.506 (0.97)	0.68

gate the influence of comfort in individual mode choice work trips using a multi-dimensional approach. Nine attributes were used to define comfort variable. These attributes which described vehicular comfort, station comfort and psychological comfort, are the following:

- protection from weather
- possibility of adjusting temperature
- availability of storage space for parcels shopping bags, etc.
- clearness of immediate environment
- number of stops (pick-up stops, traffic lights, etc.)
- visibility of the surrounding
- fatigue feeling
- feeling of privacy
- easiness when entering or leaving from means of travel.

A self-administrated questionnaire was designed to gain information on travel mode used, individual characteristics, and comparative judgement information about the nine comfort attributes and the several travel modes identified. The survey was conducted in Ithaca, New York and yielded in 141 responses. A comfort index built by derived similarities solution (see Tongersen [15] for explanation of the techniques) was found to have higher correlations with individual mode choice than cost and time difference

variables as shown in Table 2.14. Nicholaides also built a linear regression model as given below:

$$\text{Choice} = 0.63940 + 0.00107\ (\text{TIMDIF}) + 0.53502\ (\text{COMDIF})$$

where, TIMDIF and COMDIF stand for travel time difference and comfort indices difference, respectively.

The attitudinal variable, reliability was introduced to mode choice behavior for work trips by Prashker [26]. Using a self administered questionnaire, a survey was conducted among commuters who worked in downtown Chicago and commuted to work from two northern suburbs of the metropolitan area. The alternative modes included: private car, commuter train, and rapid transit. The questionnaire was designed to obtain information about travel time and cost, reliability measure of the modes, and socioeconomic data about the individuals surveyed. A total of 137 responses were used in the analysis representing a response rate of 14 percent. To measure the reliability performance of the modes, psychometric scaling techniques, including factor analysis and a multidimensional scaling technique were used. The following nine attributes were used to measure the reliability of transportation modes. These attributes are:

- Vehicle is as fast as possible;

- feel confident that the vehicle would not need to stop for

Table 2.14: Correlation Matrix

Variable Number	1	2	3	4	5	6	7	8	9	10
1	1.000	0.224	0.580	0.366	-0.367	0.637	-0.861	-0.443	0.486	0.822
2		1.000	0.314	0.102	-0.183	0.184	-0.331	0.305	0.177	0.282
3			1.000	0.454	-0.191	0.644	-0.686	-0.808	0.466	0.731
4				1.000	-0.093	0.578	-0.367	-0.393	0.855	0.522
5					1.000	-0.222	0.368	0.078	-0.596	-0.323
6						1.000	-0.652	-0.532	0.582	0.912
7							1.000	0.483	-0.487	-0.905
8								1.000	-0.358	-0.559
9									1.000	0.589
10										1.000

Variable Number	Description of Variables
1	Choice
2	Travel Time with Usual Mode
3	Travel Time with Alternative Mode
4	Travel Cost with Usual Mode
5	Travel Cost with Alternative Mode
6	Comfort Index for the Usual Mode
7	Comfort Index for the Alternative Mode
8	Travel Time Difference
9	Travel Cost Difference
10	Comfort Indices Difference

repairs;

- vehicle travel time is unaffected by traffic congestion or frequent stops;

- if vehicle travel time varies by less than one minute, rather than 15 minutes from day to day;

- feel confident that vehicle will get you to your destination without an accident;

- vehicle is available not later than 1 minute, rather than not later than 10 minutes from the time it is expected;

- able to estimate the actual time of arrival at destination.

- vehicle travel time performance is not influenced by weather; and

- having to search for a parking place not longer than 1 minute, rather than not longer than 10 minutes.

In addition to mode reliability measures, travel cost and travel time variables were used to construct multinomial logit mode choice models. Reliability measures were statistically significant and improved the explanatory power of the models.

Another research carried out by Neveu [27], studied the influence of comfort, convenience and reliability on mode choice

behavior for work trips. The following 14 attributes were used to define the qualitative concepts:

Variables	Attributes
Comfort	Protection from weather Cleanliness of vehicle and station Fatigue felt when travelling Control of immediate surroundings Feeling of personal safety Feeling of privacy
Convenience	Transfers required Stops required Frequency of service Accessibility to means of travel
Reliability	Variability of travel time Waiting required Likelihood of accident or breakdown Influence of weather on travel time.

These attributes were chosen because they were the most important ones in previous studies. Perceptual data were collected through a self-administered questionnaire distributed among work commuters in Chicago. Using factor analysis, preference regression and first preference logit, the researcher concluded that people do not perceive comfort, convenience and reliability as independent variables in mode choice. Significant overlap exists in public perception. In addition, the three variables are perceived differently for access and main mode of travel.

Chapter 3

RESEARCH METHODOLOGY

To achieve the goals and objectives of this thesis, the research was divided into two stages. In the first stage focus was on the development of attitudinal scales for perceptual concepts. In the second stage, behavioral intercity mode-choice models were developed for the purpose of testing the contribution of attitudinal variables in the explanation of intercity travel mode choice behavior. The general outline of research methodology is shown in Figure 3.1.

3.1 DEVELOPMENT OF ATTITUDINAL SCALES

The two most commonly used approaches in transportation planning for quantifying attitudinal model attributes are the use of dummy variables and the use of integer-based proxy variables.

> "The primary difference that is implied between a dummy variable and a proxy variable is that the former is an "on-off" type of variable, used to signify the presence or absence of an attribute, while the latter is an integer value used to approximate an amount of an attribute by an alternative" [28].

The dummy variable approach was used by Purker and Clark [29] and Lave [30] in their work on quantifying comfort variable. The alternative approach was implemented by Bock in

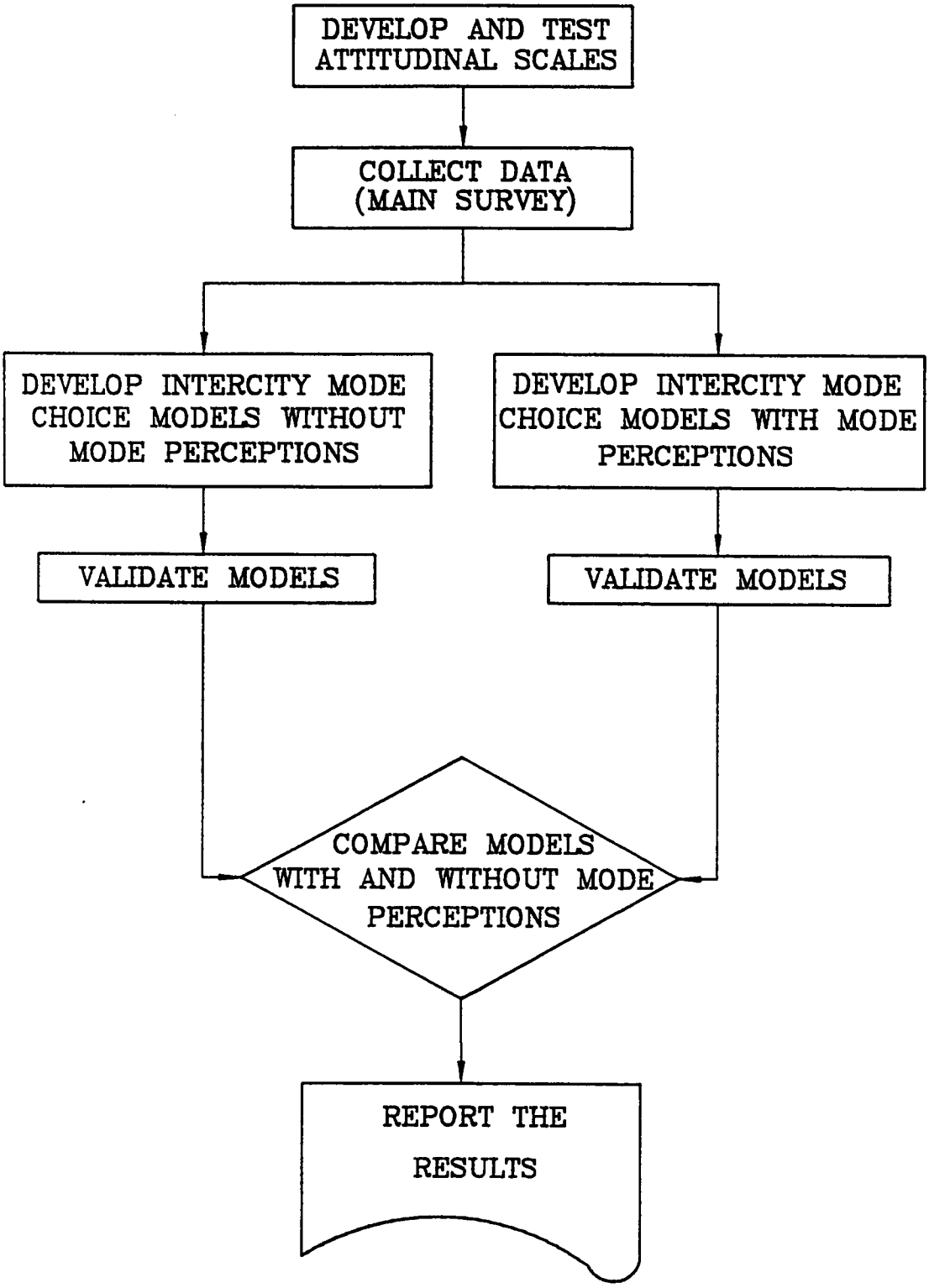


FIGURE 3.1 GENERAL RESEARCH METHODOLOGY

quantifying comfort and convenience variables [31]. In his work, comfort and convenience were combined into a single variable that assigned the values 1 for auto, 2 for commuter railroad, 3 for subway, and 4 or 6 for bus. These values were assigned by the researcher based on a purely intuitive and subjective basis.

Watson used a proxy variable for measuring convenience [32]. The proxy variable was formed by counting the number of separate travel activities involved in completing the trip, that is to count each walk, wait and ride and the resulting integer value was assigned to the mode of travel. In Watson's work, no weights were assigned to each separate travel activity which reflected different utilities of the activities. Both of these approaches included subjective assessment by the researcher in quantifying qualitative attributes. The values obtained are not readily forecastable for existing modes nor can they be used to describe a new mode, hence they are not useful in analyzing policy and investment decisions. Both of these approaches improved the statistical fit of the behavioral models and reduced the size of the alternative specific constant. However, this improvement was not as large as might be expected.

A third approach, which is based on psychometrics is used to quantify qualitative variables and to overcome the shortcoming of earlier approaches. This approach is based on a branch of experimental psychology called psychometrics, which is principally

concerned with quantification of attitudes and preferences of individuals and groups. Two principal techniques are available for this purpose which are unidimensional and multidimensional scaling techniques. Both techniques produce scales that can be used to measure people's attitudes towards qualitative variables. The primary difference between these techniques is that in the unidimensional scaling the attribute to be measured is assumed to exist in a one-dimensional space and can be described along a linear continuum. On the other hand, no such assumption is made for multidimensional scaling. Both scaling techniques were derived from the Law of Comparative Judgement which was first formalized by Thurstone in the 1920's. For the theoretical development of the law, see Thurstone's original work [33]. On the basis of Thurstone's work, unidimensional scales were developed first, followed by the development of a broader concept of multidimensional scaling. The development of both techniques is described by Torgerson [25]. Both techniques have been used in quantifying attitudinal variables in transportation planning. As previously mentioned, Spear used unidimensional scaling to quantify convenience and Nicolaidis used the multidimensional approach for the definition of comfort variables [34,35]. The results of their work indicated that both approaches are useful in attempting to quantify such qualitative variables.

In this research, attitudinal scales were constructed for the purpose of quantifying perceptual variables, using the method

suggested by Ergun, [36] the general outline of which is given in Figure 3.2.

The steps involved in scale construction are outlined below:

1. Stating the purpose of measurement for developing the attitudinal scales.

2. Definition of the environment to which the hypothetical concepts have to be related.

3. Definition of the behavioral criteria of the environment, based on the hypothesis that the selection of an alternative by a traveller depends not only on the quantitative variables but also on qualitative attributes.

4. Specifying the hypothetical concepts through literature surveys, focus group meetings, expert opinion and common sense.

5. Writing attributes or items related in measuring respondents' attitudes.

6. Removal of any ambiguities in the item list through experts' consent.

7. Conducting a pilot survey with a convenient sample through a pretest questionnaire that contains the items that measure respondents' attitudes towards the hypothesized concepts.

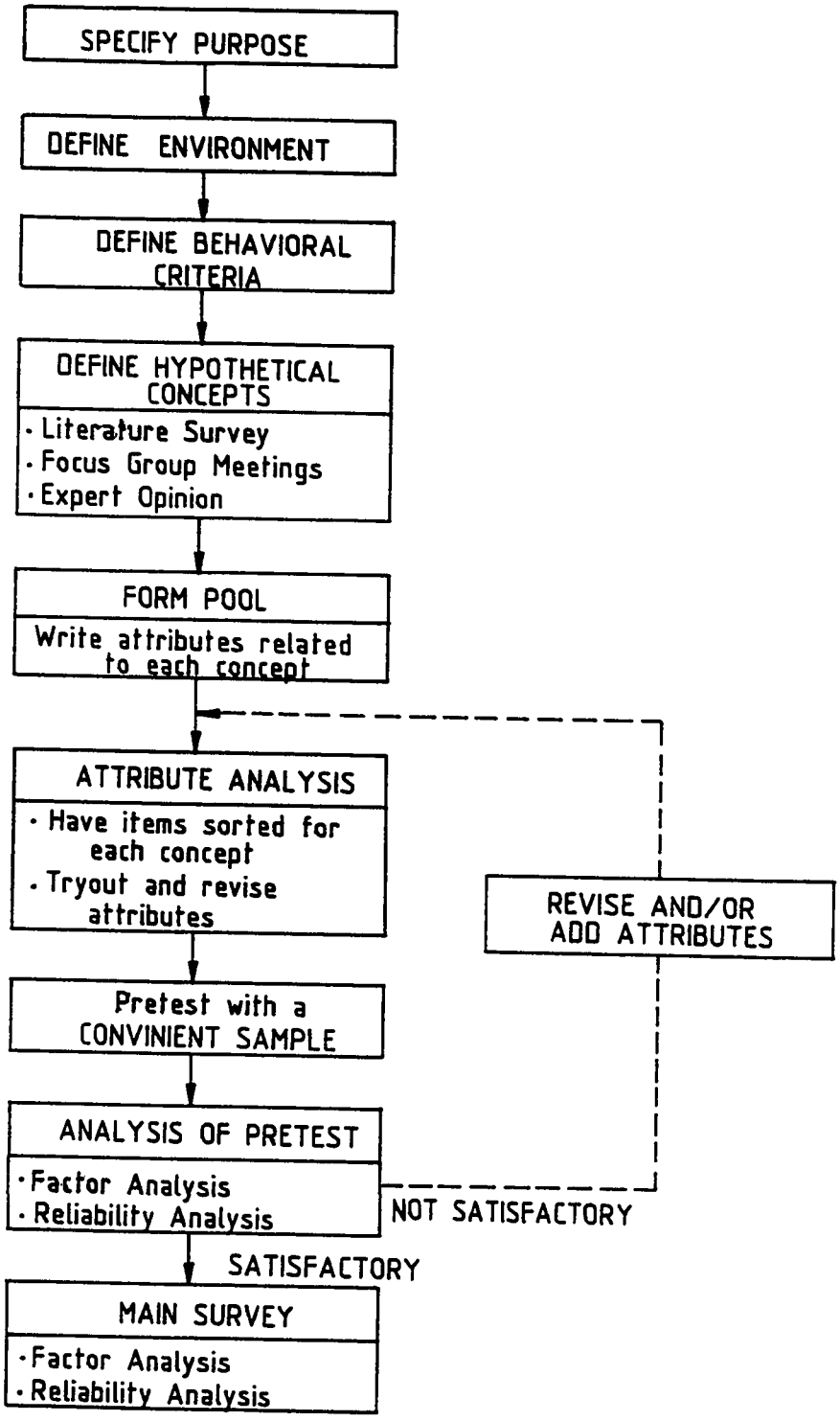


Figure: 3.2 Development of Attitudinal Scale

Source: Ergun, G. [36]

8. Subjecting the responses obtained from the pilot survey to factor analysis to confirm that the listed items represent the hypothetical concepts.

9. Refinement and selection of the best attributes describing each perceptual concept that were included in the development of the main survey instrument.

3.2 DEVELOPMENT OF INTERCITY MODE-CHOICE MODELS

3.2.1 Model Variables

The variables needed for the mode choice model can be categorized as socio-economic variables, level of service variables and trip variables. From a literature review of previous research, the following list of variables was obtained.

The socioeconomic variables that were shown to play a role in the mode choice behavior are listed below:

1. Income: Household income is considered to be a major factor in deciding between different modes because it indicates the trade-off between cost and other variables.

2. Car Ownership: This variable is important as it shows whether the traveller has a complete set of mode choices or he is captive to other modes.

3. License: This variable is used to find out if the traveller can drive a car and the car is one of his choices.

4. Size of Travelling Group: This factor is important because the behavior of a single traveller may differ from the behavior of a group of travellers.

5. Family and Children: This variable is used to determine whether the traveller is travelling with his family and children or another unrelated group. The actual cost of the trip can be estimated, depending on the family size.

6. Nationality: The nationality of the traveller will be determined from the questionnaire to find out if the travel behavior of Saudi travellers is different from that of other nationalities.

7. Age: This variable will be introduced to find its effect on mode choice.

The level of service variables are those attributes that describe the characteristics of the mode which influence traveller choice in areas such as travel time and travel cost. The following level of service variables is considered important in many studies so they need to be collected by the survey.

1. Travel Cost: Travel cost is one of the most important level of service variables that has been considered by

many researchers in mode choice decision. Travel cost is considered as the total cost that the trip maker incurs for his trip starting from his home and continuing to his final destination. Both actual and perceived cost have to be tested because travellers' choices are based on their perceptions. Dobson and Tischer concluded that perceived costs worked better than actual cost in mode choice prediction [37]. However, Golob, Horowitz and Wachs stressed that both actual and perceived costs should always be included in mode choice studies [38].

2. Travel Time: Travel time is one of the traditional variables which is used to build mode choice models. It is the time necessary for an individual to complete his trip starting from his origin and continuing to his final destination. The value of time changes between different people, depending on their socioeconomic characteristics. However, in this country most people may place a high value on time due to their high standard of living. Many researchers have recommended the use of perceived time values rather than measured values in modeling mode choice [39,40,41]. Others have found that the perception of travel time varied as a function of the mode, degree of comfort and the level of convenience

[42]. A large difference could exist between the perceived value of travel time and the measured one. In a study undertaken by Dobson and Tischer [37] in which they built different models using the actual value of travel time and cost; perceived value of travel time and cost and demographic values, they found that the model using perceived values performed better than the other models. In this study the reported value of travel time for each mode was used. In addition the total travel time can be broken down into the following components:

- In-Vehicle Travel Time: It is the time spent in the mode.
- Waiting Time: It is the time spent on the terminal before departure.
- Access Time: It is the time spent on the way to the mode of choice.
- Egress Time: It is the time spent betwen leaving the mode and arriving at the final destination.

3. Perceptual Variables: The variables considered by researchers as important in mode choice are mode comfort, convenience, privacy and reliability. In this survey, as indicated earlier, scales will be constructed to measure comfort, convenience, privacy and reliability of travel modes.

In addition to socioeconomic variables and level of service variables, data regarding the trip were collected. These variables include:

1. Trip Purpose: Trip purpose is an important factor that affects mode choice since traveller mode choice may differ for different trip purposes.

2. Duration of Stay: The duration of stay at the destination may affect the traveller's choice. For shorter trip travellers tend to use faster modes.

3. Trip Length: The trip length may affect the choice of traveller. It is believed that the traveller will choose a faster mode for long trips and will rely on his car for short trips.

3.2.2 Proposed Model

The development of disaggregate mode choice models came after discovering the shortcomings of aggregate models. One of the shortcomings of aggregate models, as indicated by many researchers, is the loss of efficiency (i.e. large variances of the estimates of model coefficients) due to data aggregation before model calibration [44,45]. The problem is solved in disaggregate models since the collected data at individual level are used. With this approach the predictive power of a disaggregate model has

improved. In a study performed by Watson, aggregate and disaggregate binary mode choice models were calibrated using data from the Edinburgh-Glasgow corridor. The results of his study indicated that a disaggregate model provides a better statistical explanation of mode choice behavior and the prediction errors are 12 to 15 times higher in an aggregate approach than those for a disaggregate approach [46,2]. His conclusions were supported by other researchers [47].

Another shortcoming of aggregate models is that the models are not transferable to another geographic area unless the characteristics of the group of individuals, are controlled or unchanged. This is due to the fact that a group of individuals, on average, may not behave the same as individuals who possess the averaged value of the group characteristics.

Another problem of aggregate models is derives from the fact that these models are based on aggregate variables of a group of individuals who do not necessarily reflect the actual individual behavior. This problem is reported in literature as 'ecological fallacy' [47,48]. In the disaggregate approach this problem is eliminated, since the models are based on the individual, the smallest element of the population.

Due to the above shortcomings of the aggregate approach, it was decided to carry out this research utilizing the advantages

of the disaggregate approach. These can be summarized by their superior estimation results, data efficiency and their better representation of the individual traveller's decision.

Most of the calibrated disaggregate mode choice models are probabalistic models. Based on the socioeconomic characteristics of the individual and the characteristics of available modes, the probability of choosing a particular model can be determined.

The building of disaggregate mode choice models is based on the principles of utility theory. The utility theory assumes that a trip maker will choose a transportation mode which maximizes his travel utility for that trip. In other words, a traveller in his choice process will try to maximize his benefit by reducing his travel time and travel cost and by maximizing his convenience, privacy and comfort [45,49,50].

Since the behavior of traveller can not be predicted with 100% certainty, we can only estimate the probability of traveller's choice. For this reason the utility function can be partitioned into two components; a systematic component, or "representative utility", V and a random component ε which represents the utility of unobserved attributes, unobserved taste variations, measurement errors and imperfect information. The utility function can be presented mathematically as:

$$U_{ki} = V_{ki} + \varepsilon_{ki}$$

where

U_{ki} = the utility function of mode k to i;

V_{ki} = the systematic component of utility function of mode k to i;

ε_{ki} = the random component of utility function of mode k to i.

The systematic component of the utility function for mode choice can be stated mathematically as follows:

$$V_{ki} = \sum_{n=1}^{N} \beta_n X_{kin} + \sum_{l=1}^{L} \alpha_l S_{il}$$

where:

V_{ki} = The utility function of mode k to i;

X_{kin} = value of attribute n of mode k for i;

S_{il} = the socioeconomic characteristic l of i;

β_n = coefficient of attribute n; and

α_l = coefficient of socioeconomic characteristic l.

Using this principle, individual will rank his alternative

modes according to their utility function value. It is assumed that the value of the utility function will reflect individual preferences. So if the value of the utility for one mode exceeds the value for another, that first mode is preferred to the other.

Various functions have been used to represent the stochastic disaggregate modes. The most frequently used ones are multinomial logit and multinomial probit functions [49].

The only difference between the multinomial probit and multinomial logit functional forms is the assumption made concerning the distribution of random elements in the utility function. The logit model assumes that the random component is independent, and identically distributed with a Gumbel distribution function, while the probit assumes that the random component has multivariate normal distribution. There are no differences between the two functional forms in their prediction ability. Many studies indicated that results obtained using logit models were similar to those using probit models [49].

Finally it was decided to use the multinomial logit function since both multinomial logit and probit have the same prediction capability and probit models require more a complex computational procedure than logit models. Computer packages for logit models have been used and tested by many researchers. Such a package BLOGIT [50] was also available to the researcher.

The general form of the multinomial logit model is shown in the following equation:

$$P_{ki} = \frac{EXP\ (V_{ki})}{\sum_{j} EXP\ (V_{ji})}$$

where:

P_{ki} = The probability of i choosing mode k

V_{ki} = The systematic component of utility function of mode k to i;

The utility function V_{ki}, as indicated earlier, is a function of socioeconomic characteristics of i and the characteristics of mode k.

3.2.3 Model Calibration

The next stage in model development was to estimate model parameters. This was done by fitting a model to the collected data. For the multinomial logit model, the maximum likelihood estimation technique is generally used, [49,51] with this method the coefficients of the model were estimated so as to maximize the likelihood according to model being developed, of observing the choices made by the individual in the collected sample. This was done by iteratively solving the utility function until the best fit

was obtained.

A number of computer packages are available for the calibration of logit models. Examples of such packages are BLOGIT [50], SLOGIT and ULOGIT [44] In this research the BLOGIT package was used to calibrate the disaggregate intercity logit models since this package was available to the researcher. This package uses the maximum likelihood technique to calibrate logit models.

Using maximum likelihood estimation technique, the BLOGIT package will produce estimates of individual parameters by calculating various goodness of fit. The package produces the following tests for the model testing:

1. t-test for parameter estimates.

2. Log likelihood function value $L(\beta)$ at its maximum.

3. Log likelihood function value $L(0)$ when all parameters are zero, in other words when all alternatives are assumed to have equal probability of being chosen.

4. Goodness of fit index ρ^2 (rho squared) that measures the fraction of an initial log likelihood value explained by the model. This value is computed as

$$\rho^2 = 1 - (L(\beta)/L(0))$$

5. Corrected goodness of fit index $\bar{\rho}^2$ (rho - bar squared) similar to ρ^2 but corrected for the number of parameters estimated. $\bar{\rho}^2$ can be calculated using the following equation:

$$\bar{\rho}^2 = 1 - (L(\beta) - K)/L(0)$$

where K is the number of parameters in the model.

6. Prediction success table that shows the number of individuals predicted to use each mode.

In addition, the calibrated models should have expected coefficient signs. In this process the sign for each coefficient was examined and if the coefficient did not have the expected sign then the model was considered to be a valid model. Hence, travel time and travel cost should have negative signs since the increase in these variables will decrease the travel demand.

In addition to the computer package output, the following tests were performed using the likelihood ratio test:

1) Test for All Model Parameters:

This test is performed to find if all model parameters are significantly different from zero, that is,

$$H_0: \beta_1 = \beta_2 = ... \beta_k = 0$$

the statistic

$$-2(L(0) - L(\beta))$$

is Chi square distributed with k degrees of freedom, where k is the number of model parameters.

2) ***Test for All Model Parameters Except the Alternative Specific Constants:***

This test is performed to find if all model parameters, except alternative specific constants are significantly different from zero, that is,

$$H_0: \beta_j = \beta_{j+1} = ... \beta_k = 0$$

the statistic

$$-2(L(C) - L(\beta))$$

where L(C) is the log likelihood of the model containing constants only.

This test is Chi square distributed with k - J + 1 degrees of freedom, where k is the number of parameters and J is the number of alternatives.

3) Test for Difference Between Models:

This test was used to compare two models. It was used to find the effect of introducing mode perceptual variables. If a significant difference exists between Model 1 (the model with mode perception) and Model 2 (the model without mode perception) then we can conclude that mode perception significantly affects the individual mode choice behavior. So, the null hypothesis states that no difference exists between Model 1 and Model 2, or that parameter estimates of all percentual variables are equal to zero. To test this the following test statistics can be used:

$$-2\left(L(\beta_1) - L(\beta_2)\right)$$

where,

$L(\beta_1)$ = Log-likelihood of model with perceptual variables

$L(\beta_2)$ = Log-likelihood of model without perceptual variables

This test is chi square distributed with $k_2 - k_1$ degrees of freedom.

3.2.4 Model Validation

After the calibration process was completed validity of the succeeding models was tested. The model validation process was

done by using a portion of the collected data, other than that used in model calibration, to predict mode choice using the calibrated models. So, the collected survey data was divided into two parts. The first part was used for model calibration while the other was used for model validation.

The validity of the models was tested by comparing observed choices and the predicted choices using the calibrated models. Also, the likelihood ratio test for difference between models was used to compare the calibrated models with models that were calibrated using a portion of the collected data other than that used for model calibration.

Chapter 4

DATA COLLECTION

4.1 INTRODUCTION

This chapter explains data collection efforts for the pilot and main surveys. In addition to this, pilot survey details, which were carried out for scale development, are also presented. The procedure adopted in scale construction is explained in a stepwise manner. The design of the main survey instrument is presented next. The chapter is concluded by explaining the method used in collection and preparation of the data for analysis.

4.2 PILOT SURVEY FOR SCALE CONSTRUCTION

The procedure adopted in scale construction has been extensively used in psychological research and was outlined in Figure 3.2. Following is a step by step explanation of the procedure indicated in Figure 3.2.

The first step is to specify purpose of measurement. The purpose of this research is to develop scales for measuring comfort, convenience, privacy and reliability of travel which will be used in improving the understanding of intercity mode choice behavior.

The next step is to define the environment to which the perceptions will be related. This is the intercity travel environment and the perceptions and choices of travellers who are making intercity trips.

Behavioral criteria is the mode choice in intercity travel. Therefore, the perceptions to be constructed are those which are relevant to mode choice behavior of people.

The next stage in developing a scale is to define hypothetical concepts. It was found from the literature survey that mode comfort, convenience and reliability affect the choice of the traveller. A further concept "privacy" was added to these concepts because it was believed to be an important dimension especially considering local customs in Saudi Arabia.

After defining the hypothetical concepts, a pool of items (statements) or attributes describing these concepts was prepared. A literature survey, expert opinion, focus group meetings and common sense were used to generate this list of items. This process was difficult and required several iterations before a reasonably satisfactory set of items was obtained. This set of items was subjected to a variety of tests and revisions at the items analysis stage. The items were reviewed and tested by many people to assure that no ambiguities were contained in the list. At this stage, concepts were described to several people and they were

then asked to sort the items in these defined concepts. After rounds of review and analysis, a total of 31 items were grouped into four hypothetical concepts namely: comfort, convenience, privacy and reliability. The final list of perceptual items is presented in Table 4.1.

The next stage was to conduct a pilot survey to test perceptual items and the reliability of the scale before conducting the main survey.

4.2.1 Development of Survey Instrument

The pilot survey was designed to test the perceptual items that would be used in the main survey instrument. As shown in Table 4.1, the final list of perceptual items contained 31 items. It was very difficult to include all the listed items in the main survey. Hence the main objectives of pilot survey can be stated as follows:

1. To investigate whether the perceptual items can be categorized into four groups as originally hypothesized.

2. To reduce the number of items in each concept to a manageable number by choosing items which have a high correlation with others in the same concept but a low correlation with items in other concepts.

Table 4.1: List of Perceptual Items

Concept	Item Code	Item
PRIVACY		
	PRIVACY	Having some privacy
	TKFMLY	Taking freely with family members or friends
	ALONFMLY	Being alone with family members or friends
	SITSTGR	Avoid sitting next to a stranger
	DEPOTHRS	Travelling without depending on others
	FEELINDP	Feeling of independence
	TKTOSTRG	Avoid talking to strangers
COMFORT		
	RELAX	Relaxing while travelling
	AVDCRWD	Avoid crowded conditions
	CLEANVEH	Cleanliness of vehicle
	BTHROTHR	Being bothered by other people
	COMFORT	Comfort
	FEELTIRD	Feeling tired at the end of the trip
CONVENIENCE		
	LOCSTOP	Freedom in choosing locations and time of stops
	CHSTIME	Freedom in choosing departure time
	ACCHOME	Accessibility from home

Table 4.1 (continued)

Concept	Item Code	Item
	CARYLUG	Carrying luggage and other belongings easily
	CHNGVEH	The need to change vehicle in reaching final destination
	EFRTSTRT	The efforts required to start the trip
	CONV	Convenience
	EASYDEST	The easiness of reaching final destination after leaving the vehicle
	ADVPLNG	The need for advance planning
	WTTIME	The amount of waiting time and delays
	WAITOTHR	Time spent waiting for others
RELIABILITY		
	ARRONTM	Arriving destination on time
	EFWTHRCN	The effect of weather condition on the trip
	VEHREPR	The feeling that the vehicle would not be delayed for repair
	VARITT	The variation on total travel time
	RELIBLTY	Reliability
	EFWTHRTT	The effect of weather on travel time
	ACCBRKD	The likelihood of accident or breakdown during the trip

A questionnaire was designed to collect information about mode attributes related to comfort, convenience, privacy and reliability. The questionnaire form, shown in Appendix A, consisted of the following parts:

1. Cover Letter: The cover letter explained the purpose of the survey, its importance and confidentiality of responses.

2. PART-I: In this part, people were asked to evaluate four means of travel, namely: bus, private car, plane and train with respect to all the 31 attributes describing the four concepts. The items were randomly arranged. The respondents were asked to record their response on a 5-point scale ranging from WORST (1) to BEST (5) as shown in the following format:

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO:

COMFORT

	WORST				**BEST**
Bus	1	2	3	4	5
Private Car	1	2	3	4	5
Plane	1	2	3	4	5
Train	1	2	3	4	5

3. PART II - Socioeconomic Characteristics of the Respondent was included in this section.

More than 200 questionnaires were distributed among university faculty, students, bus and train travellers. Although this procedure would result in a biased sample, the results can be accepted as our objective is to find correlational structure between the items and to develop the perceptual scales. Nunnally (52) stated that using a biased sample would not harm this objective.

A total of 135 usable questionnaires were collected and analyzed.

4.2.2 Determination of Sample Size for Pilot Survey

The pilot survey was carried out to test perceptual items which were included in the main survey. For this purpose factor analysis was performed on perceptual items. Harman (53) recommended 4-5 responses for each item as a rule of thumb to yield reasonable accuracy. Based on this, since there were 31 perceptual items in the pilot survey, approximately 120 responses were required to perform the analysis. It should be further noted that each respondent was asked to evaluate four alternatives in the pilot survey which means that the actual sample size achieved is four times the number of respondents to the questionnaire.

4.2.3 Development of Preliminary Scales

The 31 statements related to mode perceptions were sub-

jected to factor analysis in order to validate the hypothesized concepts. Based on the correlations among the 31 items, factor analysis groups these items into factors.

The basic assumption of factor analysis is that some underlying dimensions or factors, can be used to explain complex phenomena [53]. Correlations between variables might be attributed to such shared factors as one of the hypothetical concepts.

The use of factor analysis can be classified into the following categories:

1. Explanatory uses - the explanation and detection of patterning of variables with a view to the discovery of new concepts, and a possible reduction of data.

2. Confirmatory uses - the testing of the hypothesis about structuring variables in terms of the expected number of significant factors and factor loadings.

3. Uses as a measuring device - the construction of indices to be used as new variables in later analysis.

In this research, factor analysis was used in a "confirmatory" manner because factors had already been hypothesized earlier. Moreover, it was used to reduce the number of items to a reasonable number for inclusion in the main survey.

Factor analysis was performed according to the principal component technique /varimax rotation using the Statistical Analysis System (SAS) package. Initial factors were determined by common factor analysis with iterations. These factors were orthogonally rotated by the Varimax Method. The rotated factor loadings were obtained for solutions in two through ten dimensions. Table 4.2, 4.3, 4.4 and 4.5 show the rotated factor patterns and variances, explained by each factor for the two-three-four-five-factor solutions respectively. The results of these solutions are summarized in Figure 4.1. In this figure, only those attributes that have high loadings (a loading more than 0.4) on each factor solution, are indicated.

There are a number of criteria to determine the number of factors that are sufficient or adequate for the research. The most frequently used criteria is eigenvalues of one, discontinuity and interpretability. The eigenvalue-one criterion is to limit the factors to those with eigenvalues greater than unity. The discontinuity criterion is to stop increasing the number of factors when there is a sharp decrease in the eigenvalue or the proportion of total variance explained. One other criterion is to continue extracting factors as long as they are interpretable.

The eigenvalue falls below 1.0 at the fifth factor indicating that up to four factors can be extracted. The eigenvalue plot for different number of factors is given in Figure 4.2.

Table 4.2: Rotated Factor Pattern for Two-Factor Solution

Variable	Factor 1	Factor 2
FEELINDP	0.85665	0.19171
ALONFMLY	0.80114	011680
SITSTGR	0.79993	0.01229
CHSTIME	0.75690	-0.25581
LOCSTOP	0.75312	-0.44318
ACCHOME	0.74741	-0.18532
BTHROTHR	0.73782	0.31390
EASYDEST	0.73526	-0.04659
TKFAMLY	0.72191	0.13272
PRIVACY	0.70577	0.27484
ADVPLNG	0.69767	-0.35774
DEPOTHRS	0.68781	0.20334
WTTIME	0.65925	0.22768
CHNGVEH	0.65560	0.06349
CRYLUG	0.61652	0.19884
WAITOTHR	0.56027	0.36523
AVDCRWD	0.54730	0.42940
COMFORT	0.16333	0.78770
VARITT	0.05405	0.73621
RELAX	-0.10303	0.66040
CLEANVEH	0.37295	0.65837
FEELTIRD	-0.08582	0.63736
ACCDBRKD	-0.11985	0.63060
CONV	0.50809	0.60339
ARRONTM	0.35314	0.59698
RELIVLTY	0.41461	0.57902
EFWTHRTT	-0.01505	0.52785
VEHREPR	0.08941	0.50819
EFRTSTRT	0.027838	0.42785
EFWTHRCN	-0.00989	0.36755

Table 4.3: Rotated Factor Pattern for Three-Factor Solution

Variable	Factor 1	Factor 2	Factor 3
FEELINDP	0.82575	0.30405	-0.02787
SITSTRG	0.80239	0.06440	0.05309
LOCSTOP	0.79243	-0.34201	-0.15878
ALONFMLY	0.78918	0.18101	0.04919
ACCHOME	0.76684	-0.11864	-0.03087
CHSTIME	0.76484	-0.11045	-0.21415
EASYDEST	0.74955	-0.02172	0.08643
TKTOSTRG	0.74810	0.26191	0.01480
ADVPLNG	0.74328	-0.32471	-0.00456
TKFAMLY	0.70419	0.20651	0.01566
BTHROTHR	0.68063	0.46844	-0.11770
PRIVACY	0.66838	0.36379	0.00951
DEPOTHRS	0.66731	0.25411	-0.07342
CHNGVEH	0.65351	0.09912	0.07010
WTTIME	0.64942	0.22204	0.19484
CARYLUG	0.58601	0.28619	-0.02127
WAITOTHR	0.53532	0.35138	0.22145
COMFORT	0.06639	0.84432	0.07700
CLEANVEH	0.28504	0.75357	-0.00898
CONV	0.43012	0.69411	0.03465
VARITT	-0.01296	0.68521	0.27681
FEELTIRD	-0.16178	0.65472	0.07941
ARRONTM	0.29642	0.59139	0.21018
RELAX	-0.15981	0.58836	0.27429
RELIBLTY	0.36073	0.57513	0.21527
ADVCRWD	0.48629	0.53201	-0.01979
EFRTSTRT	0.23621	0.43218	0.13775
EFWTHRCN	0.03582	0.01830	0.83167
EFWTHRTT	0.00284	0.21968	0.77549
VEHREPR	0.09165	0.28096	0.61743
ACCDBRKD	-0.14856	0.45670	0.48509

Table 4.4: Rotated Factor Pattern for Four-Factor Solution

Variable	Factor 1	Factor 2	Factor 3	Factor 4
FEELINDP	0.82671	0.31786	-0.00299	-0.08215
SITSTRG	0.80420	0.08078	0.08199	-0.11604
LOCSTOP	0.79423	-0.34131	-0.15927	0.00222
ALONFMLY	0.79111	0.20029	0.08340	-0.13866
CHSTIME	0.76583	-0.11153	-0.21723	0.02719
ACCHOME	0.76579	-0.12523	-0.04227	0.08973
TKTOSTRG	0.75039	0.28354	0.05307	-0.16084
EASYDEST	0.74486	-0.04301	0.05100	0.24182
ADVPLNG	0.74001	0.34724	-0.04368	0.23289
TKFAMLY	0.70780	0.23437	0.06434	-0.22564
BTHROTHR	0.68106	0.47911	-0.09821	-0.05473
PRIVACY	0.66978	0.38197	0.04219	-0.12619
DEPOTHRS	0.66085	0.22769	-0.03009	0.30109
CHNGVEH	0.64981	0.08502	0.04720	0.17364
WTTIME	0.64604	0.21654	0.18776	0.10367
CARYLUG	0.58234	0.27271	-0.04302	0.16932
WAITOTHR	0.52973	0.33644	0.19882	0.19763
COMFORT	0.06176	0.83823	0.07007	-0.10916
CLEANVEH	0.28293	0.75843	-0.02010	0.00513
CONV	0.42778	0.69780	0.04379	0.02118
VARITT	-0.01718	0.68470	0.27995	0.05459
FEELTIRD	-0.16937	0.62720	0.03518	0.29584
ARRONTM	0.29296	0.59216	0.21495	0.04757
RELAX	-0.16325	0.58964	0.28004	0.02568
RELIBLTY	0.35551	0.56604	0.20325	0.14475
ADVCRWD	0.48543	0.53910	-0.00570	-0.02039
EFWTHRCN	0.03301	0.03133	0.85887	-0.07826
EFWTHRTT	-0.00138	0.22679	0.79294	-0.01528
VEHREPR	0.08263	0.25704	0.58135	0.28209
EFRTSTRT	0.22400	0.37744	0.04693	0.56728
ACCDBRKD	-0.16016	0.41634	0.42069	0.43176

Table 4.5: Rotated Factor Pattern for Five-Factor Solution

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
FEELINDP	0.82782	0.29598	0.03176	0.13657	0.03067
SITSTRG	0.80674	0.07238	0.09733	-0.06321	-0.06496
ALONFMLY	0.79517	0.19101	0.10241	-0.08990	-0.07069
LOCSTOP	0.78834	-0.36010	-0.13947	-0.04310	0.01673
ACCHOME	0.76927	-0.12436	-0.09760	0.12908	-0.03687
CHSTIME	0.76076	-0.13723	-0.19211	-0.08450	0.07420
TKTPSTRG	0.75728	0.27660	0.06528	-0.09887	-0.10297
EASYDEST	0.74602	0.04272	-0.02544	0.22564	0.13292
ADVPLNG	0.73357	-0.35692	-0.08416	-0.16711	0.15731
TKFMLY	0.70491	0.20769	0.15626	-0.26290	-0.02223
BTHROTHR	0.68404	0.45515	-0.06921	-0.15514	0.05684
PRIVACY	0.67626	-0.37248	0.05523	-0.10301	-0.05558
CHNGVEH	0.65695	-0.09367	-0.04301	0.21812	0.04086
DEPOTHRS	0.65419	-0.20418	0.01039	-0.09928	0.33513
WTTIME	0.64796	0.21340	0.15617	0.10105	0.10132
CARYLUG	0.57571	-0.24336	-0.02320	-0.03566	0.26604
WAITOTHR	0.53243	-0.33523	0.14534	-0.16083	0.17190
COMFORT	0.07126	0.83535	0.03208	-0.02533	0.13697
CLEANVEH	0.29634	0.75918	-0.02144	-0.00263	0.00926
VARITT	0.00996	0.68957	0.25523	0.04849	0.09779
CONV	0.43466	0.68569	0.03735	-0.05513	0.09521
FEELTIRD	-0.16228	0.63222	-0.04841	0.18619	0.22368
ARRONTM	0.31109	0.61637	0.11326	-0.18746	-0.06804
RELAX	-0.15334	0.60487	0.23828	0.08530	0.01879
RELIBLTY	0.37138	0.58706	0.08999	0.23771	0.01463
AVDCRWD	0.48197	0.50645	0.05947	-0.19898	0.17321
EFWTHRCN	0.02908	0.05118	0.88323	0.11647	0.01697
EFWTHRTT	0.00445	0.24159	0.81022	0.11219	0.08780
VEHREPR	0.10736	0.32793	0.34032	0.64555	-0.10224
ACCDBRKD	0.14801	0.45604	0.24164	0.51878	0.18662
EFRTSTRT	0.19510	0.31424	0.11876	-0.00801	0.81607

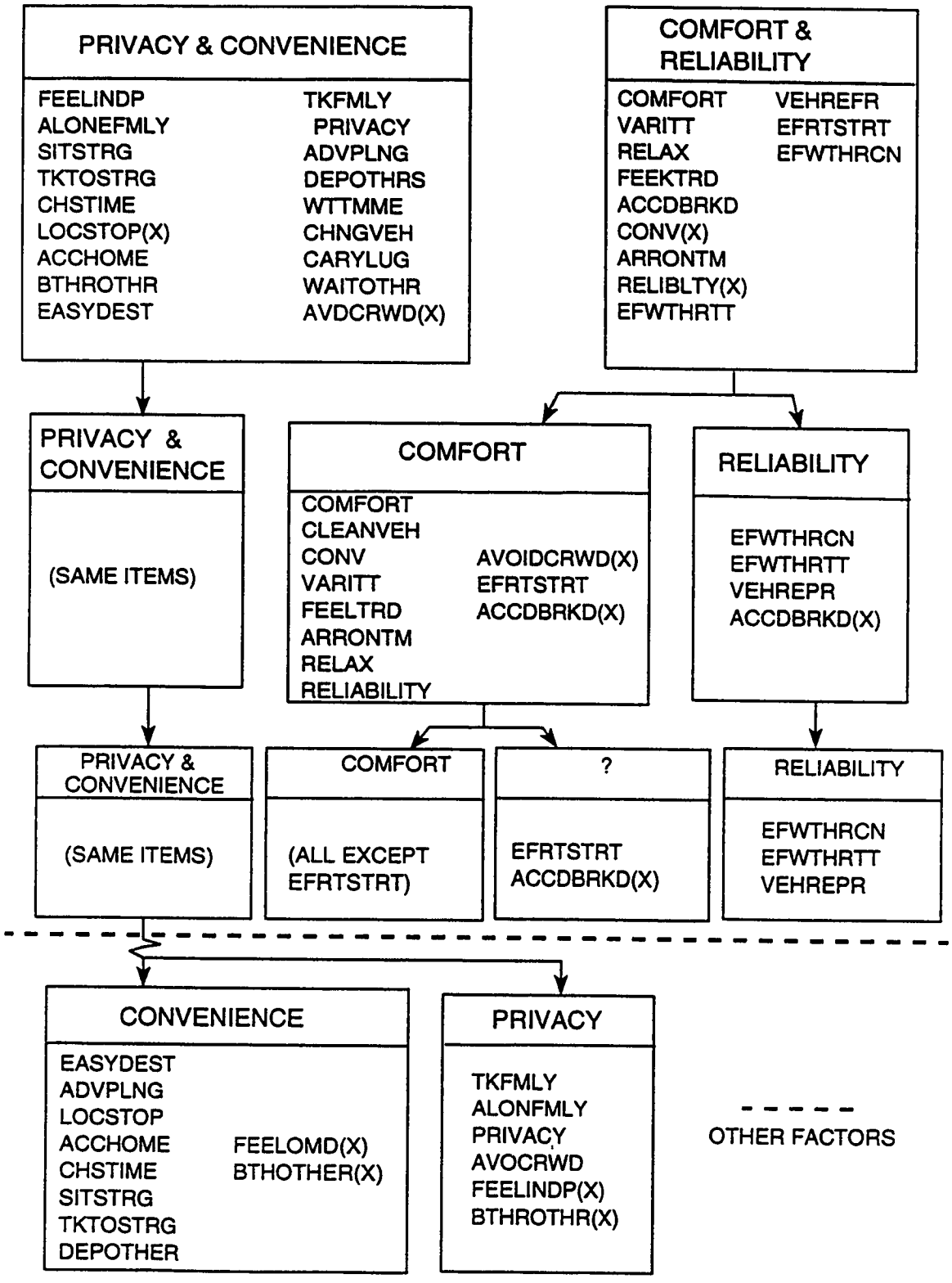


Figure 4.1 Summary of Factor Analysis Results

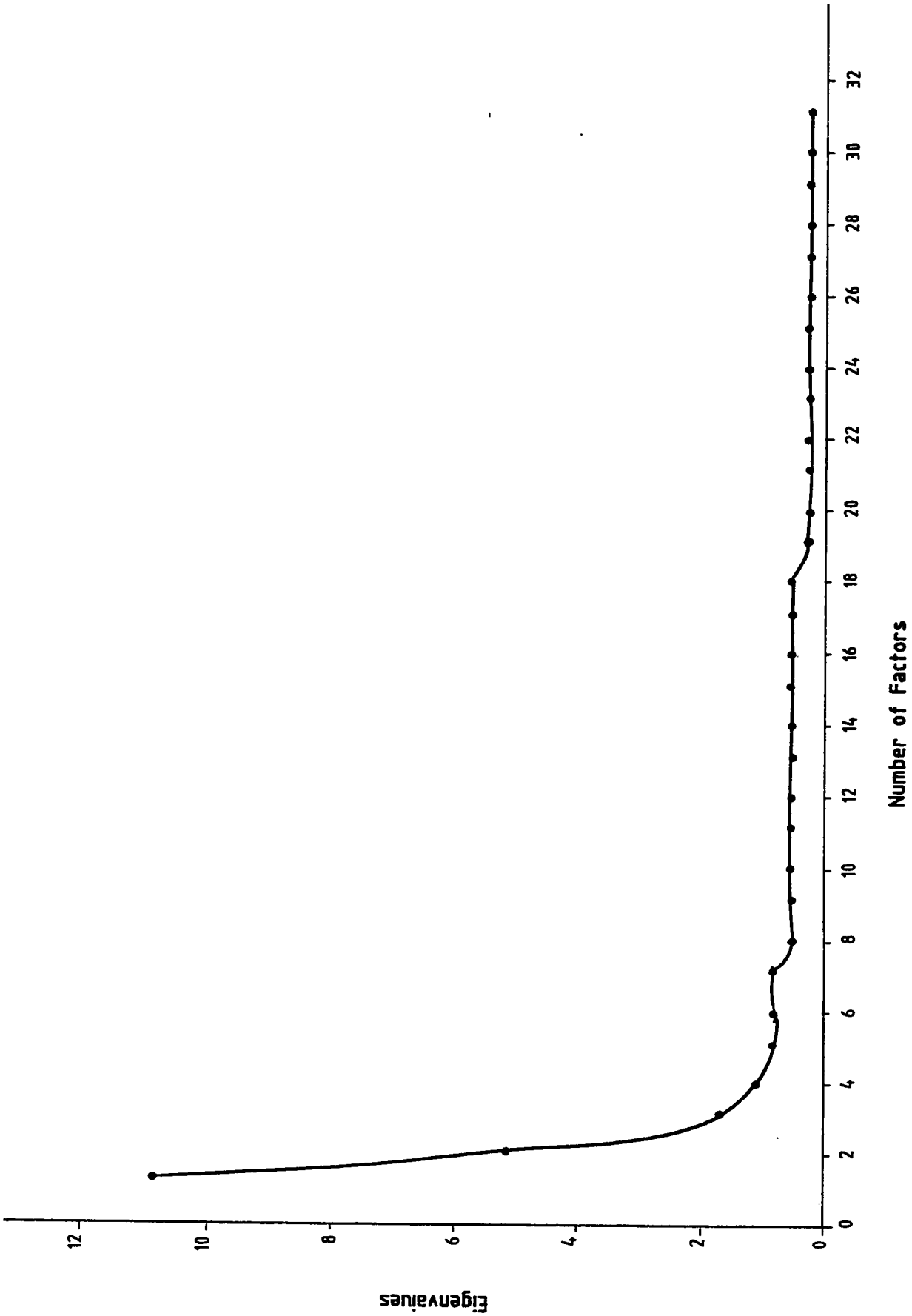


Figure: 4.2 Plot of Eigenvalues.

The results of factor analysis which are summarized in Figure 4.1, revealed that items related to convenience and privacy are loaded in the first factor. The items included in this factor remain in it until the 10-factor solution, where privacy items are separated from convenience items and form a separate factor. The second factor in the two factor solution contains items related to comfort and reliability. It should be noted that items having double loadings in two factors are indicated by (X).

In the three-factor solution, comfort and reliability items are separated from each other and form separate factors. All factors at this stage are interpretable.

In the four-factor solution, factor 3, gets some items from factor 2 and factor 3 of the three-factor solution. It is a meaningless factor as it has only one highly loaded item and another one with a double loading.

In lieu of the above analysis, it can be seen that privacy and convenience items are somewhat correlated. On the other hand, reliability and comfort items constitute separate dimensions. However, since in the tenth factor solution, privacy and convenience items are loaded in separate dimensions and have many items without double loadings, it was decided to keep all four original hypothetical concepts for testing and confirmation using the main survey instrument. Hence a further test for factors will be made

with the data collected in the main survey instrument.

In order to reduce the number of items under each hypothetical concept to a manageable number, only three items with the highest factor loadings were chosen for each factor. These items are listed below:

CONVENIENCE ATTRIBUTES

ADVPLNG	The need for advance planning
LOCSTOP	Freedom in choosing locations and time of stops
ACCHOME	Accessibility from home

PRIVACY ATTRIBUTES

TKFMLY	Talking freely with family members or friends
PRIVACY	Having some privacy
FEELINDP	Feeling of independence

COMFORT ATTRIBUTES

COMFORT	Comfort
CLEANVEH	Cleanliness of vehicles
FEELTIRD	Feeling tired at the end of the trip

RELIABILITY ATTRIBUTES

EFWTHRCN	The effect of weather condition on the trip
VEHREPR	The feeling that the vehicle would not be delayed for repair

EFWTHRTT The effect of weather condition on the travel time

Finally, it is essential for summative scaling to use some reliability measure to investigate the internal consistency of the scale. The goal of reliability analysis is to assess how reliable a sum of scores across items, is as an estimate of the true score of a concept which consists of the items.

The reliability coefficient can be computed by the average correlation among the items using the following formula by Nunnally [52]:

$$r_{kk} = \frac{k\bar{r}_{ij}}{1 + (K - 1)\,\bar{r}_{ij}}$$

where

$\bar{r}_{kk}$ = split-half reliability coefficient of the factor

K = number of items in the factor

$\bar{r}_{ij}$ = average of all possible pairwise correlations between the items.

Since only three items were selected from each factor the K value is 3. The calculated reliability coefficients for each factor are given in the following table:

Factor	$\bar{r}_{kk}$
Privacy	0.85
Convenience	0.84
Comfort	0.76
Reliability	0.70

A satisfactory level of reliability depends on the research type. Split-half reliabilities of 0.70 or higher are considered to be acceptable (Nunnally, 52).

4.3 MAIN SURVEY INSTRUMENT

4.3.1 Development of Main Survey Instrument

The main survey questionnaire was designed to satisfy the requirements for the development of an intercity mode-choice model. It was intended to adopt disaggregate behavioral approach in developing the mode choice models. This approach is relatively recent especially in the intercity travel demand context and is directly related to observing the behavioral patterns of individuals. Therefore, it should include data regarding level of service of available modes, the socioeconomic characteristics of travellers and their perceptions regarding travel modes.

In order to obtain this information there are many possible approaches; ranging from direct interview with individuals to interviewing them by telephone or mailing out questionnaires; keeping in view the basic objectives of the study. These approaches vary as regard to cost, reliability, comprehensiveness and validity.

For this research a self-response questionnaire was distributed to travellers for obtaining necessary information about their intercity trips. The researcher adopted this approach for many reasons. Some of the basic reasons for using self-response questionnaire are cited below:

1) The information to be collected was too vast and complex to be obtained through telephone or by personal interview, which might have resulted in insufficient or unreliable responses.

2) Because of the infrequency of intercity trips by an individual as compared to intracity trips, recall problem might have been faced by the individuals if they were not asked the questions while they were travelling.

3) A mail-out, mail-back survey was not adopted in this research due to the low response rate of such surveys in addition to the recall problem mentioned earlier.

4) The distribution and collection of the questionnaire at the same time or during the trip was expected to increase the response rate. In addition, difficulty in answering the questions could be eliminated.

The design of the questionnaire was finalized after performing a thorough literature survey and several reviews. The final questionnaire included in Appendix (B) is composed of the following parts:

Part I: This part consists of various questions regarding the present trip and characteristics of the mode selected. Separate questionnaires were prepared for different modes. This part started with some general questions regarding trip characteristics, i.e. origin, destination, place of residence, purpose of the trip, duration of stay at the destination and the number of family members making the trip (excluding the respondent) arranged accordingly one after the other.

The remaining questions in this part included the characteristics of the mode selected for travel. As an illustration, air mode travel included egress time, access time, waiting time and time haul. The cost incurred including ticket as well as limousine or taxi fare during travel and the paying party was also asked in this phase. The questions in this part were concluded after noting down the delays experienced in the departure time.

Part II: In this part of the questionnaire details regarding alternative modes and their characteristics were obtained. The first question is related to information regarding captive riders which were not included in the modeling process.

Part III: This part contained the socioeconomic characteristics of the respondents. The information requested covers age, marital status, car ownership, driver's license ownership, occupation, nationality, education and personal and household income.

Part IV: This part includes the evaluation of alternatives with respect to perceptual characteristics. Alternative modes were evaluated with respect to the four perceptual concepts. In this part the 12 perceptual items obtained through the pilot survey were evaluated by the respondent.

Part V: In this part the respondents were asked to indicate the relative importance of the 12 perceptual items in selecting the means of travel. The respondents were asked to record their answers on a 5-point scale ranging from "of no importance" (1) to "extremely important" (5).

In order to remove the irregularity while sorting the questionnaire for data coding, separate forms were prepared for each mode in two languages, viz., Arabic and English. These questionnaires are appended in the appendix for reference.

The survey was conducted in the months of January and February 1993, during the intersemester break for schools. The survey was conducted with assistance from graduate students in various cities around the Kingdom. Various strategies were chosen for increasing reliability during the data collection. For the auto mode, to avoid further delay, respondents were interviewed at gas stations around the major study areas, i.e. Dammam, Riyadh, Madinah, Jeddah and Taif. For air mode the questionnaire was distributed and collected at airport terminals while travellers were waiting at the gates. The travellers were asked to fill in the questionnaire and submit it before departure. For late-comers an addressed envelope was supplied and they were asked to send their replies by mail.

For bus travellers, the questionnaires were distributed and explained inside the bus and travellers were asked to fill them in while in transit. The questionnaires were collected by the bus driver and sent to the bus station the next day. As a consequence of the low educational level of bus riders, most of the questionnaires were completed through interviews.

4.3.2 Determination of Sample Size for Main Survey

A choice-based sampling procedure was used to collect the data. This type of sampling is recommended for an unevenly distributed transportation demand with passengers on roadsides,

trains or planes. With this technique observations are drawn based on the outcome of the decision making process. After identifying the decision group of interest, a random sample of individuals was chosen from this group.

As stated by Snedecor and Cochran [54] the required sample size could be determined, based on the allowable error (L) in the sample mean, the standard deviation and the desired degree of confidence. The formula suggested by Snedecor and Cochran is shown below:

$$n = \frac{[Z(1 - \alpha)/2]^2 \sigma}{L^2}$$

where:

n = sample size

σ = standard deviation

L = allowable error

Z = normal random variable

$1 - \alpha$ = level of confidence

The income variable contains the highest variation among the other variables hence, this variable was used in determining the sample size. In Al-Ahmadi's study (11) the above formula was

used to determine the required sample size. Using the mean household income and standard deviation the required sample was about 90 observations. Richards and Ben-Akiva [43] stated that a sample of 200 to 500 is reasonable for model calibration, however, samples as small as 50 to 70 per mode produced reasonable results.

From the above discussion a sample size of 200 observations was targeted for each market segment. This sample size provided reasonable estimates of the variables, moreover, it was sufficient for model calibration. The data was segregated into two market segments based on the purpose of the trip. So 400 observations were required for model calibration. In addition an independent dataset was needed for validating the calibrated models. It was desirable to use 50% of the total sample size for this purpose. Hence, the total number of observations required for both the calibration and validation process was 600.

Since, the majority of intercity trips in Saudi Arabia are carried out using private autos and the air mode, the sample size of these two alternatives was more than the bus mode; in order to improve reliability.

A total of 1800 questionnaires have been printed and distributed to travellers in all the three modes. Most of these questionnaires were filled through interviews. After discarding non-usable forms a total of 1247 forms were ready to be transferred into

the computer. This represents a response rate of approximately 70%. For a long questionnaire as the one used in this study, this can be considered to be a high response rate compared to similar studies [26,36].

4.4 PREPARATION OF DATA AND DATA CHECKS

After the questionnaire forms were collected, a coding manual was designed to be used for data entry. The coding manual is shown in Appendix (C). The data was entered using numerical codes. Each questionnaire form is represented in two rows of numbers, each row contains 95 columns. Coding was done using specially designed coding sheets. Data then was transferred into the computer by professional data input personnel at the KFUPM Data Processing Center and was also verified by them.

A SAS program was written for checking the data for possible errors in data entry or coding. Three types of data checks were performed:

1. Check for Special Characters:

Since all the data was numeric, alphabetic characters or special characters were not allowed.

2. Range Checks:

Range checks were used to find out whether the value of

a specific variable was exceeded. For instance, mode can only take values between 1 and 3, other values are not valid.

3. Logical Checks:

For instance, household income should be equal to or greater than personal income.

The program was prepared so that it printed the questionnaire number, gave an error message and printed the value causing the error. The errors were corrected referring to the original questionnaires.

4.5 SUMMARY

This chapter explained the techniques used in collecting data for the pilot and main surveys. The methodology adopted in scale construction was also explained. The procedure outlined in Figure 3.2 has been followed and explained step by step. A pilot survey was carried out to test perceptual items that would be used in the main survey instrument. The collected data was subjected to factor analysis in order to validate the hypothesized concept. The results of factor analysis are summarized in Figure 4.1. Out of 31 items only three items with highest factor loadings were chosen for each of the four concepts. To investigate the internal consistency of the scale their reliability coefficients were estimated using the

formula proposed by Nunnally (52). It was found that split-half reliability coefficients of all the four concepts were above 0.70, which was considered to be acceptable.

The main survey instrument was designed to satisfy the requirements for the development of the intercity mode-choice model. A self-response questionnaire was distributed to the traveller to obtain the necessary information about their intercity trip. The final questionnaire contained five parts. The first part included general questions regarding trip characteristics, whereas in the second part information regarding alternative means of travel was obtained. The socioeconomic characteristics of the travellers were contained in Part 3. In Parts 4 and 5 the respondent was asked to evaluate alternative means of travel with respect to the perceptual concepts. The survey was carried out in the months of January and February, 1993, on al the major corridors of the Kingdom. Finally, the collected questionnaire forms were coded and checked for any possible errors in the data entry or coding.

Chapter 5

ANALYSIS OF DATA

5.1 INTRODUCTION

After preparing the collected data and performing the necessary checks the data was ready for analysis. This chapter is devoted to the analysis of the collected data. Initially, frequency tables as well as cross-frequency tables were highlighted to study the effect of the variables affecting the mode-choice. Furthermore, using the main survey data, factor analysis was performed for testing the scales constructed from the pilot survey. In addition, mode perception variables were analyzed for different mode users. Finally, the effect of the socioeconomic characteristics of the travellers on mode perception was investigated.

5.2 PRELIMINARY ANALYSIS OF COLLECTED DATA

A total of 867 questionnaires were used for this study, excluding captive riders from the analysis. Captive travellers are those who stated that they "would never use" any of the alternative modes for a trip similar to the one that they were making at the time of the interview. Captive riders have been excluded from the analysis since these riders did not have the choice of mode,

hence their responses are not be used in modeling the choice of mode for intercity trips. The following numbers of travellers selected the three models: air 399, private cars 268, and bus 200.

The preliminary analysis of the collected data was carried out using the SAS (Statistical Analysis System) package [55].

Tables 5.1 through 5.12 show the frequency distributions of various characteristics of trips and travellers. Around 35 percent of the intercity trips were work or personal business trips, as shown in Table 5.1. Social and recreational trips constituted 38.8%. Fifty percent of the intercity trips were shorter than 600 kilometers (see Table 5.2).

The duration of stay of about 50% of intercity trips was less than four days as shown in Table 5.3. For 18.5% of trips, the trip duration was more than seven days.

Table 5.4 shows that the age of 8.5% of the interviewed travellers was less than 20 years. About 43% of them were 20-30 years old. As can be seen from Table 5.5 about 70% of travellers were married. In addition, Table 5.6 shows the analysis of the travellers with respect to their car ownership. It was found that about 15.3% of the intercity travellers did not own a car.

Table 5.7 highlights the frequency results of various travellers' occupations. It can be seen that 15.8% of travellers were

Table 5.1: Frequency Table for Various Trip Purposes

Trip Purpose	Frequency	Percent
Work	173	20.0
Personal Business	126	14.5
Social/Recreation	336	38.8
Educational/Study	27	3.1
Umra	152	17.5
Others	52	6.0

Table 5.2: Frequency Table for Different Trip Lengths

Trip Length (km)	Frequency	Percent
< 400	377	43.5
400 - 600	79	9.1
600 - 800	49	5.7
800 - 1000	176	20.3
1000 - 1200	44	5.1
1200 - 1400	125	14.4
> 1400	17	2.0

Table 5.3: Frequency Table for Different Durations of Stay at Destinations

Duration of Stay	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1 - 3 days	437	50.4	437	50.4
4 - 7 days	270	31.1	707	81.5
8 - 30 days	101	11.6	808	93.2
> 30 days	58	6.7	866	100.0

Table 5.4: Frequency Table for Various Age Groups

Age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
< 20	74	8.5	74	8.5
20 - 30	374	43.1	448	51.7
30 - 40	266	30.7	714	82.4
40 - 50	121	14.0	835	96.3
> 50	32	3.7	867	100.0

Table 5.5: Frequency Table for Marital Status

Marital Status	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Married	601	69.3	601	69.3
Not Married	266	30.7	867	100.0

Table 5.6: Frequency Table for Car Ownership

Number of Cars	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	133	15.3	133	15.3
1	565	65.2	698	80.5
2	118	13.6	816	94.1
> 2	51	5.8	867	100.0

Table 5.7: Frequency Table for Different Occupations

Occupation	Frequency	Percent
Student	137	15.8
Govt. Employee	422	48.7
Businessman	97	11.2
Unemployed	14	1.6
Retired	9	1.0
Private Sector	186	21.5

Table 5.8: Frequency Table for Different Nationalities

Nationality	Frequency	Percent
Saudis	610	70.4
Americans	7	0.8
Europeans and Australians	8	0.9
Asians and Far Easterners	42	4.8
Other Arabs	189	21.8
Africans	5	0.6
Unsp. Non-Saudi	6	0.6

students, 48.7% were government employees and 21.5% were employed in the private sector. Analysis of the nationalities of the travellers showed that about 70% of them were Saudi. The remaining were various different nationalities. The details of this analysis are shown in Table 5.8. The highest level of education for more than 50% of the travellers was high school or lower. Table 5.9 shows the level of education of the interviewed travellers. Only 9.6% of travellers had no driving license (see Table 5.10).

The highest percentage of travellers had a monthly income between SR 2500 - SR 5000. These percentages were 29.2% for personal income and 26.3% for household income. The monthly personal income of about 57% was not greater than SR 5000, while 57.4% had monthly household income of not greater than SR 7500. The results of this analysis are reported in Tables 5.11 and 5.12 for both personal and household income respectively.

To make a preliminary study for the effects of these socioeconomic variables on the chosen modes, various cross-frequency tables were prepared. In Table 5.13 selected mode with various trip purposes is presented. The entries in the cells, from top to bottom, represent cell frequency, cell percentage, row percentage (Row Pct) and Column Percentage (Col Pct), respectively. It can be observed from the table that a very large portion of work and personal business trips (64% and 62% respectively), were

Table 5.9: Frequency Table for Different Educational Levels

Level of Education	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Primary or Lower	54	6.2	54	6.2
Intermediate and High School	388	44.9	442	51.0
University Degree	420	48.4	862	99.4

Table 5.10: Frequency Table for Driving License Possession

Driving License	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Have	784	90.4	784	90.4
Don't Have	83	9.6	867	100.0

Table 5.11: Frequency Table for Various Personal Income Categories

Personal Income	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Less Than SR 1000	116	13.4	116	13.4
1001 - 2500 SR	125	14.4	241	27.8
2501 - 5000 SR	253	29.2	494	57.0
5001 - 7500 SR	147	17.0	641	73.9
7501 - 10000 SR	121	14.0	762	87.9
10001 - 12500 SR	45	5.2	807	93.1
12501 - 15000 SR	19	2.2	826	95.3
More than 15000 SR	41	4.7	867	100.0

Table 5.12: Frequency Table for Various Household Income Categories

Household Income	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Less Than SR 1000	25	2.9	25	2.9
1001 - 2500 SR	80	,9.2	105	12.1
2501 - 5000 SR	228	26.3	333	38.5
5001 - 7500 SR	164	18.9	497	57.4
7501 - 10000 SR	154	17.8	651	75.2
10001 - 12500 SR	67	7.7	718	82.9
12501 - 15000 SR	53	6.1	771	89.0
More than 15000 SR	95	11.0	866	100.0

Table 5.13: Cross-Frequency Table for Mode by Trip Purpose

Mode	Trip Purpose						
	Work	Personal Business	Soc./Recr.	Educ./ Study	Umra	Others	
Air	111.00° 12.80°° 27.82± 64.16±±	78.00 9.00 19.55 61.90	132.00 15.22 33.08 39.29	20.00 2.31 5.01 74.07	24.00 2.77 6.02 15.79	34.00 3.92 8.52 65.38	399.00 46.02
Car	19.00° 2.19°° 7.09± 10.98±±	18.00 2.08 6.72 14.29	140.00 16.15 52.24 41.67	1.00 0.12 0.37 3.70	79.00 9.11 29.48 51.97	11.00 1.27 4.10 21.15	268.00 30.91
Bus	43.00° 4.96°° 21.50± 24.86±±	30.00 3.46 15.00 23.81	64.00 7.38 32.00 19.05	6.00 0.69 3.00 22.22	49.00 5.65 24.50 32.24	7.00 0.81 3.50 13.46	200.00 23.07
Total	173.00 19.95	126.00 14.53	336.00 38.75	27.00 3.11	152.00 17.53	52.00 6.00	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

carried out using air mode. Private cars were used for most of the social and recreational trips (42%). However, an almost equal portion (39%) of such trips were made by air. Air mode was used in 74.07% of the educational or study trips. Most of those travellers were students, due to the special discount given (50%) by SAUDIA Airlines. The preference of Umra travellers was private car (52%).

Table 5.14 shows that the travel distance of about 60% of auto trips was less than 600 kilometers. As the distance increases, the percentage of car use decreases. It seems that people tend to use air mode for long distances. About 48% of air trips were for a distance more than 800 kilometers and as the distance increased the percentage of air trips also increased. The share of buses does not seem to be affected by the travel distance.

The duration of stay for various modes is shown in Table 5.15. This table shows that the duration of stay of about 63% of trips using air mode was 1-3 days. On the other hand, the duration of stay of about 58% of auto travellers was more than three days. Therefore, it seems that the air mode is preferred for trips with a short duration of stay. For a long duration of stay, people tend to use their car for such trips since it can be used as long as they stay in their destination. The duration of stay of about

Table 5.14: Cross-Frequency Table for Mode by Trip Length

Mode	Trip Length (km)							
	< 400	400-600	600-800	800-1000	1000-1200	1200-1400	> 1400	Total
Air	166.00° 19.15°° 41.60± 44.03±±	20.00 2.31 5.01 25.32	21.00 2.42 5.26 42.85	70.00 8.07 17.54 39.77	22.00 2.54 5.51 50.00	84.00 9.69 21.05 67.20	16.00 1.85 4.01 94.12	399.00 46.02
Car	114.00° 13.15°° 42.54± 30.24±±	47.00 5.42 17.54 59.49	18.00 2.08 6.72 36.73	69.00 7.96 25.75 39.20	08.00 0.92 2.99 18.18	12.00 1.38 4.48 9.60	0.00 0.00 0.00 0.00	268.00 30.91
Bus	97.00° 11.19°° 48.50± 25.73±±	12.00 1.38 6.00 15.19	10.00 1.15 5.00 20.41	37.00 4.27 18.50 21.02	14.00 1.61 7.00 31.82	29.00 3.34 14.50 23.26	1.00 0.12 0.50 5.88	200.00 23.07
Total	377.00 43.48	79.00 9.11	49.00 5.65	176.00 20.30	44.00 5.07	125.00 14.42	17.00 1.96	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Table 5.15: Cross-Frequency Table for Mode by Duration of Stay

Mode	Duration				
	1-3 Days	4-7 Days	8-30 Days	>30 Days	Total
Air	252.00° 29.07°° 63.16± 57.67±±	93.00 10.73 23.31 34.44	33.00 3.81 8.27 32.67	21.00 2.42 5.26 36.21	399.00 46.02
Car	113.00° 13.03°° 42.16± 25.86±±	109.00 12.57 40.67 40.37	35.00 4.04 13.06 34.65	11.00 1.27 4.10 18.97	268.00 30.91
Bus	72.00° 8.30°° 36.00± 16.48±±	68.00 7.84 34.00 25.19	33.00 3.81 16.59 32.67	26.00 3.00 13.00 44.84	199.00 23.07
Total	437.00 50.40	270.00 31.14	101.00 11.65	58.00 6.69	866.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

64% of bus riders was more than three days. Hence the travel time of the bus is long and people tend to use the bus for long duration of stay trips.

Table 5.16 shows that more than 70% of the travellers using air or bus mode were travelling alone. On the other hand about 80% of auto travellers were accompanied by their family members. So people accompanied by their family tended to use private car since the cost of travel is not affected by the number of travellers, while in other modes cost of travel increases as number of family members increases.

Car ownership is shown in Table 5.17. About 15% of the travellers did not own cars, out of which 63.9% selected the bus for their intercity trips. So, the preference of travellers without private cars was the bus, since most of those people belong to low income categories.

Table 5.18 shows that 90.4% of travellers had driving licences and 63.86% of the remaining travellers selected the bus. So people without driver's licences tend to use the bus since they do not own cars mostly due to their low income or age.

Table 5.19 shows that more than 50% of the interviewed bus riders were from the Far East, Asia or other Arab countries but 79.1% of car users were Saudi. More than 80% of air travellers

Table 5.16: Cross-Frequency Table for Mode by Accompanied Family Size

Mode	Family Size					
	1	2	3	4	>4	Total
Air	292.00° 33.68°° 73.18± 59.59±±	54.00 6.23 13.53 43.90	21.00 2.42 5.26 27.63	12.00 1.38 3.01 17.65	20.00 2.31 5.01 18.18	399.00 46.02
Car	55.00° 6.34°° 20.52± 11.22±±	40.00 4.61 14.93 32.52	44.00 5.07 16.42 57.89	50.00 9.11 18.66 73.53	79.00 0.00 24.48 71.82	268.00 30.91
Bus	143.00° 16.49°° 71.50± 29.18±±	29.00 3.34 14.50 23.58	11.00 1.27 5.50 14.47	6.00 0.69 3.00 8.82	11.00 1.27 5.50 100.00	200.00 23.07
Total	490.00 56.52	123.00 14.19	76.00 8.77	68.00 7.84	110.00 12.69	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Table 5.17: Cross Frequency Table for Mode by Car Ownership

Mode	Number of Cars				
	0	1	2	> 2	Total
Air	38.00° 4.38°° 9.52± 28.57±±	274.00 31.60 68.67 48.50	62.00 7.15 15.54 52.54	25.00 2.89 6.27 49.02	399.00 46.02
Car	10.00° 1.15°° 3.73± 7.52±±	193.00 22.26 72.01 34.16	46.00 5.31 17.16 38.98	19.00 2.19 7.09 37.25	268.00 30.91
Bus	85.00° 9.80°° 42.50± 63.91±±	98.00 11.30 49.01 17.35	10.00 1.15 5.00 8.47	7.00 0.81 3.50 13.73	200.00 23.07
Total	133.00 15.34	565.00 65.17	118.00 13.61	51.00 5.88	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Table 5.18: Cross Frequency Table for Mode by Driving License

Mode	Driving License		
	Have	Don't Have	Total
Air	375.00° 43.25°° 93.98± 47.83±±	24.00 2.77 6.02 28.92	399.00 46.02
Car	262.00° 30.22°° 97.76± 33.42±±	6.00 0.69 2.24 7.23	268.00 30.91
Bus	147.00° 16.96°° 73.50± 18.75±±	53.00 6.11 26.50 63.86	200.00 23.07
Total	784.00 90.43	83.00 9.57	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Table 5.19: Cross-Frequency Table for Mode by Nationality

Mode	Nationality							
	Saudi	Americans	European/ Austral.	Asian and Far East	Other Arabs	Africans	Unspecf. Non-Saudis	Total
Air	312.00° 35.99°° 78.20± 51.15±±	3.00 0.35 0.75 42.86	8.00 0.92 2.01 100.00	7.00 0.81 1.75 16.67	68.00 7.84 17.04 35.98	0.00 0.00 0.00 0.00	1.00 0.12 0.25 16.67	399.00 46.02
Car	212.00° 24.45°° 79.10± 34.75±±	2.00 0.23 0.75 28.57	0.00 0.00 0.00 0.00	5.00 0.58 1.87 11.90	45.00 5.19 16.79 23.81	2.00 0.23 0.75 40.00	2.00 0.23 0.75 33.33	268.00 30.91
Bus	86.00° 9.92°° 43.00± 14.10±±	2.00 0.23 1.00 28.57	0.00 0.00 0.00 0.00	30.00 3.46 15.00 71.43	76.00 8.77 38.00 40.21	3.00 0.35 1.50 60.00	3.00 0.35 1.50 50.00	200.00 23.07
Total	610.00 60.36	7.00 0.81	8.00 0.92	42.00 4.84	189.00 21.80	5.00 0.58	6.00 0.69	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

were either Saudis, Americans, Europeans or Australians. So, the air mode was preferred by nationalities in the high income category while the bus was used by nationalities in the low income categories. Saudi travellers were the highest users of private cars since most of them own reliable cars and are familiar with the road network.

Personal as well as household incomes for the three different modes are shown in Tables 5.20 and 5.21, respectively. These tables show that most of the bus riders belong to the low income category. On the other hand, as income increases the percentage of people choosing the air mode increases.

The age and marital status of the trip makers seems not to affect the mode choice.

5.3 CONFIRMATORY ANALYSIS OF SCALES WITH MAIN SURVEY DATA

Factor analysis was performed using the main survey data for testing the scales constructed in the pilot survey and to test the basic assumption that the chosen 12 items in the pilot survey represent measures of mode comfort, convenience, privacy and reliability. In this way factor analysis is used in a confirmatory manner because factors were already established in the pilot survey.

Table 5.20: Cross-Frequency Table for Mode by Personal Income

Mode	Personal Income								
	Less Than 1000 (SR)	1001-2500 (SR)	2501-5000 (SR)	5001-7500 (SR)	7501-10000 (SR)	10001-12500 (SR)	12501-15000 (SR)	More Than 15000 (SR)	Total
Air	51.00° 5.88°° 12.78± 43.97±±	39.00 4.50 9.77 31.20	94.00 10.84 23.56 37.15	68.00 7.84 17.04 46.26	74.00 8.54 18.55 61.16	25.00 2.88 6.27 55.56	15.00 1.73 3.76 78.95	33.00 3.81 8.27 80.49	399.00 46.02
Car	25.00° 2.88°° 9.33± 21.55±±	19.00 2.19 7.09 15.20	95.00 10.96 35.45 37.55	65.00 7.50 24.25 44.22	42.00 4.84 15.67 34.71	15.00 1.73 5.60 33.33	3.00 0.35 1.12 15.79	4.00 0.46 1.49 9.76	268.00 30.91
Bus	40.00° 4.61°° 20.00± 34.48±±	67.00 7.73 33.50 53.60	64.00 7.38 32.00 25.30	14.00 1.61 7.00 9.52	5.00 0.58 2.50 4.13	5.00 0.58 2.50 11.11	1.00 0.12 0.50 5.26	4.00 0.46 2.00 9.76	200.00 23.07
Total	116.00 13.38	125.00 14.42	253.00 29.18	147.00 16.96	121.00 13.96	45.00 5.19	19.00 2.19	41.00 4.73	867.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Table 5.21: Cross-Frequency Table for Mode by Household Income

Mode	Household Income								
	Less Than 1000 (SR)	1001-2500 (SR)	2501-5000 (SR)	5001-7500 (SR)	7501-10000 (SR)	10001-12500 (SR)	12501-15000 (SR)	More Than 15000 (SR)	Total
Air	6.00° 0.69° 1.50° 24.00°°	18.00 2.08 4.51 22.50	84.00 9.70 21.05 36.84	64.00 7.39 16.04 39.02	91.00 10.51 22.81 59.09	36.00 4.16 9.02 53.73	33.00 3.81 8.27 62.26	67.00 7.74 16.79 70.53	399.00 46.02
Car	4.00° 0.46° 1.50° 16.00°°	12.00 1.39 4.49 15.00	75.00 8.66 28.09 32.89	60.00 6.93 22.47 36.59	55.00 6.35 20.60 35.71	23.00 2.66 8.61 34.33	16.00 1.85 5.99 30.19	22.00 2.54 8.24 23.16	267.00 30.83
Bus	15.00° 1.73° 7.50° 60.00°°	50.00 5.77 25.00 62.50	69.00 7.97 34.50 30.26	40.00 4.62 20.00 24.39	8.00 0.92 4.00 5.19	8.00 0.92 4.00 11.94	4.00 0.46 2.00 7.55	6.00 0.69 3.00 6.32	200.00 23.09
Total	25.00 2.89	80.00 9.24	228.00 26.33	164.00 18.94	154.00 17.78	67.00 7.74	53.00 6.12	95.00 10.97	866.00 100.00

Frequency°
Percent°°
Row Percent±
Col. Percent±±

Factor analysis was performed using the principal component technique and varimax rotation with the SAS package [55]. Rotated orthogonal factor loadings were obtained for solutions in 2 - 5 dimensions. The rotated factor patterns for these solutions are given in Tables 5.22, 5.23, 5.24 and 5.25. The results of these solutions are summarized in Figure 5.1. In this figure the attributes that have high loads on each factor solution are indicated and the factors have been named after the items that have high loadings on them.

A criterion for deciding on the number of factors is the eigenvalue, as mentioned earlier in this report. This criterion suggests that factor extraction should be stopped when the eigenvalue drops below 1. The eigenvalue plot for different number of factors is given in Figure 5.2. According to this figure eigenvalues fall below 1 at the fourth factor, therefore, up to three factors can be extracted.

Another criterion is the "interpretability" of the factors. The loaded items in the factors should represent a clear meaning. In the two factor solution, the first factor has all of the items related to privacy and convenience. The items included in this factor remain in the three-, four-, and five-factor solution, which indicate that privacy and convenience items are somewhat correlated. In the second factor, comfort and reliability items were

Table 5.22: Rotated Factor Pattern for Two-Factor Solution

Variable	Factor 1	Factor 2	Variable description
LOCSTOP	0.84519	-0.22292	Location and Time of Stops
ACCHOME	0.81328	-0.00649	Accessibility from Home
FEELINDP	0.80447	-0.30815	Feeling of Independence
TKFAMLY	0.78472	0.26816	Talking freely with family
ADVPLNG	0.75106	-0.12143	Need for advance planning
PRIVACY	0.72130	0.37529	Have some privacy
COMFORT	0.05925	0.79957	Comfort
FEELTIRD	-0.20070	0.76700	Feeling tired at the end of trip
CLEANVEH	0.27400	0.68853	Cleanliness of vehicle
EFWTHRTT	0.01335	0.68258	Effect of weather on travel time
EFWTHRCN	0.02860	0.63300	Effect of weather condition
VEHREPR	0.18193	0.61952	Vehicle not delayed for repair

Table 5.23: Rotated Factor Pattern for Three-Factor Solution

Variable	Factor 1	Factor 2	Factor 3	Variable Description
LOCSTOP	0.85099	-0.21863	-0.6095	Location and time of stops
ACCHOME	0.81465	-0.04079	0.06274	Accessibility from home
FEELINDP	0.79691	0.31135	0.13162	Feeling of independence
TKFAMLY	0.77811	0.27307	0.11450	Talking freely with family
ADVPLNG	0.75525	-0.15351	0.01659	Need for advance planning
PRIVACY	0.71049	0.43513	0.08568	Have some privacy
COMFORT	0.03871	0.81494	0.27313	Comfort
CLEANVEH	0.25483	0.75965	0.17249	Cleanliness of vehicle
FEELTIRD	-0.21989	0.75885	0.28181	Feeling tired at the end of trip
EFWTHRCN	0.02615	0.13131	0.83089	Effect of weather condition
EFWTHRTT	0.00888	0.20934	0.81435	Effect of weather on travel time
VEHREPR	0.17503	0.29772	0.61517	Vehicle not delayed for repair

Table 5.24: Rotated Factor Pattern for Four-Factor Solution

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Variable Description
LOCSTOP	0.85017	-0.22546	-0.05288	-0.03399	Location and time of stops
ACCHOME	0.81645	-0.04378	0.05399	0.01827	Accessibility from home
FEELINDP	0.30795	0.30795	0.08971	0.18312	Feeling of independence
TKFAMLY	0.77960	0.26761	0.06632	-0.09676	Talking freely with family
ADVPLNG	0.74739	-0.16759	-0.03956	0.12470	Need for advance planning
PRIVACY	0.71937	0.43718	0.07815	-0.01095	Have some privacy
COMFORT	0.04444	0.81793	0.19249	0.18115	Comfort
FEELTIRD	-0.20884	0.77130	0.24676	0.08966	Feeling tired at the end of trip
CLEANVEH	0.26347	0.76328	0.12786	0.07793	Cleanliness of vehicle
EFWTHRCN	0.05228	0.17653	0.87379	0.06843	Effect of weather condition
EFWTHRTT	0.02733	0.24407	0.79974	0.18954	Effect of weather on travel time
VEHREPR	0.14131	0.26211	0.26038	0.90505	Vehicle not delayed for repair

Table 5.25: Rotated Factor Pattern for Five-Factor Solution

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Variable Description
FEELINDP	0.84205	0.20739	0.08195	0.13644	-0.06211	Feeling of independence
LOCSTOP	0.82268	-0.29866	-0.04787	-0.00876	0.12320	Location and time of stops
TKFMLY	0.78517	0.21262	0.05760	0.011041	-0.12756	Talking freely with family
ACCHOME	0.78392	-0.08510	-0.05291	0.01884	0.22507	Accessibility from home
PRIVACY	0.78196	-0.33594	0.06875	0.04567	0.12279	Have some privacy
COMFORT	0.10361	0.82960	0.17023	0.17229	-0.00307	Comfort
FEELTIRD	-0.16222	0.82532	0.22612	0.05706	0.04314	Feeling tired at the end of trip
CLEANVEH	0.35543	0.70440	-0.10995	-0.11890	-0.19230	Cleanliness of vehicle
EFWTHRCN	0.10398	0.14254	0.87044	0.12369	-0.21241	Effect of weather condition
EFWTHRTT	0.00593	0.31367	0.78925	0.15246	0.22554	Effect of weather on travel time
VEHREPR	0.14348	0.24301	0.24398	0.092433	-0.01783	Vehicle not delayed for repair
ADVPLNG	0.62715	-0.10419	-0.04228	0.03405	0.66345	Need for advance planning

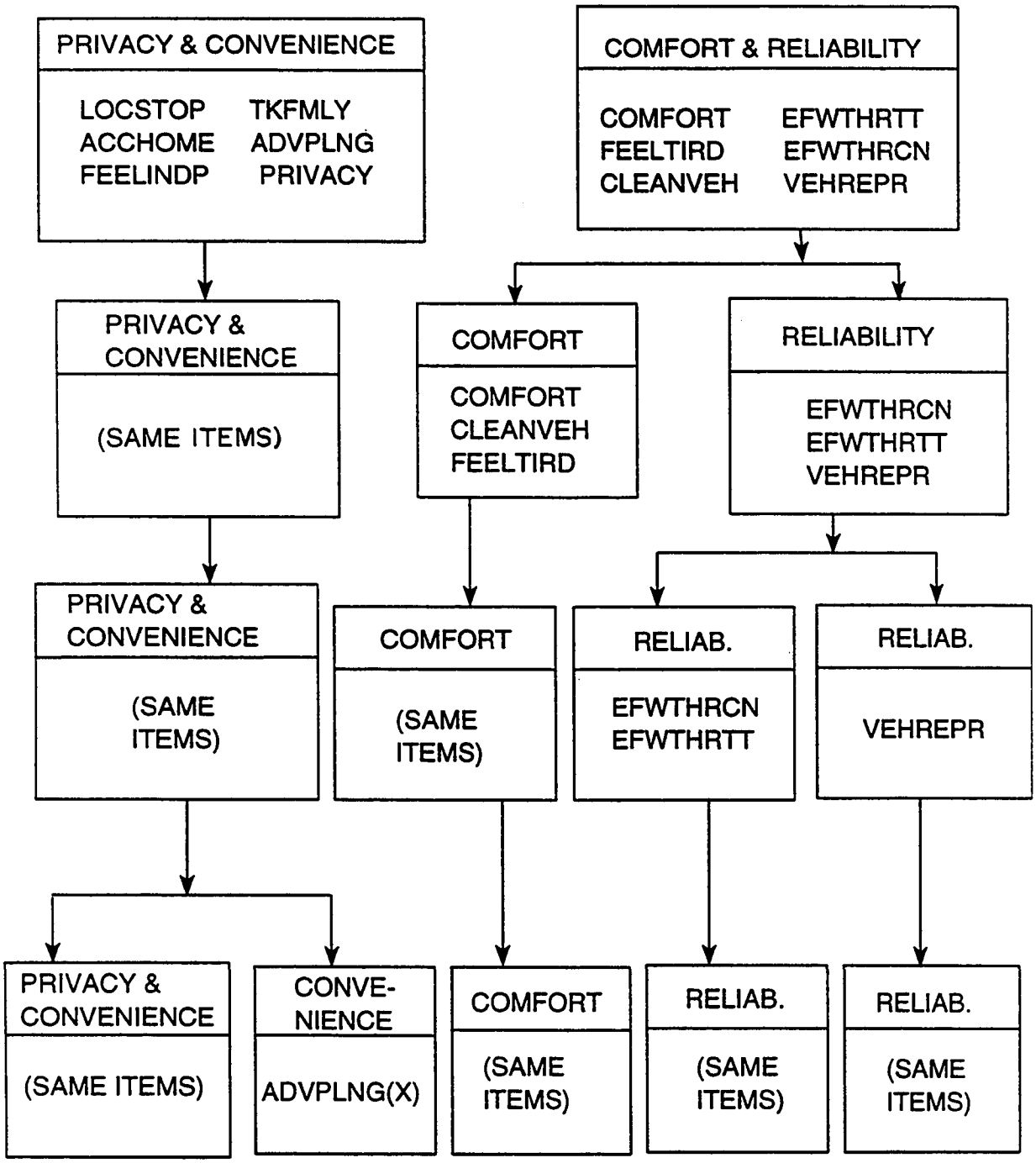


Figure 5.1 : Summary of Factor Analysis Results

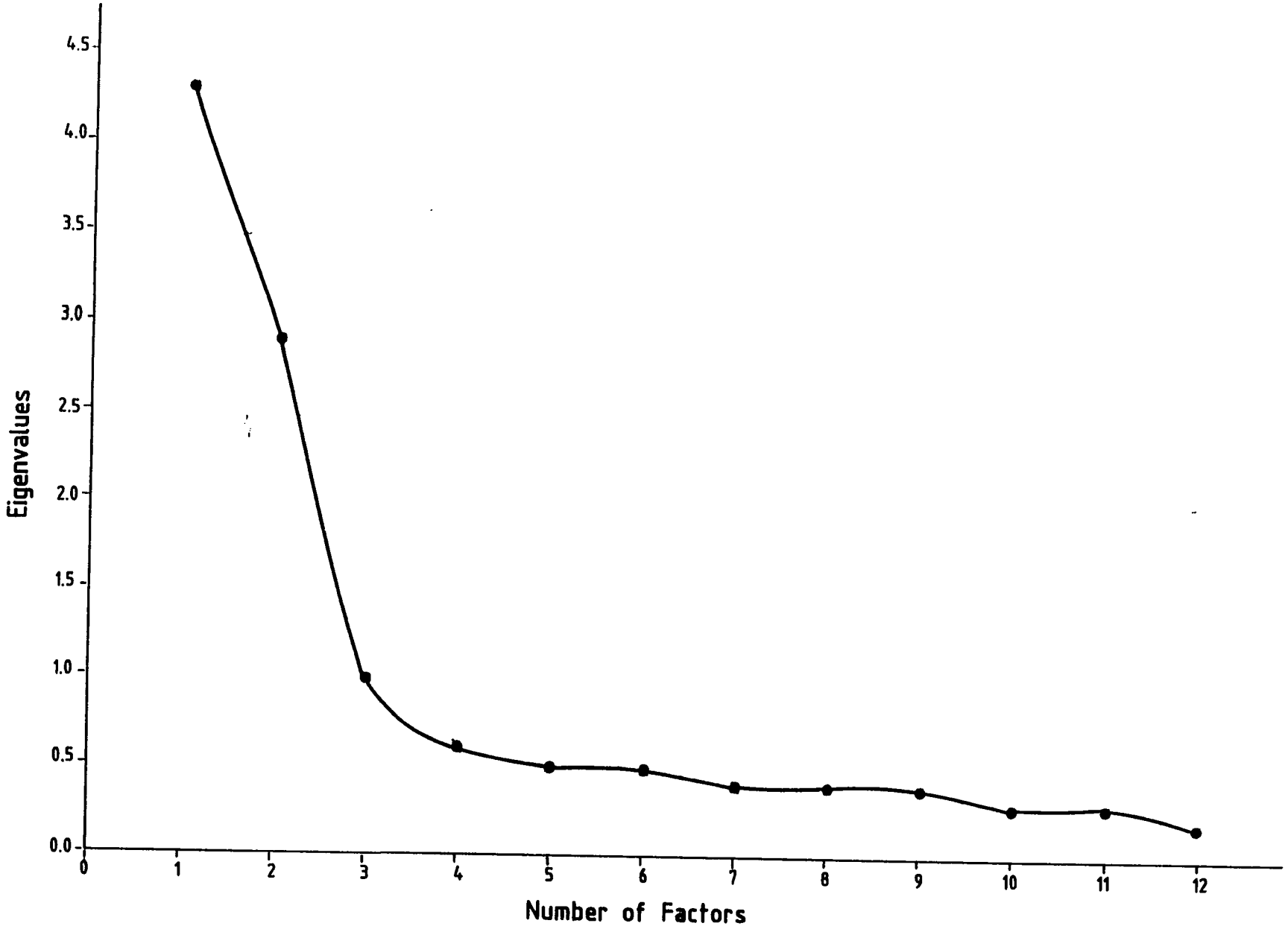


Figure: 5.2 Plot of Eigenvalues.

loaded.

In the three-factor solution, comfort and reliability items split from each other forming separate factors. All the factors here are interpretable.

In the four-factor solution, the reliability was split into two factors with the item VEHREPR loaded in the fourth factor. Also here, the eigenvalue dropped to 0.6329. The four factor as well as the five factor solutions are meaningless as the fourth and the fifth factors have only one item and furthermore one of these items (ADVPLNG) has double loadings in two factors.

As a result of this analysis, it seems that privacy and convenience are somehow related to each other; however, the "reliability" and "comfort" dimensions appear as separate factors which confirm the analysis done in the pilot survey and the constructed scale.

Further analysis was performed on the perceptual items related to privacy and convenience concepts to investigate whether these items could be separated into two factors. The result of factor analysis for privacy and convenience items revealed that the items were loaded into two different factors. Table 5.26 shows the rotated factor pattern for a two-factor solution. From the table it can be seen that all items related to privacy were highly loaded in

Table 5.26: Rotated Factor Pattern for Two-Factor Solution for Privacy and Convenience Items

Variable	Factor 1	Factor 2	Variable Description
PRIVACY	0.86457	0.20832	Have some privacy
FEELINDP	0.82547	0.35127	Feeling of independence
TKFAMLY	0.76214	0.38665	Talking freely with family
ADVPLNG	0.18276	0.86314	Need for advance planning
LOCSTOP	0.36997	0.78212	Location and time of stops
ACCHOME	0.44378	0.70366	Accessibility from home

the first factor while the convenience items were highly loaded in the second. In addition, the plot of factor 1 and factor 2, shown in Figure 5.3, indicates that the items of both concepts are separated from each other and the items of each concept are concentrated in one location in the plot.

As a result of the factor analysis it can be concluded that although privacy and convenience items were correlated they form different dimensions. So Privacy, Convenience, Comfort and Reliability constitute different concepts. Their effect will be tested in mode choice.

5.4 ANALYSIS OF MODE PERCEPTIONS

In this section, first an analysis of four perceptual dimensions is presented for all intercity travellers, regardless of mode use. Then, the mode perceptions for different modes are analyzed. Table 5.27 describes the results of the analysis for all the modes and shows variables, number of responses, mean and standard deviation and minimum and maximum value for the perceptual item for each mode. To simplify the results, a plot was drawn based on the mean of each perceptual item (See Figure 5.4). In this plot, the items were sorted by concept.

The perception of bus was rated low since the mean of all

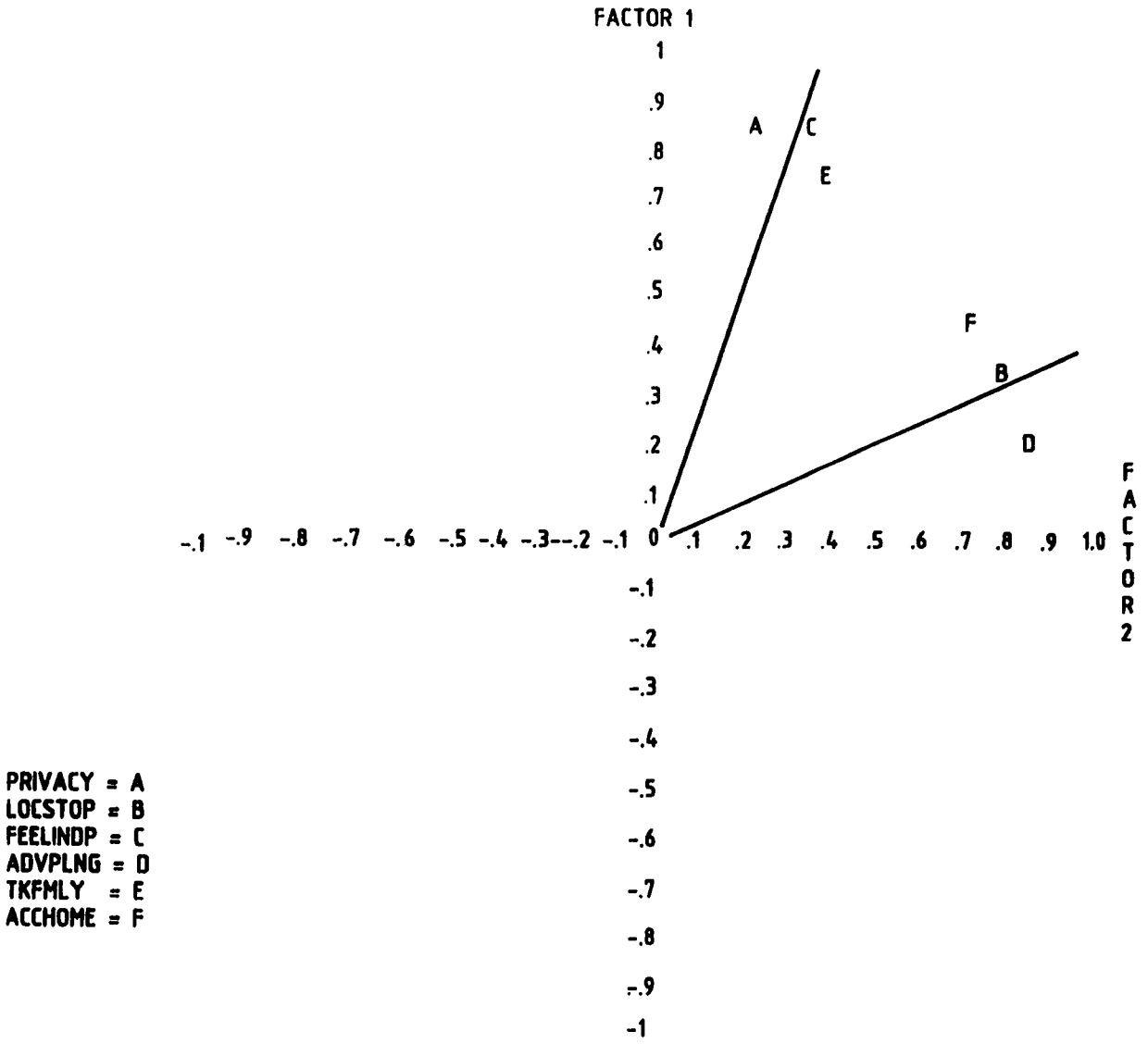


Figure: 5.3. Plot of Factor 1 and Factor 2 for Privacy and Convenience items.

Table 5.27: Means and Standard Deviations for Perceptual Items

Perceptual Concept	Perceptual Item	Perception of Air		Perception of Bus		Perception of Auto	
		Mean	Stan. Dev.	Mean	Stan. Dev.	Mean	Stan. Dev.
PRIVACY	PRIVACY	3.44	1.09	2.26	1.00	4.62	0.73
	FEELIND	3.21	1.04	2.30	1.04	4.81	0.54
	TKFMLY	3.29	1.00	2.52	1.05	4.81	0.57
CONVENIENCE	LOCSTOP	1.44	1.01	2.41	1.03	4.88	0.47
	ADVPLNG	2.34	1.46	2.89	1.03	4.67	0.78
	ACCHOME	2.63	1.23	2.73	1.00	4.83	0.55
COMFORT	CLEANVH	4.65	0.71	2.98	1.19	4.25	0.90
	COMFORT	4.71	0.67	2.71	1.10	3.60	0.97
	FEELTIR	4.57	0.78	2.22	1.14	2.59	1.19
RELIABILITY	EFWTHCN	3.51	1.48	2.67	1.08	3.12	1.20
	EFWTHRT	3.64	1.35	2.61	1.03	3.09	1.08
	VEHREPR	3.65	1.35	2.72	1.08	3.57	1.12

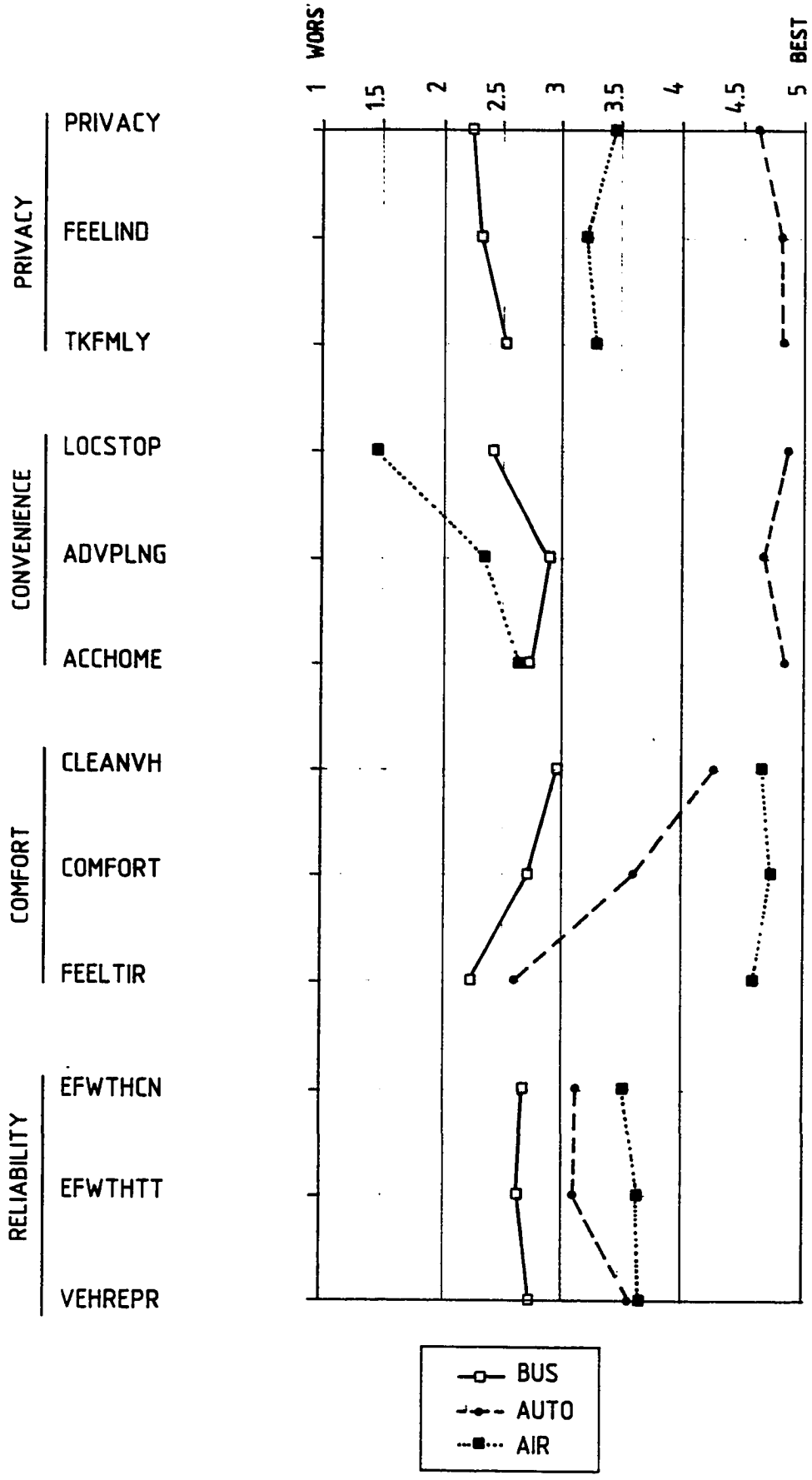


Figure: 5.4 Plot of perceptual items means for different travel modes.

items was between 2 and 3. From the plot, it can be observed that there is significant difference between the score of each mode in the Privacy concept. In addition, the score of each item for a specific mode did not change significantly. The auto was rated high with an average of approximately 4.8, followed by air mode which has an average score of 3.3. Finally, the bus was rated the lowest in terms of Privacy with an average of approximately 2.35.

In the Convenience concept, it can be noted that the auto scored the highest with an average of approximately 4.8. On the other hand, both bus and air were given a low score in this concept with an average of approximately 2.7 and 2.2 respectively. There was a great consistency in the score of each item, with respect to mode for both Privacy and Convenience concepts.

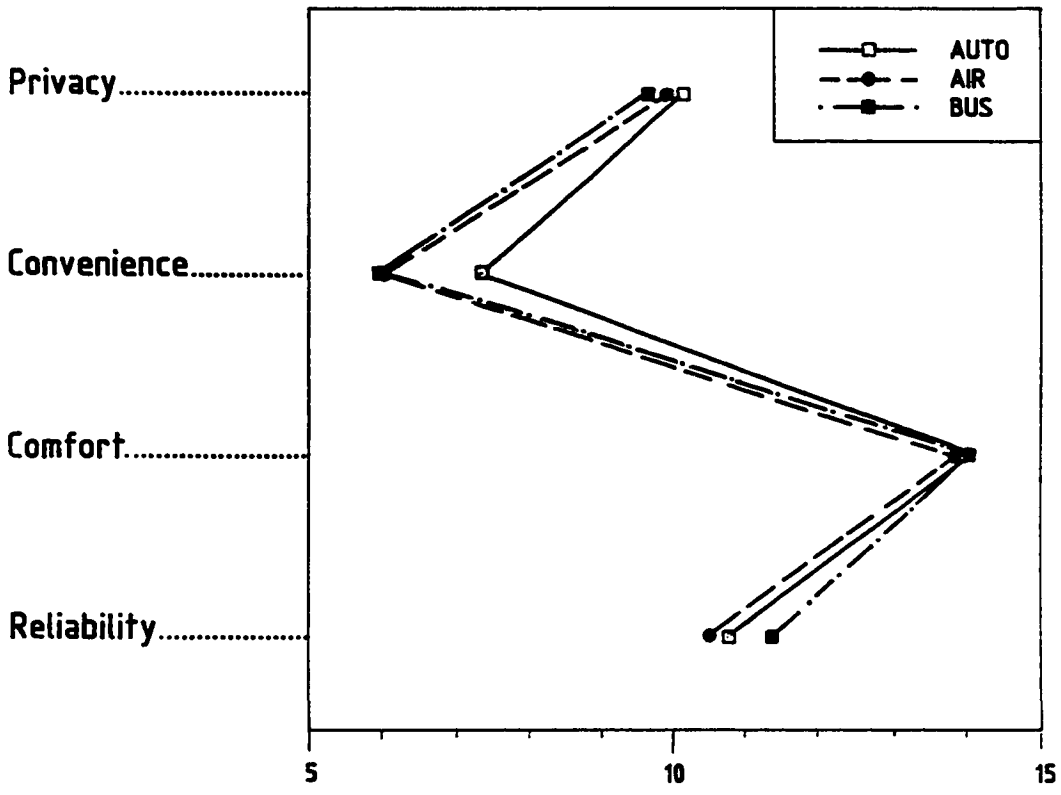
As far as the Comfort concept is concerned, it can be seen that there is a difference in score between the modes. The air mode scored the highest, with an average score of approximately 4.65. On the contrary, the bus had the lowest score in terms of Comfort with an average score of approximately 2.6. The auto varied from 2.6 for FEELTIR to 4.26 in CLEANVH, with an average score of approximately 3.45.

Finally, the analysis of the three modes in the Reliability concept revealed that there is not much difference in the score since the air mode had the highest score, 3.6 while the auto had

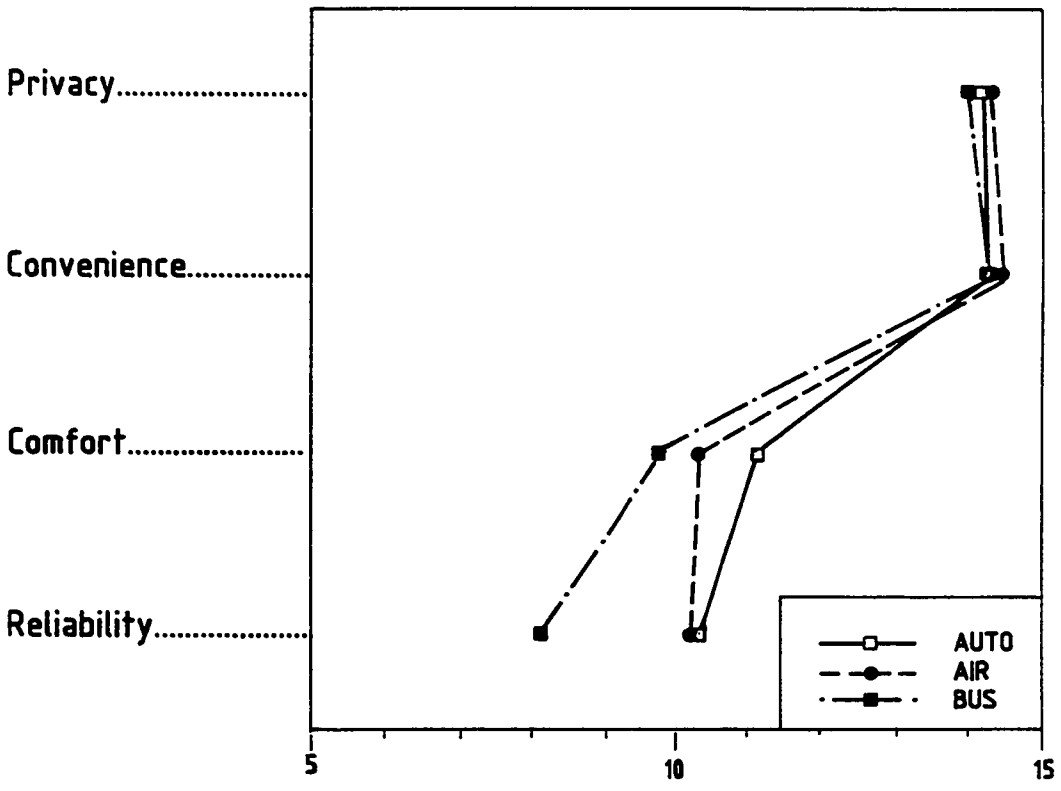
approximately 3.3 and bus approximately 2.7. Also it was noticed that there is consistency of score for the different items in this concept.

Figure 5.5 shows the perception of air mode by different mode users for each of the four perceptual concepts. It can be noticed from the figure that there is an agreement between different mode users about the perception of air comfort, however, little deviation exists on the score of other perceptual concepts by different mode users. A similar plot (Figure 5.6) for the perception of auto mode by different mode users revealed that the perception of auto convenience and privacy is almost similar, whereas, the perception of auto comfort and reliability vary for different mode users. The perception of bus mode by different mode users in Figure 5.7 showed that the perception of bus varies with respect to different mode users with the largest variation in the perception of bus comfort.

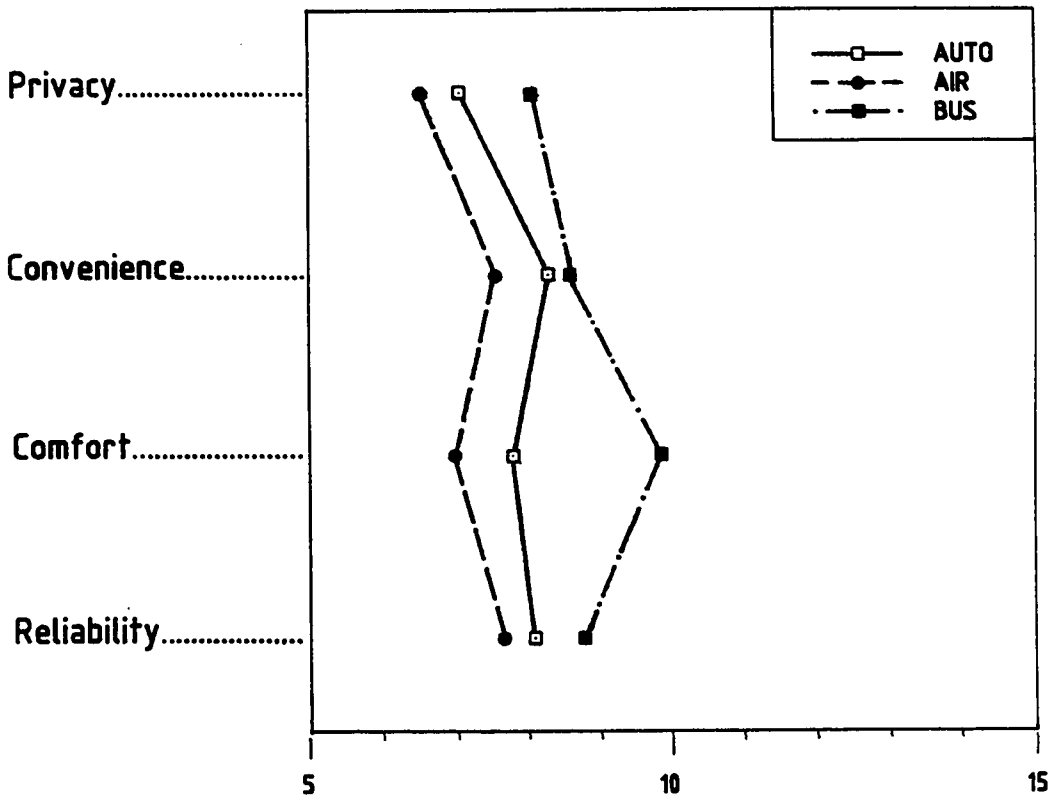
In order to test the effect of chosen mode in mode perceptions, analysis of variance was carried out. The results of this analysis are reported in Table 5.28. It can be observed from the table that there exists no significant effect at 95% confidence interval between chosen and non-chosen mode. From Table 5.28 it can be seen that the significant level α dropped below 0.05 for air and bus convenience, auto comfort, and air and auto reliability; indi-



Figure, 5.5 : Perception of Air mode by different mode users.



Figure, 5.6 : Perception of Auto mode by different mode users.



Figure, 5.7 : Perception of Bus mode by different mode users.

Table 5.28: Effect of Choice on Mode Perception

Perceptual Concept	Significance Level α		
	Perception of Air	Perception of Bus	Perception of Auto
Privacy	0.5932	0.9545	0.1291
Convenience	0.0001	0.0143	0.4074
Comfort	0.3711	0.2693	0.0001
Reliability	0.0083	0.8273	0.0001

cating that a significant difference exists between the chosen and non-chosen mode for the perception of these concepts.

Similar analysis was carried out to test the effect of socioeconomic characteristics of a traveller life income, age, nationality, etc., on perception of mode's comfort, reliability, convenience and privacy. To test this effect, analysis of variance was carried out and the results are reported in Table 5.29. It provides F-values and a significance level for testing the effect of equality of means for each of the socioeconomic variables. The null hypothesis that was tested states that the socioeconomic characteristics of the traveller have no effect on the mode perception. Table 5.29 shows that significant level α for all the four perceptual concepts is less than 0.05. Hence, the null hypothesis can be rejected at 95% confidence interval, indicating that the household income has a significant effect on the perception of mode comfort, convenience and reliability.

The nationalities of the trvellers were divided into Saudis and non-Saudis to figure out the differences in mode perception for each of these two groups. The null hypothesis which states that no significant difference exists between the perception of Saudi and non-Saudi travellers can be rejected at 95% confidence interval for all the four perceptual variables.

On the other hand, the analysis revealed that the age

Table 5.29: Effect of Socioeconomics on Mode Perceptions

Socioeconomic Variable	Effect Type	F-Value and (Significance level α) For			
		Privacy	Convenience	Comfort	Reliability
INCOME	Mode	2700(.0001)	3583(.0001)	1768(.0001)	228(.0001)
	Income	8.62(.0002)	4.12(.0164)	13.84(.0001)	8.34(.0002)
	Interaction	9.29(.0001)	4.47(.0013)	11.76(.0001)	15.4(.0001)
NATIONALITY	Mode	2173(.0001)	2974(.0001)	1374(.0001)	198(.0001)
	Nationality	7.66(.0057)	4.09(.0433)	11.5(.0007)	15.14(.0001)
	Interaction	5.34(.0048)	7.55(.0005)	23.78(.0001)	27.78(.0001)
AGE	Mode	1256(.0001)	1643(.0001)	800(.0001)	111(.0001)
	Age	1.36(.2466)	3.98(.0032)	4.40(.0015)	6.21(.0001)
	Interaction	0.96(.4631)	3.15(.0015)	2.28(.0196)	1.86(.0614)
EDUCATION	Mode	1112(.0001)	1514(.0001)	681(.0001)	103(.0001)
	Education	0.83(.4365)	0.66(.5748)	8.55(.0002)	0.07(.9337)
	Interaction	2.66(.0311)	2.04(.0866)	3.96(.0033)	1.38(.238)

Table 5.29 (continued)

Socioeconomic Variable	Effect Type	F-Value and (Significance level α) For			
		Privacy	Convenience	Comfort	Reliability
OCCUPATION	Mode	518(.0001)	700(.0001)	517(.0001)	52.7(.0001)
	Occupation	0.94(.4564)	0.41(.8405)	2.44(.0296)	1.32(.2545)
	Interaction	1.18(.3014)	1.62(.0940)	1.45(.1535)	1.59(.1046)
MARITAL STATUS	Mode	2310(.0001)	3153(.0001)	1562(.0001)	220(.0001)
	Mar. Status	6.20(.0128)	10.63(.5748)	26.23(.0001)	15.05(.0001)
	Interaction	0.68(.5060)	1.65(.1930)	4.40(.0123)	2.47(.0849)
CHOICE	Mode	2017(.0001)	2871(.0001)	1663(.0001)	220(.0001)
	Choice	0.49(.4834)	3.82(.0507)	14.66(.0001)	55.90(.0001)
	Interaction	1.17(.3100)	14.40(.0001)	7.14(.0008)	29.81(.0001)

group affects the perception of mode comfort, convenience and reliability significantly since the significance level α dropped below 0.05 for these perceptual concepts. In addition, level of education and occupation of the trip maker have a significant effect on the perception of mode comfort only.

Similarly, the occupation of the trip maker has no significant effect on the perception of mode privacy, convenience and reliability. However, it affects mode comfort significantly.

Another analysis was performed to study in greater detail the effect of household income. Figures 5.8 through 5.11 show a plot of mode privacy, convenience, and comfort and reliability versus the three categories of household income namely: low, with income less than 5000 SR, medium, with income between 5000-10000 SR and high with income greater than 10000 SR. Each plot shows a decrease in the perception of the merit air and bus travel as income increases. Hence low income people are more easily satisfied than high income people who look for better life style and facilities. Conversely, perception of auto mode increases as household income increases. This is due to the fact that high income people own better cars than the low income group, and those cars provide greater comfort and are more reliable.

To perform a comparison between different income level groups for the perception of modes, a t-test was conducted to test

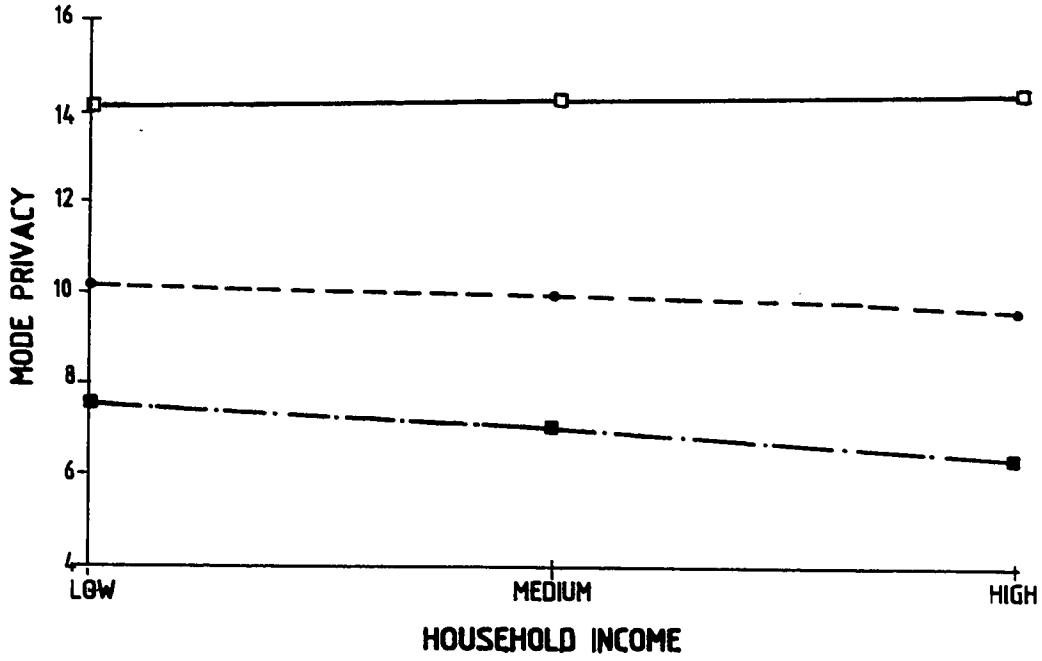


Figure: 5.8 Perception of mode privacy for different household income groups.

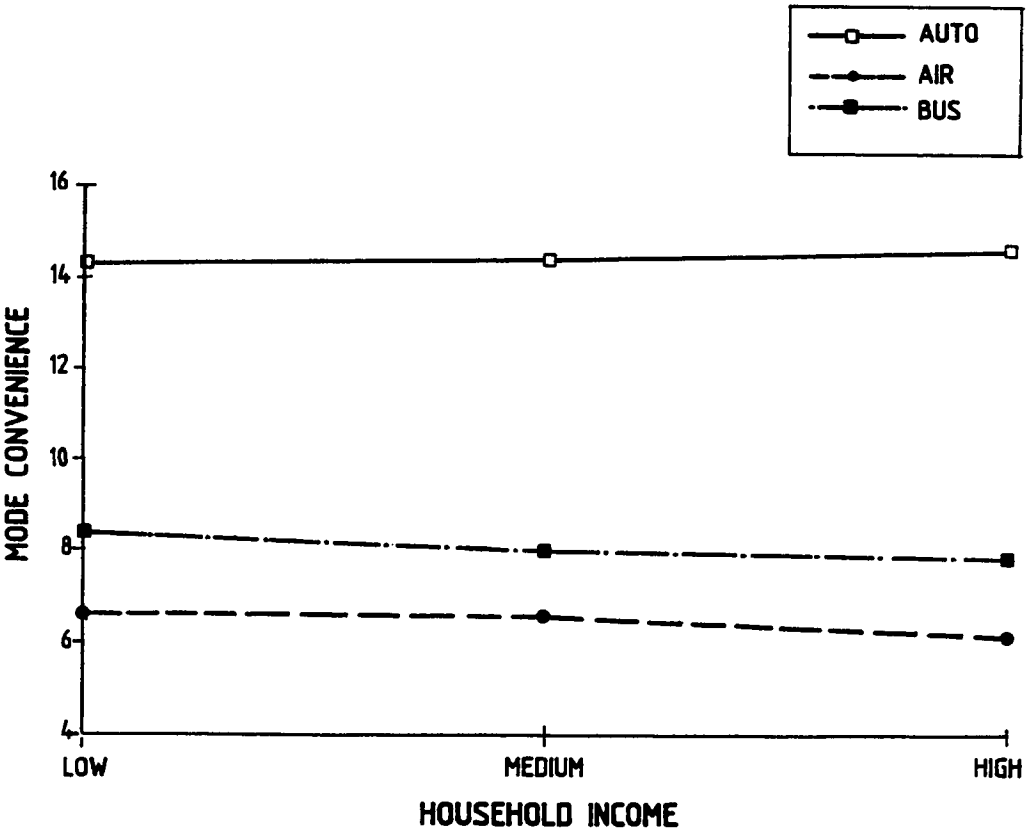


Figure: 5.9 Perception of mode convenience for different household income groups.

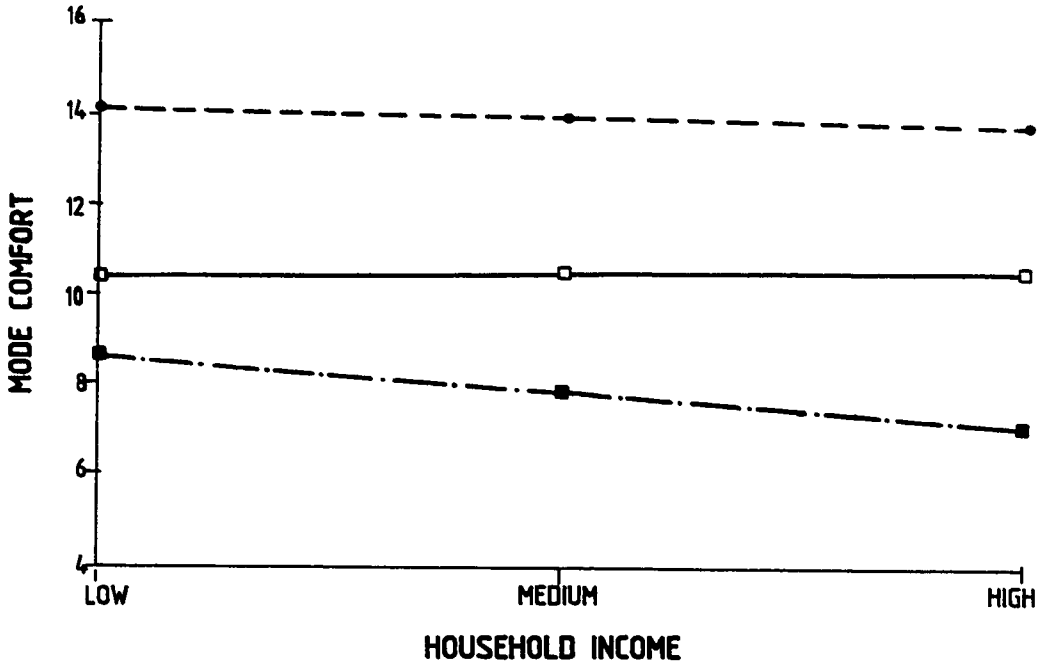


Figure: 5.10 Perception of mode comfort for different household income groups.

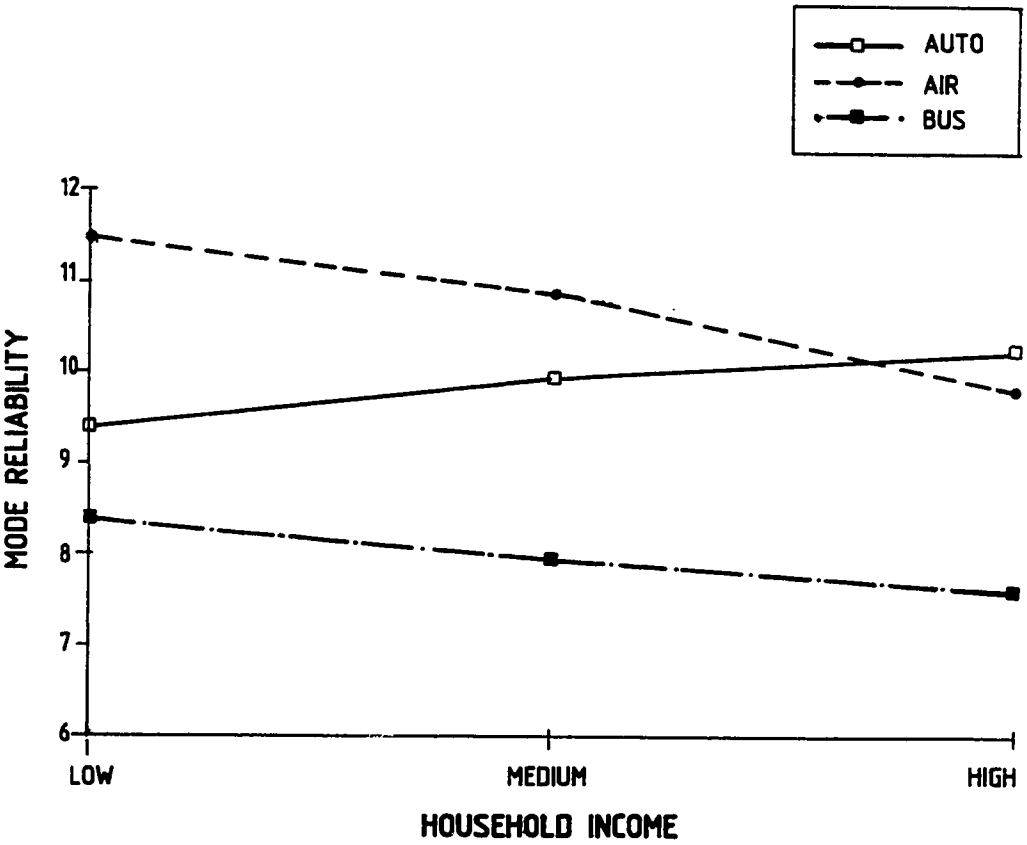


Figure: 5.11 Perception of mode reliability for different household income groups.

the hypothesis that the means are equal at significant level $\alpha = 0.05$. Table 5.30 shows the results of the test. From the table it can be seen that there is a significant difference between the high and the low income group in the perception of air and auto privacy. Perception of bus privacy differs significantly between different income groups. The perception of air convenience differs significantly between low and high; and between medium and high income groups, although the perception of bus convenience differs significantly between low and medium and between low and high income groups. However, no significant difference was noticed in the perception of auto convenience between different incomes.

The analysis also revealed that the income level has no significant effect on the perception of air and auto comfort. On the other hand, it affects bus comfort significantly. Finally, the reliability of air mode was affected significantly by the income level of trveller. However, there is no significant effect on the perception of bus and auto reliability between medium and high income level.

As a result of the analysis of variance it can be concluded that the perceptions of travel mode are affected by some of the socioeconomic characteristics of travellers in this country.

Part V of the questionnaire covers information about the

Table 5.30: Effect of Household Income on Mode Perception

Perceptual Concept	Income Level	Significance Level α								
		Perception of Air			Perception of Bus			Perception of Auto		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
Privacy	Low	------	0.2559	0.0041	------	0.0026	0.0001	------	0.2092	0.0339
	Medium	0.2559	------	0.0662	0.0026	------	0.0002	0.2029	------	0.3226
	High	0.0041	0.0662	------	0.0001	0.0002	------	0.0339	0.3226	------
Convenience	Low	------	0.4996	0.0016	------	0.0092	0.0008	------	0.6405	0.1094
	Medium	0.4996	------	0.0115	0.0092	------	0.3090	0.6405	------	0.2408
	High	0.0016	0.0115	------	0.0008	0.3090	------	0.1094	0.2408	------
Comfort	Low	------	0.3719	0.1425	------	0.0001	0.0001	------	0.5266	0.4148
	Medium	0.3719	------	0.5082	0.0001	------	0.0001	0.5266	------	0.8054
	High	0.1425	0.5082	------	0.0001	0.0001	------	0.4148	0.8054	------
Reliability	Low	------	0.0032	0.0001	------	0.0307	0.0006	------	0.0089	0.0003
	Medium	0.0032	------	0.0001	0.0307	------	0.1357	0.0089	------	0.2186
	High	0.0001	0.0001	------	0.0006	0.1357	------	0.0003	0.2186	------

importance of perceptual items. The analysis of this part is shown in Table 5.31. The mean, standard deviation, minimum and maximum score for each perceptual item are shown in the table. It can be noticed that the importance of the items ranges from 3.77 to 4.54. With COMFORT being the most important item and FEELTIRD being least important. The importance of perceptual items can be arranged in accordance to their importance as follows:

1. Comfort
2. Cleanliness of vehicles
3. The feeling that the vehicle would not be delayed for repair
4. Accessibility from home
5. Feeling of independence
6. The need for advance planning
7. Having some privacy
8. Talking freely with family members or friends
9. The effect of weather condition on travel time
10. Freedom in choosing locations and time of stops
11. The effect of weather condition on the trip
12. Feeling tired at the end of the trip.

Furthermore, by totalling the scores of items related to each of the four perceptual concepts, the comfort concept received the highest score (12.81) followed by privacy (12.3), convenience

Table 5.31: Importance of Perceptual Items

Perceptual Concept	Perceptual Items	Mean	Std.Dev.	Minimum	Maximum
COMFORT	COMFORT	4.54	0.78	1.00	5.00
	CLEANVH	4.50	0.81	1.00	5.00
	FEELTIRD	3.77	1.29	1.00	5.00
CONVENIENCE	ACCHOME	4.16	1.07	1.00	5.00
	ADVPLNG	4.12	1.11	1.00	5.00
	LOCSTOP	3.85	1.31	1.00	5.00
PRIVACY	FEELIND	4.19	1.08	1.00	5.00
	PRIVACY	4.07	1.19	1.00	5.00
	TKFMLY	4.04	1.15	1.00	5.00
RELIABILITY	VEHREPR	4.28	1.03	1.00	5.00
	EFWTHRT	3.92	1.09	1.00	5.00
	EFWTHCN	3.79	1.16	1.00	5.00

(12.13) and finally reliability (11.99). Hence it can be concluded that the perception of mode comfort was the most important perceptual concept considered by intercity travellers during their journey.

5.5 SUMMARY

This chapter presented the results of a statistical analysis of the collected data for a total of 867 non-captive travellers. Frequency and cross-frequency tables were prepared for various trip purposes, level of service variables and socioeconomic characteristics of the traveller. It was found from the analysis that the majority of work and personal business trips were made by air mode, in contrast, social and recreational trips were carried out using private auto. Apart from trip length affecting the mode share, it was found that the duration of stay at the destination also influenced the selection of the particular mode. Air mode was preferred for short duration of stay, up to 3 days. Auto was found to be the preferred mode for travellers accompanied by their family members. Bus riders were greatly affected by the car ownership. Apart from car ownership, it was found that the nationality of trip makers, and their income, significantly affected the choice of travel mode. The socioeconomic characteristics of the travellers were also analyzed. The details of the analysis are doc-

umented in the form of tables.

Using the main survey data, factor analysis was performed for testing the scale constructed in the pilot survey. The results of the analysis confirmed the basic assumption that the chosen 12 items in the pilot survey represent measures of mode comfort, convenience, privacy and reliability.

Further analysis was carried out on the perceptual items for various statistical indicators. The analysis indicated a marked difference in mode perception based on comfort, convenience, reliability and privacy. Air mode was ranked first comfortwise whereas, auto scored the highest in privacy. However the perception of bus mode was relatively low compared to other alternatives. Furthermore, analysis of variance was carried out to investigate the effect of chosen mode on mode perception. The results of this analysis were summarized in tabular format. Later, the effect of socioeconomic characteristics was studied through analysis of variance. It was found that income, nationality and age have a significant effect in mode perception whereas, the educational level of traveller has no significant effect.

Finally the important perceptual items were analyzed in the concluding part of this chapter. It was found that the importance of item ranges from 3.77 to 4.54 which indicated that each perceptual item possesses a degree of importance. In addition, the

perception of mode comfort was the most important perceptual variable considered by intercity trip makers during their journey.

Chapter 6

MODELS CALIBRATION AND VALIDATION

6.1 INTRODUCTION

In this chapter, development of mode-choice models will be presented in detail. The calibration process is carried out in two stages. In the first stage focus was on the development of mode-choice models which were developed without the perceptual concepts. In the latter stage, the perceived variables were incorporated into the previously built models to study their effects. The results of preliminary analysis presented in the previous chapter were utilized to segment the collected data and to select the best potential variables that affect the mode choice of the traveller. Finally, the validation process was carried out and the results obtained were presented.

6.2 MODEL SEGMENTATION

From the preliminary analysis of the collected data, it was noticed that the mode shares were affected by the trip purposes. Since business trips have different characteristics from social trips, and since it is suspected that they will have different sensitivities to variables affecting mode choice; such as travel time and

travel cost, the data were segmented, based on trip purpose into the following categories.

1. Business trips: This segment includes all personal business as well as trips related to work, since a high percentage of these trips were carried out using the air mode. This segment included a total of 299 observations 2/3rds of which were used for model calibration and the remaining 1/3rd were reserved for validation of the calibrated model.

2. Social and Recreational Trips: This segment included a total of 337 observations; 219 of which were used in calibration and the remaining 118 observations were kept for model validation. The selection of calibration and validation data for both trip purposes was randomized.

Trips made for other reasons, such as Umra, and Educational purposes, were eliminated from the analysis since there was not enough data available to calibrate models from them.

6.3 MODEL SPECIFICATIONS

The process of model calibration requires the use of different model specifications. A different combination of model specifications has to be tested in order to determine which combination of independent variables gives the best fit for different trip pur-

poses. In addition to level of service variables, such as travel time and travel cost, other variables that were found to be affecting the choice of travellers from the preliminary analysis of data were tested to assess their significance. The following represents a list of variables, with their abbreviations, that were used in model calibration:

1. TKCOST: Ticket cost for bus/air including the cost of accompanied family; for private auto fuel cost was used

2. TOTCOST: Total cost of the trip including TKCOST and other costs, such as limousine or taxi cost

3. COST/FMLY: Total cost per member of accompanied family

4. COST/INC: Total travel cost over household income of traveller

5. TOTTT: Total travel time reported by traveller in hours

6. INVTT: In-vehicle travel time reported by traveller in hours

7. OUTVTT: Out-of vehicle travel time which included access, egress time and waiting time

8. ACSSEGST: Access and egress time in hours

9. WAITT: Waiting time or rest time in hours

10. INVTT/DIST: In-vehicle travel time per kilometer

11. $PERINC_A$: Monthly personal income specific to air mode

12. $HHINC_A$: Monthly household income specific to air mode

13. $HHINC_B$: Monthly household income specific for bus mode

14. $DHHINC_B$: Dummy variable for household income specific for bus

    = 1 if monthly household income is less than SR2500

    = 0 otherwise

15. $DIST_A$: Distance travelled in kilometers, this variable is specific to air mode

16. $DIST_C$: Distance travelled in kilometers, this variable is specific to car mode

17. $DDIST_C$: Dummy variable for distance travelled specific to car

    = 1 if distance travelled is less than 900 kilometers

    = 0 otherwise

18. $FMLY_C$: The size of accompanied family group, this variable is specific to auto mode

19. DFMLY: Dummy variable for the size of accompanied family specific to auto mode

= 1 if travelling family is greater than 1

= 0 otherwise

20. $DNCAR_B$: Dummy variable for number of cars owned by travellers. This variable is specific for bus

= 1 if traveller did not own a car

= 0 otherwise

21. $DDUR_A$: Dummy variable for duration of stay. This variable is specific to air mode

= 1 if duration of stay is 1-3 days

= 0 otherwise

22. $DNATION_A$: Dummy variable for nationality of traveller. This variable is specific to air mode

= 1 if nationality is Saudi, American, European

= 0 otherwise

23. $DNATION_B$: Dummy variable for nationality of traveller. This variable is specific to bus mode

= 1 if nationality is Far Eastern Asian, or other Arab

= 0 otherwise

24. Privacy: An attitudinal variable used to measure the perception of different modes of travel with respect to privacy. Summative score of the three items related to privacy were used to represent this variable.

25. Convenience: An attitudinal variable used to measure the perception of different modes of travel with respect to convenience. The summative score of the three items related to convenience was used to represent this variable.

26. Comfort: An attitudinal variable used to measure the perception of different modes of travel with respect to comfort. The summative score of the three items related to comfort was used to represent this variable.

27. Reliability: An attitudinal variable used to measure the perception of different modes of travel with respect to reliability. The summative score of the three items related to reliability was used to represent this variable.

6.4 DEVELOPMENT OF INTERCITY MODE-CHOICE MODELS

6.4.1 Calibration of Business Trips Model

For calibrating mode-choice model for business trips, a systematic procedure was adopted. First of all the best attributes of travel time and travel cost were determined by using different components and formulations of these variables in the model building process. Then other variables were introduced in a sequential manner to find the best model specification.

The calibration process was initiated by using ticket cost (TKCOST) and total travel time (TOTTT) as the variables in model 1 as shown in Table 6.1. This resulted in insignificant (i.e. not significantly different from 0) coefficient estimates and a low rho-square. Replacing TOTTT by in-vehicle travel time (INVTT) in model 2 resulted in parameter estimates that were significant at 10% level for both the variables as well as an increased value of rho-square. Hence it was decided to use INVTT rather than TOTTT. Total travel cost (TOTCOST) instead of TKCOST was used in model 3 alongwith INVTT. The parameter estimates for both of the variables became significant at less than 5% level and in addition, the rho-square value increased drastically from 0.196 to 0.258. In models 4 and 5 composite variables i.e., total travel cost per household income (COST/INC) and total travel cost per accompanied family size (COST/FMLY) were incorporated. The inclusion of

Table 6.1: Intercity Mode Choice Models for Business Trips

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 1	Model 2	Model 3	Model 4	Model 5
ASC-AIR	1.8987(6.39)	1.787(5.74)	1.822(4.90)	1.603(4.69)	.775(1.7)
ASC-BUS	1.544(5.01)	1.587(5.27)	1.810(5.56)	1.654(5.40)	1.055(3.01)
TKCOST	- .0013(-1.68)	- .0014(-1.74)			
TOTCOST			- .0037(-3.68)		
COST/FMLY.					- .0043(-1.03)
COST/INC				-0.0138(-3.46)	
INVTT		-0.0506(-1.58)	-.1324(-3.34)	-.1247(-3.19)	-.0314(-0.58)
OUTVTT					
TOTTT	- .0327(-1.09)				
ACSSEGST					
WAITT					
INVTT/DIST					
$HHINC_A$					
$PERINC_A$					
LL (β)	-145.74	-145.07	-133.91	-133.97	-140.62
LL(O)	-180.49	-180.49	-180.49	-180.49	-180.49
Rho sq. ρ^2	0.193	0.196	0.258	0.258	0.221
Rho bar sq.	0.185	0.188	0.251	0.250	0.213

Table 6.1 (Continued)

Variable Name	Estimated Variable Coefficients				
	Model 6	Model 7	Model 8	Model 9	Model 10
ASC-AIR	0.937(1.85)	1.695(2.67)	1.493(3.74)	0.911(.16)	0.0105(.018)
ASC-BUS	1.448(4.20)	1.727(3.67)	1.851(5.65)	1.76(5.29)	1.801(5.41)
TKCOST					
TOTCOST	-0.0031(-3.16)	-.0037(-3.69)	-.0030(-3.05)	- .0036(-3.62)	-0.0041(-4.03)
COST/FMLY					
COST/INC					
INVTT	-0.1562(-3.74)	-0.1323(-3.34)-	0.1601(-3.74)	-0.1487(-3.59)	-0.1557(-3.71)
OUTVTT	0.558(2.54)				
TOTTT					
ACSSEGST		0.1197(.24)			
WAITT			0.638(2.68)		
INVTT/DIST					
$HHINC_A$					0.400(3.92)
$PERINC_A$				.426(3.80)	
LL (β)	-130.64	-133.88	-130.331	-125.17	-124.93
LL(O)	-180.49	-180.49	-180.49	-180.49	-180.49
Rho sq. ρ^2	.276	.258	.278	.307	.308
Rbo bar sq.	.267	.249	.269	.298	.299

Table 6.1 (Continued)

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 11	Model 12	Model 13	Model 14	Model 15
ASC-AIR	0.604(.93)	-.0097(-.02)	-.604(-.91)	-.761(-1.11)	-.703(-.79)
ASC-BUS	2.47(4.98)	1.803(5.38)	1.483(4.00)	0.798(1.37)	1.81(4.50)
TOTCOST	-0.0019(-1.22)	-.0034(-2.35)	-.0044(-4.12)	-.0047(4.12)	-.0031(-3.24)
INVTT	-0.1198(-2.64)	-.1452(-3.25)	-.0775(.59)	-.1350(-3.18)	
INVTT/DIST					-1.88(-1.94)
$HHINC_A$	.388(3.80)	0.395(3.87)	.402(3.90)	.401(3.93)	.372(3.76)
$DIST_C$				-.0016(-1.92)	
$DIST_A$			.0029(1.84)		
$FMLY_C$	0.611(1.90)				
$DFMLY_C$		0.575(0.66)			
LL (β)	-123.06	-124.71	-123.15	-122.78	-130.55
LL(O)	-180.49	-180.49	-180.49	-180.49	-180.49
Rho sq. ρ^2	.318	.309	.318	.320	.277
Rho bar sq.	.308	.299	.308	.310	.268

Table 6.1 (Continued)

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 16	Model 17	Model 18	Model 19	Model 20
ASC-AIR	1.275(1.48)	.082(0.8)	.091(.09)	.234(.23)	1.732(2.11)
ASC-BUS	2.839(4.30)	2.88(3.83)	2.753(4.02)	3.62(3.63)	4.517(4.76)
TOTCOST	-0.0046(-4.10)	-.0052(-4.18)	-.0051(-4.20)	-.0049(-4.12)	-.0047(-3.91)
INVTT	-0.1363(-3.18)	-.1435(-3.61)	-.2056(-3.97)	-.2061(-3.96)	-.1901(-3.78)
$HHINC_A$	.404(3.93)	.303(2.45)	.387(3.30)	0.297(2.19)	
$HHINC_B$				-.213(-1.21)	-.414(-2.76)
$DDIST_C$	1.366(2.05)	1.485(2.18)	1.381(2.04)	1.323(1.95)	1.265(1.84)
$DNCAR_B$		.582(.89)	1.150(2.01)	.932(1.55)	1.034(1.72)
$DNATION_A$		.613(1.06)			
$DNATION_B$		-.238(-.38)			
$DDUR_A$		2.096(4.87)	2.071(4.94)	2.067(4.91)	1.919(4.85)
$DHHINC_B$		1.702(1.73)			
LL (β)	-122.4	-102.63	-105.36	-104.61	-107.18
LL(O)	-180.49	-180.48	-180.49	-180.49	-180.49
Rho sq. ρ^2	.322	.431	.416	.420	.406
Rho bar sq.	.312	.402	.405	.407	.394

these variables instead of TOTCOST failed to improve the fit of the model. Hence it was decided to use TOTCOST variable as the best cost component.

In addition to TOTCOST and INVTT, other travel-time components were tested in models 6, 7 and 8. Out-of-vehicle travel time (OUTVTT) was introduced in model 6, access and egress time variable (ACSSEGST) in model 7, and waiting time (WAITT) in model 8. This resulted in counter-intuitive signs for all the three components although the coefficients of OUTVTT and WAITT were significant. This led to the conclusion that TOTCOST and INVTT best replicates the data for the intercity rider which is represented in model 3.

Next, monthly income of the traveller was introduced to see its effect on the model specifications. It should be noted that socioeconomic variables can only be introduced as alternative specific variables or as interaction variables with other level of service variables. Personal income specific to air mode ($PERINC_A$) and household income specific to air mode ($HHINC_A$) were included with INVTT and TOTCOST in models 9 and 10 respectively. The inclusion of these variables resulted in an improved fit, the latter being marginally better than the earlier with respect to its estimated coefficient and, therefore, it was included in the model.

To see if there would be any further improvement in the

overall fit of the model, family accompanied specific to car ($FMLY_C$) and a dummy variable of family accompanied specific to car ($DFMLY_C$) were introduced in models 11 and 12 respectively. It was observed that the coefficients of these variables were insignificant and furthermore the incorporation of $FMLY_C$ rendered the TOTCOST variable insignificant. This may be attributed to the high correlation between the cost component TOTCOST and $FMLY_C$. Thus, it was decided not to include the latter variable in further model building stages.

Trip length variables were included in models 13, 14, 15 and 16. The incorporation of variables, trip length specific to air mode ($DIST_A$) and trip length specific to car ($DIST_C$) modes in the 13th and 14th models resulted in insignificant coefficient estimates for the variables. A composite variable built using distance, in-vehicle travel time per unit distance (INVTT/DIST), did not improve the overall fit of the model as shown in model 15. But the inclusion of a dummy variable for trip length specific to auto ($DDIST_C$) in model 16 resulted in a significant estimate of its coefficient and furthermore, the rho-square value increased considerably. Thus it was decided to include $DDIST_C$ variable alongwith TOTCOST, INVTT and $HHINC_A$ variables in further calibration stages.

A series of dummy variables viz., car ownership specific to bus mode ($DNCAR_B$), nationality for air ($DNATION_A$), and bus ($DNATION_B$), duration of stay with regard to air ($DDUR_A$) and household income with respect to bus ($DHHINC_B$) were introduced in model 17. In this model, only the $DDUR_A$ variable had a significant coefficient at a 95% confidence level while the rest were insignificant. All the insignificant variables were dropped and those found to be good at 0.05 level were used for building the model i.e., model 18. This resulted in an increased value of the rho-square to 0.416 and all the estimated coefficients were significant.

Income variables viz., household income specific for bus ($HHINC_B$) and household income with respect to air mode ($HHINC_A$) were incorporated into model 19. But the inclusion of these variables resulted in a decreased significance of the coefficients of DNCAR and $HHINC_B$. Thus the variable $HHINC_A$ was dropped. $HHINC_B$ was used with other variables from model 18 instead of $HHINC_A$ in model 20. This showed a loss in significance of the variables $DDIST_A$ and DNCAR as well as in the overall fit of the model. Thus it was inferred that the socioeconomic variable $HHINC_A$ best represents the behavior of the travellers.

From the above analysis it can be concluded that model 18

which included in it $HHINC_A$, $DDIST_C$, $DNCAR_B$, $DDUR_A$ besides TOTCOST and INVTT best represents the model specification and can be used for explaining the behavior of the intercity rider for business trips. All the variable coefficients were found to be statistically significant at 0.05 confidence level, moreover good fit with high rho-squared value. The details of this model are provided in Table 6.1. The utility function for each mode is given below.

For air mode (A).

$$U_A = 0.091 - 0.2056\ INVTT_A - 0.0051\ TOTCOST_A + 0.387\ HHINC - 2.071\ DDUR$$

For bus mode (B):

$$U_B = 2.753 - 0.2056\ INVTT_B - 0.0051\ TOTCOST_B + 1.150\ DNCAR$$

For auto mode (C):

$$U_C = - 0.2056\ INVTT_C - 0.0051\ TOTCOST_C + 1.381\ DDIST$$

6.4.2 Calibration of Social and Recreational Trip Models

The procedure adopted in building a mode-choice model for social and recreational trips is similar to that which has been adopted for business trips. This is done by first selecting the best

components of travel time and travel cost and then incorporating other variables into it.

To start with, total travel time (TOTTT) and ticket cost (TKCOST) were selected in model 1, as shown in Table 6.2. Both components were significant at 95% confidence level with a low rho-square value. In model 2, TOTTT was replaced by in-vehicle travel time (INVTT) keeping the same cost component as in model 1. This resulted in increased significance of time component and a simultaneous increase in the rho-square value. Hence it was decided to use INVTT as the time component instead of TOTTT. Total travel cost (TOTCOST) was included with INVTT as the cost component in model 3. It was found that TOTCOST was more significant than the TKCOST and moreover, the significance of INVTT increased too. It can also be notice from model 3 that the rho-square value has increased sharply from 0.182 to 0.275. In model 4, 5 TOTCOST was replaced by the composite variables total cost per accompanied family size (COST/FMLY) and, total cost per household income (COST/INC) to find out whether these variables would improve the goodness-of-fit. By observing model 4 and 5 it can be seen that the inclusion of these variables resulted in a decreased significance of these components as well as a decrease in rho-square values. It can be concluded from the previous models that TOTCOST represents the best cost component.

Models 6, 7, 8 and 9 investigate the incorporation of

Table 6.2: Intercity Mode Choice Models for Social & Recreational Trips

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 1	Model 2	Model 3	Model 4	Model 5
ASC-AIR	.171(.73)	-.138((- .52)	-.803(-2.39)	-.994(-3.06)	-1.067(-3.03)
ASC-BUS	.523(2.00)	.466((1.88)	.569(2.19)	.413(1.65)	0.300(1.05)
TKCOST	-.0016(-3.88)	-.0016(-3.89)			
TOTCOST			-.0021(-4.51)		
COST/FMLY.					-.0045(-1.74)
COST/INC				-.0075(-3.92)	
INVTT		-.1577(-4.03)	-.3008(-5.76)	-.2875(-5.67)	-.2842(-4.97)
OUTVTT					
TOTTT	-.1316(-3.67)				
ACSSEGST					
WAITT					
INVTT/DIST					
$HHINC_A$					
$PERINC_A$					
LL(β)	-187.41	-185.86	-164.83	-167.59	-176.18
LL(O)	-227.26	-227.26	-227.26	-227.26	-227.26
Rho sq. ρ^2	.175	.182	.275	.263	.225
Rho-bar sq.	.168	.175	.268	.256	.218

Table 6.2 (Continued)

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 6	Model 7	Model 8	Model 9	Model 10
ASC-AIR	-1.004(-2.30)	-1.197(-2.11)	- .852(-2.39)	.283(2.80)	-1.854(-3.70)
ASC-BUS	.437(1.63)	.331(.88)	.555(2.13)	.294(-1.08)	0.629(2 .38)
TKCOST				-.0011(-2.91)	
TOTCOST	-.0020(4.38)	.0021(-4.53)	-.0020(-4.38)		-.0024(-4.90)
COST/FMLY					
COST/INC					
INVTT	-.3066(-4.37)	-.3011(-5.78)	-.3044(-5.74)		-.3266(-6.00)
OUTVTT	.1144(.72)				
TOTTT					
ACSSEGST		0.361(.86)			
WAITTT			.740(.42)		
INVTT/DIST				109.7(2.003)	
$HHINC_A$					
$PERINC_A$					0.298(2.96)
LL (β)	164.58	-164.45	-164.75	-192.42	-160.21
LL(O)	-227.26	-227.26	-227.26	-227.26	-227.26
Rho sq. ρ^2	.276	.276	.275	.153	.295
Rho bar sq.	.267	.268	.267	.145	.287

Table 6.2 (Continued)

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 11	Model 12	Model 13	Model 14	Model 15
ASC-AIR	-2.336(-4.06)	-1.918(-3.18)	-2.187(-3.72)	-1.220(-1.88)	-1.514(2.44)
ASC-BUS	0.520(1.96)	2.48(3.46)	0.370(1.31)	3.127(4.06)	2.73(3.69)
TOTCOST	-0.0022(-4.66)	-.0027(-4.59)	-.0021(-4.61)	-.0001(-.11)	-.0026(-1.14)
INVTT	-0.3177(-5.87)	-.324(-5.90)	-.3145(-5.74)	-.2643(-4.73)	-.2819(-5.11)
$HHINC_A$	.3131(3.45)	0.215(2.26)	.283(3.05)	.220(2.24)	0.182(1.85)
$HHINC_B$		-0.485(-2.87)		-.452(-2.60)	-.460(-2.70)
$DHHINC_B$			1.043(1.66)		
DIST					
$FMLY_C$				0.530(3.07)	
$DFMLY_C$					1.663(3.57)
LL (β)	-158.45	-153.45	-157.02	-147.81	-146.69
LL(O)	-227.26	-227.26	-227.26	227.26	-227.26
Rho sq. ρ^2	.303	.325	.309	.350	.354
Rho bar sq.	.295	.315	.299	.339	.344

Table 6.2 (Continued)

Variable Name	Estimated Variable Coefficients (t-stat)					
	Model 16	Model 17	Model 18	Model 19	Model 20	Model 21
ASC-AIR	-2.661(-4.05)	-2.89(-4.27)	1.669(1.55))	-2.421(-2.75)	-3.268(-4.30)	-2.791(-4.09)
ASC-BUS	1.802(2.48)	0.375(.45)	4.99(4.89)	- .418(-.46)	-.536(.59)	-.149(-.17)
TOTCOST	-0.0027(-5.17)	-.0034(-5.30)	-.0034(-4.94)	-.0034(-5.25)	.0034 (-5.22)	-.0034(-5.31)
INVTT	-0.1448(1.11)	-.2057(-3.62)	-.2179(-3.91)	-.1880(-3.27)	-.2218(- 3.60)	-.2100(-3.56)
$HHINC_A$	0.236(2.39)	0.217(2.13)	.184(1.80)	.220(2.07)	.187(1.81)	.198(1.92)
$HHINC_B$	0.428(-2.57)	-.439(-2.61)	-.460(-2.76)	-0.337(-1.97)		-.374(-2.27)
$DHHINC_B$						
$DIST_C$		-.0036(-4.23)		-.0038(-4.33)	-.0038(-4.32)	-.0037(-4.17)
$DIST_A$	.520(3.71)					
$DDIST_C$			2.880(3.44)			
$FMLY_C$						
$DFMLY_C$						
$DNATION_A$				- .513(-.66)		
$DNATION_B$				-1.506(2.05)	0.746(1.22)	
$DDUR_A$					0.650(1.72)	
$DNCAR_B$					1.921(2.77)	2.034(3.09)
LL (β)	-146.12	-142.16	-142.23	-139.611	-134.55	-136.90
LL(0)	-227.26	-227.26	-227.26	-227.26	-227.26	-227.26
Rho sq. ρ^2	.357	.374	.374	.386	.408	.398
Rho bar sq.	.347	.364	.364	.373	.394	.386

different travel time components with TOTCOST. In addition to INVTT: out-of-vehicle travel time (OUTVTT) was added in model 6. Access and egress time (ACSSEGST) in model 7, and waiting time (WAITT) in model 8. The inclusion of these variables resulted in parameter estimates with counter-intuitive signs, furthermore, none of these parameters was significant at 95% confidence level. In model 9, the composite variable in vehicle travel time per unit distance (INVTT/DIST) instead of INVTT was used. It resulted in a significant drop in the rho-square value although the coefficient of the variable was statistically significant. From the above analysis it can be inferred that the best components representing travel time and travel cost are the INVTT and the TOTCOST respectively, which are represented in model 3.

After having determined the best components of time and cost variable, other variables were introduced to find their effect. Personal income ($PERINC_A$) as well as household income ($HHINC_A$) specific to air mode were introduced into models 10 and 11 respectively. It was found that both were significant whereas the latter variable viz., $HHINC_A$ improved the rho-square more than $PERINC_A$. So it was decided to keep this variable in subsequent models. In model 12, household income specific to bus mode ($HHINC_B$) was introduced, alongwith $HHINC_A$. It can be seen from Table 6.2 that the coefficients of all the variables included were

significant. The effect of dummy variable for household income for bus ($DHHINC_B$) was found to be insignificant in model 13.

In models 14 and 15, the effect of the accompanied family was investigated by introducing the variables $FMLY_C$ and the dummy variable for $FMLY_C$ viz., $DFMLY_C$ respectively. It was found that the coefficients of the variables were significant but the coefficient of TOTCOST dropped drastically and a sharp reduction in t-value of this coefficient made it insignificant. This happened due to of the strong correlation between the cost and family. Hence, it was decided not to use these variables in the model.

In addition to cost, time and income variables, trip length was introduced specific to air ($DIST_A$) in model 16, specific to car ($DIST_C$) in model 17 and as a dummy for car ($DDIST_C$) in model 18. It can be seen in model 16 that, although the variable $DIST_A$ is significant, its inclusion resulted in an insignificant INVTT variable. Whereas in models 17 and 18 the incorporation of $DIST_C$, $DDIST_C$ improved the fit of the model. It was decided to use $DIST_C$ because of its higher significance

In further models other dummy variables were tested to investigate their effect. Dummy variables for nationality for air ($DNATION_A$) as well as for bus ($DNATION_B$) were introduced

simultaneously in model 19. Only the latter was found to be significant so it was kept in model 20, in addition to dummy for duration of stay for air ($DDUR_A$) and another dummy for car ownership specific to bus ($DNCAR_B$). The significance of $DNATION_B$ was decreased, furthermore $DDUR_A$ was also insignificant. Hence they were excluded from further analysis. Finally, the variable which was found significant in Model 20 $DNCAR_B$ was included in model 21 alongwith $DIST_C$, $HHINC_A$, $HHINC_B$, $HHINC_B$, INVTT and TOTCOST. These variables resulted in a good fit with a rho-square value of approximately 0.4 and significant coefficients. The complete model parameters are provided in Table 6.2. The utility functions of each mode are shown below:

For air mode (A):

$$U_A = -2.791 - 0.2100\ INVTT_A - 0.0034\ TOTCOST_A + 0.198\ HHINC$$

For bus mode (B):

$$U_B = -0.149 - 0.2100\ INVTT_B - 0.0034\ TOTCOST_B - 0.374\ HHINC + 2.034\ DNCAR$$

For auto mode (C):

$$U_C = -0.2100\ INVTT_C - 0.0034\ TOTCOST_C - 0.0037\ DIST$$

6.5 INTERCITY MODE CHOICE MODELS WITH MODE PERCEPTIONS

The objective of the mode-choice investigation here is to infer whether the perceptual variables increase the explanatory power of traditional mode-choice models, which have cost, time, other socioeconomic variables. Furthermore, models were built using only the level of service variables and the perceptual variables to investigate the explanatory power of the latter variables in comparison to the socioeconomic variables.

6.5.1 Models for Business trips

It was found earlier that TOTCOST, INVTT, $HHINC_A$, $DDUR_A$, $DDIST_C$, $DNCAR_B$ best explain the behavior of the intercity traveller for business trips. In addition to the above variables, privacy (PRIV) was incorporated into model 1, convenience (CONV) into model 2, comfort (COMF) in model 3 and reliability (RELIB) into model 4 (as shown in Table 6.3). It was found that the estimated coefficients of the variables were insignificant at 0.05 confidence level for PRIV and RELIB, whereas the inclusion of CONV and COMF improved the overall fit of the model resulting in an increased value of rho-square from 0.416 to 0.427, in case of the CONV variable, and to 0.430 for the COMF variable. Furthermore, the coefficients were statistically significant. In model 5 the inclusion of both CONV and COMF variables resulted in a much better fit of the overall model with the rho-square value

Table 6.3: Intercity Mode Choice Models for Busines Trips Including Perceptual Variables

Variable Name	Estimated Variable Coefficients (t-stat)				
	Model 1	Model 2	Model 3	Model 4	Model 5
ASC-AIR	.172(.17)	.998(.85)	-.573(- .56)	.112(.11)	.480(.3 9)
ASC-BUS	3.235(3.94)	3.621(4.26)	2.911(4.23)	2.790(4.04)	3.692(4.33)
TOTCOST	-.0050(4.15)	-.0048(-3.94)	-.0047(-3.79)	.0054(-4.34)	-.0045(-3.59)
INVTT	-.2080(-4.01)	-.2012(-3.82)	-.1858(-3.50)	-.2103(-4.05)	-.1821(-3.38)
$HHINC_A$	.390(3.30)	.409(3.42)	.372(3.12)	.384(3.28)	.391(3.23)
$DDIST_C$	1.327(1.97)	1.362(2.03)	1.260(1.85)	1.485(2.17)	1.263(1.87)
$DDURA_A$	2.066(4.89)	2.069(4.82)	2.130(4.98)	2.105(4.96)	2.11(4.85)
$DNCAR_B$	1.040(1.79)	1.047(1.82)	1.054(1.79)	1.157(2.02)	0.967(1.64)
PRIV	.076(1.11)				
CONV		0.144(1.86)			0.132(1.68)
COMF			0.138(2.19)		0.130(2.01)
RELIB				-.059(-1.15)	
LL(β)	-104.72	-103.42	-102.86	-104.68	-101.31
LL(O)	-180.49	-180.49	-180.49	-180.49	-180.49
Rho sq. ρ^2	.420	.427	.430	.420	.439
Rho bar sq.	.407	.414	.417	.407	.425

being increased to 0.439. The estimated coefficients of all the variables, except for the $DNCAR_B$ variable was statistically significant at 90% confidence level, whereas for the COMF variable it was significant at 95% significance level.

In order to find out whether the behavior of the traveller can be better explained by only the perceptual variables and level of service variable, compared to the socioeconomic characteristics and other variables, mode choice models were calibrated using only the travel time and travel cost variables with the perceptual variables. Privacy (PRIV) was incorporated into Model 1, Convenience (CONV) into Model 2, Comfort (COMF) into Model 3 and Reliability (RELIB) into Model 4, as shown in Table 6.4. It can be observed from the table that the estimated coefficients of all the variables were significant at 0.05 confidence level, except for the reliability concept which had a counter-intuitive sign. In Model 5 all three significant perceptual variables were introduced with the TOTCOST and INVTT. However, the PRIV estimated coefficient was insignificant at 0.05 confidence level. So, this variable was eliminated in Model 6. In this model all estimated coefficients are statistically significant and rho-squared value was 0.298. Whereas, the rho-squared value was estimated to be 0.416 when models were built using only the level of service and socioeconomic variables. Here, it can be concluded that the perceptual variables have less explanatory power than the socioeconomic variables.

Table 6.4: Intercity Mode Choice Models for Business Trips Including Perceptual Variables and Level of Service Variables

Variable Name	Estimated Variable Coefficients (t-stat)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ASC-AIR	2.432(5.08)	3.352(4.46)	1.346(3.32)	1.872(4.95)	2.906(3.65)	2.799(3.60)
ASC-BUS	2.785(4.87)	2.915(5.07)	2.113(5.947)	1.768(5.39)	3.344(4.91)	3.120(5.29)
TOTCOST	-0.0035(-3.54)	-0.0034(-3.37)	-0.0033(-3.28)	-0.0038(-3.79)	-0.0031(-3.03)	-0.0031(-3.01)
INVTT	-0.1407(-3.50)	-0.1248(-3.12)	-0.113(-2.76)	-0.1359(-3.40)	-0.11 10(-2.66)	-0.1065(-2.59)
PRIV	0.138(2.189)				0.049(0.69)	
CONV		0.1729(2.45)			0.1454(1.92)	0.1617(2.25)
COMF			0.1629(2.87)		0.1447(2.44)	0.1547(2.69)
RELIB				-0.038(-0.853)		
LL(β)	-131.361	-130.550	-129.524	-133.540	-126.482	-126.724
LL(O)	-180.492	-180.492	-180.492	-180.492	-180.492	-180.492
Rho sq. ρ^2	0.272	0.276	0.282	0.260	0.299	0.298
Rho-bar sq.	0.263	0.267	0.273	0.250	0.286	0.287

6.5.2 Models for Social and Recreational Trips

In addition to TOTCOST, INVTT, $HHINC_A$, $HHINC_B$, $DIST_C$, $DNCAR_B$ perceptual variables were included one at a time to investigate the significance of each. Table 6.5 presents details of the calibrated models, including perceptual variables. As it can be seen in Model 1, the incorporation of PRIV did not improve the fit of the model, furthermore, the coefficient of the variable was insignificant at 95% confidence level. Similarly, the inclusion of CONV variable in Model 2 resulted in the same phenomenon and the sign of the coefficient was counter intuitive. Whereas, inclusion of comfort variable in Model 3 significantly improved the overall fit of the model resulting in an increased value of rho-square from 0.398 to 0.456. The coefficient of this variable was highly significant. Finally, RELIB was added in Model 4 along with the other variables. The coefficient was insignificant and it did not improve the fit of the model. Hence, it can be concluded that the level of Comfort offered by a mode significantly affects the choice of a traveller for social and recreational trips.

To compare the explanatory power of perceptual variables with level of service variables; and socioeconomic variables with level of service variables, mode choice models were built using only the perceptual variables and level of service variables (TOTCOST and INVTT). Table 6.6 shows the details of the calibrated models.

Table 6.5: Intercity Mode Choice Models for Social and Recreational Trips Including Perceptual Variables

Variable Name	Estimated Variable Coefficients (t-stat)			
	Model 1	Model 2	Model 3	Model 4
ASC-AIR	-2.624(-3.8)	-3.064(-4.01)	-4.204(-5.23)	-2.987(-4.17)
ASC-BUS	-0.204(-0.226)	-0.309(-0.35)	-0.397(-0.42)	-0.291(-0.334)
TOTCOST	-.0034(-5.26)	-.0034(-5.25)	-.0037(-5.23)	.0034(-5.31)
INVTT	-.212(-3.57)	-.2105(-3.55)	-.205(-3.24)	-.205(-3.49)
$HHINC_A$	.224(2.12)	.185(1.78)	.235(2.14)	.228(2.16)
$HHINC_B$	-.333(-1.97)	-.396(-2.35)	-.228(-1.32)	-.338(-2.01)
$DIST_C$	-.0037(4.21)	-.0036(-4.14)	-.0041(-4.45)	-.0037(-4.23)
$DNCAR_B$	2.149(3.20)	2.035(3.09)	2.254(3.33)	2.012(3.057)
PRIV	.086(1.58)			
CONV		-0.041(-0.82)		
COMF			0.312(4.74)	
RELIB				0.042(1.007)
LL(β)	-135.606	-136.559	-123.529	-136.390
LL(O)	-227.260	-227.260	-227.260	-227.260
Rho sq. ρ^2	.403	.399	.456	.400
Rho bar sq.	.390	.386	.445	.387

Table 6.6: Intercity Mode Choice Models for Social/Recreational Trips Including Perceptual Variables and Level of Service Variables

Variable Name	Estimated Variable Coefficients (t-stat)			
	Model 1	Model 2	Model 3	Model 4
ASC-AIR	-0.5734(-1.53)	-1.0665(-2.18)	-1.747(-4.32)	-0.8196(-2.43)
ASC-BUS	1.024(2.43)	-0.3490(0.88)	1.2404(3.93)	0.6073(2.27)
TOTCOST	-0.0020(4.49)	-0.0020(-4.44)	-0.0021(-4.35)	-0.0020(-4.50)
INVTT	-0.307(-5.80)	-0.2987(-5.70)	-0.3090(-5.63)	-0.3007(-5.75)
PRIVT	0.066(1.39)			
CONV		-0.0332(-0.74)		
COMF			0.2725(4.75)	
RELIB				0.0237(0.66)
LL(β)	-163.844	-164.555	-151.614	-164.609
LL(O)	-227.260	-227.260	-227.260	-227.260
Rho sq. ρ^2	0.279	0.275	0.332	0.275
Rho bar sq.	0.270	0.267	0.325	0.267

In Model 1 Privacy (PRIV) was incorporated, Convenience (CONV) in Model 2, Comfort (COMF) in Model 3 and Reliability (RELIB) in Model 4. Only the comfort variable was found to be significant at 0.05 confidence level. The rho-squared value was estimated to be 0.333. Whereas, the rho-squared value was 0.398 when only the socioeconomic variables were used with the level of service variables. Hence, it can be stated that the socioeconomic variables are better for explaining the behavior of travellers than the perceptual variables.

6.6 VALIDATION OF CALIBRATED MODELS

After the calibration process was completed, the validity of the calibrated models was tested. This process was performed by restricting the coefficients of the variables of the calibrated model and then running the BLOGIT program, using the data kept for the purpose of validation.

For business trips 96 observations were used, on the other hand, 118 observations were used in validating the social and recreational trip model. Likelihood Ratio Test Statistics (LRTS) were used in the validation test. (This test is asymptotically distributed as χ^2 (chi-square) with degrees of freedom equal to the number of model parameters). The test is expressed by the following relationship:

$$LRTS_i(\beta_j) = -2(LL_i(\beta_j) - LL_i(\beta_i))$$

where,

$LRTS_i(\beta_j)$ = represents the likelihood ratio test statistics which restricts the parameters estimated from data j to be used to predict mode share in data i for the same specification.

$LL_i(\beta_j)$ = log likelihood that the behavior observed in data i was generated by the model estimated in data j (restricted parameters).

$LL_i(\beta_i)$ = is the log likelihood of the models estimated in the same data i (unrestricted parameters).

Using the data reserved for validation, models were calibrated with and without attitudinal variables both for social and business trips. Table 6.7 illustrates the results of validation tests for various trip purposes. It can be noticed from the table that LRTS values were always less than the critical value of χ^2 (chi-square) at a 95% confidence level, which indicates that there is no significant difference between the observed behavior and the predicted behavior of mode choice for validation.

Furthermore, a computer program was prepared to estimate

Table 6.7: Validation Test Results

Trip Purpose	Log Likelihood Ratio		LRTS	No. of Parameters	Critical X^2 (0.05)
	Unrestricted	Restricted			
Business (without mode perception)	- 47.69	- 54.02	12.11	7	14.07
Business (with mode perception)	- 45.42	- 52.83	14.82	9	16.92
Social (without mode perception)	- 81.41	- 84.99	7.17	8	15.51
Social (with mode perception)	- 76.79	- 79.53	5.48	9	16.92

the model share for each trip purpose. The program calculates the utility of each mode for every traveller, then the probability of using each alternative is estimated. The alternative which has the highest probability is predicted to be the chosen mode for that particular individual. The number of travellers correctly predicted will be summed up for each alternative and compared with the actual share to yield the prediction ratio. Table 6.8 shows the prediction success table for business trips, considering both calibration as well as validation data. It is observed from the tables that the overall prediction ratios are 0.74 and 0.72 for calibration and validation data respectively. It can be noticed that the air mode has the highest prediction ratio (0.90) as compared to other modes.

The overall prediction ratio for business trips was improved to 0.77 for calibration data and 0.80 for validation data, when models containing perceptual variables were used for prediction as shown in Table 6.9. Comparison of Tables 6.8 and 6.9 also depicts that the prediction ratio increased for all modes, both in case of validation and calibration data.

Table 6.10 presents the details of the prediction success table for social and recreational trips using calibration and validation data. It can be noticed that among the alternatives, car has the highest prediction ratio, viz., 0.83 for calibration and 0.77 for validation respectively. The overall prediction ratio is around 0.71

Table 6.8: Prediction Success Table for Business Trips Model Without Perceptual Concepts

	Calibration Data			Validation Data		
	Alternatives			Alternatives		
	Air	Bus	Auto	Air	Bus	Auto
Number of travellers choosing this alternative	129	49	25	60	24	12
Number of travellers correctly predicted by the model	115	28	8	54	12	3
Prediction Ratio	.89	.57	.32	.90	.50	.25
Overall Prediction Ratio	.74			.72		

Table 6.9 Prediction Success Table for Business Trips Model With Perceptual Concepts

	Calibration Data			Validation Data		
	Alternatives			Alternatives		
	Air	Bus	Auto	Air	Bus	Auto
Number of travellers choosing this alternative	129	49	25	60	24	12
Number of travellers correctly predicted by the model	112	36	9	55	17	5
Prediction Ratio	.87	.73	.36	.92	.71	.42
Overall Prediction Ratio	.77			.80		

Table 6.10: Prediction Success Table for Social and Recreational Trips Model Without Perceptual Concepts

	Calibration Data			Validation Data		
	Alternatives			Alternatives		
	Air	Bus	Auto	Air	Bus	Auto
Number of travellers choosing this alternative	87	39	92	45	25	48
Number of travellers correctly predicted by the model	60	20	76	30	13	37
Prediction Ratio	.69	.51	.83	.67	.52	.77
Overall Prediction Ratio	.71			.67		

for calibration data and 0.67 for validation data.

When the models incorporating the mode perceptions were used for prediction purposes, there were marginal improvements in the overall prediction ratio from 0.71 to 0.73 for calibration data and from 0.67 to 72 with validation data. Table 6.11 shows the number of travellers correctly predicted as well as the prediction ratio for each alternative for both calibration and validation data, for social and recreational trips.

6.7 EFFECT OF PERCEPTUAL VARIABLES ON MODE-CHOICE MODELS

The null hypothesis that perceptual variables do not add to the explanation of the mode choice behavior (i.e. their coefficient estimates are collectively equal to zero) was tested using the following likelihood ratio test statistics:

$$LRT = -2\,(L(\beta_1) - L(\beta_2))$$

where $L(\beta_1)$ = Log-likelihood of model with perceptual item

$L(\beta_2)$ = Log-likelihood of model without perceptual item

This test is Chi-square distributed with $K_2 - K_1$ degrees of freedom.

Table 6.11: Prediction Success Table for Social and Recreational Trips Model with Perceptual Concepts

	Calibration Data			Validation Data		
	Alternatives			Alternatives		
	Air	Bus	Auto	Air	Bus	Auto
Number of travellers choosing this alternative	87	39	92	45	25	48
Number of travellers correctly predicted by the model	58	25	76	31	17	37
Prediction Ratio	.67	.64	.83	.69	.68	.77
Overall Prediction Ratio	.73			.72		

This test was performed on both the business and social/ recreational trips models. From the results of the test, which is reported in Table 6.12 the null hypothesis can be rejected at 95% confidence level. Hence, it can be stated that a significant difference exists between models with and without mode perceptions.

It should be noted that the work involved in constructing the scales of these perceptual variables and collecting the data was too great since filling in the questionnaire forms required approximately 20 minutes, which was not welcome by many travellers, especially those who were using private auto and accompanied by their families. However, the inclusion of these variables in the mode-choice models provided only marginal improvement. So the author suggests that the inclusion of such variables in the planning stages was not worth the effort. Furthermore, it is not possible to forecast peoples' perception of the travel modes unless another model which can predict these perceptions (for instance as a function of socioeconomic data) can be calibrated. Therefore, models containing perceptions cannot be used as forecasting models. However, studying the perceptions of travellers towards travel modes could be very useful for the operators marketing intercity travel services. By finding the most significant perceptual variables affecting the mode-choice, operators can increase the demand on their modes by improving the service provided by that mode. In this study, comfort was found to be the most significant

Table 6.12: Test for Difference Between Models With and Without Perceptual Variables

Trip Purpose	Log Likelihood Ratio		$-2(L(\beta_1)-L(B_2))$	Degrees of Freedom	Critical $\chi^2(0.05)$
	Model With Percep.Variab.	Model Without Percep.Variab.			
Business Trips	101.3	105.3	8	2	5.99
Social/Recreational Trips	123.5	134.5	22	1	3.84

perceptual variable affecting the choice of a traveller. The bus was ranked the lowest in terms of comfort. Bus operators should look into comfort related aspects in order to improve their public image. This could be done by the provision of comfortable seats, clean new vehicles, bus stops, etc.

6.8 SUMMARY

After segmenting the data by trip purpose, models were calibrated. Due to the lack of sufficient data for various trip purposes, only business and social/recreational trips were used for model calibration. The data was divided into two parts, 2/3rd for calibration and the remaining 1/3rd for validating the models. Various combinations of model specifications were tested in order to determine the best model.

Model calibration for business and social/recreational trips was done systematically. The details of the calibration process are shown in Tables 6.1 and 6.2 for business and social/recreational trips respectively. The specification of the models for both the trip purposes is presented in this chapter.

Perceptual variables were introduced into the calibration models to investigate the effect of incorporating these variables in explaining the mode-choice behavior of the trip maker. The perception of mode comfort and convenience was found to significantly

affect the choice of the traveller for business trips. Comfort variable was found to affect only social/recreational trips. The validation of the calibrated models was done by using the reserved 1/3rd of the data. The results of the Likelihood Ratio Test Statistics indicated that their was no significant difference between the restricted parameters and the parameters predicted from validation data. The calibrated model predicted over 70% of the travellers choice correctly whereas the inclusion of the perceptual variables marginally improved the overall prediction ratio. This chapter was concluded by studying the effect of introducing these variables into intercity mode choice models. Although a significant difference exists between models with and without mode perceptions, the inclusion of these variables in the planning stages was not recommended because of the amount of effort needed.

Chapter 7

SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The main objective of this research was to investigate the effect of intercity travellers' perceptions of travel modes on their mode-choice decisions. Reviewing the work done by various authors in the past, it was found that comfort, convenience and reliability of the used mode affect the choice of a traveller significantly in the intracity context. In this research, the significance of incorporating mode comfort, convenience. reliability and privacy in the intercity travel mode-choice was investigated.

To achieve this objective, first, perceptual scales were developed and tested for the purpose of quantifying the perception of modes. The procedure adopted in scale construction has been extensively used in psychological research. A pilot survey was employed to develop the perceptual scales that were used in the main survey instrument. The perceptual scales were obtained using factor analysis. The results of this analysis revealed that comfort, reliability, privacy and convenience items constituted different dimensions although the latter two were somewhat correlated. The items with the highest factor loadings in each factor were selected to represent perceptual concepts in the main survey.

For the purpose of developing behavioral mode-choice models, a self-response questionnaire was distributed to a representative sample of air, auto, bus travellers on all the major corridors of the Kingdom.

A total of 867 usable responses were analyzed using the SASSYS software [55] in the mainframe computer of the KFUPM. It was found from the analysis that the air mode attracted the majority of work and personal business trips, whereas social/recreational trips were mostly carried out using private autos. Using the main survey data, another run of factor analysis was performed for retesting the scale constructed in the pilot survey. The results of this analysis confirmed the original scales.

Further analysis on the perceptual items revealed that there were marked differences in mode perceptions of comfort, convenience, reliability and privacy among various modes. Air mode was ranked first, comfortwise, whereas auto scored the highest in privacy. The bus mode rated lowest among all perceptual items, compared to other alternatives. The effect of socioeconomic characteristics on mode perceptions was studied through analysis of variance. It was found that travellers' income, nationality and age significantly affect their mode perceptions. The importance of the perceptual items ranged from 3.77 to 4.54 on a 5.00-point scale scale which indicated that all items possess a degree of importance for travellers while making mode choice. In addition, the

perception of mode comfort was found to be the most important perceptual variable considered by travellers during their journey.

In order to study the effect of perceptual concepts on mode-choice, disaggregate mode-choice models were calibrated for business trips as well as social/recreational trips. The calibration process was carried out in two stages. In the first stage, the main thrust was on developing mode-choice model that best replicated the collected data excluding perceptual variables. In the latter stage perceived variables were incorporated in the previously developed models to study their effect. BLOGIT software was utilized for this purpose. The data for these trip purposes was segmented into two parts: two thirds of the data was utilized for model calibration and the remaining one third was reserved for validation of the calibrated models. Different model specifications have been tested in order to determine the best models. Tables 7.1 and 7.2 show the final calibrated models for business and social/recreational trips. Introducing perceptual variables to these models revealed that the perception of mode comfort significantly improved the overall fit of the model for social/recreational trips resulting in an increased value of rho-square from 0.398 to 0.456. Whereas, the inclusion of convenience and comfort variables resulted in an increase in the rho-square value from 0.416 to 0.439 for business trips. The validation process was carried out using calibrated models to predict mode-share for reserved data that

Table 7.1: Intercity Mode-Choice Models for Business Trips With and Without Perceptual Variables

Independent Variable Name	Model Without Mode Perception		Model With Mode Perception	
	Coefficient	t-Stat	Coefficient	t-Stat
ASC-AIR	0.091	0.09	0.480	0.39
ASC-BUS	2.753	4.02	3.692	4.33
TOTCOST	-0.0051	-4.20	-0.0045	-3.59
INVTT	-0.2056	-3.97	-0.1821	-3.38
$HHINC_A$	0.387	3.30	0.391	3.23
$DDIST_C$	1.381	2.04	1.263	1.87
$DNCAR_B$	1.150	2.01	0.967	1.64
$DDUR_A$	2.071	4.94	2.11	4.85
CONV	--	--	0.132	1.68
COMFORT	--	--	0.130	2.01
LL (β)	-105.35		-101.31	
LL (O)	-180.49		-180.49	
Rho-Sq ρ^2	0.416		0.439	
Rho-Bar Sq	0.405		0.425	

Table 7.2: Intercity Mode-Choice Models for Social Recreational Trips With and Without Perceptual Variables

Independent Variable Name	Model Without Mode Perception		Model With Mode Perception	
	Coefficient	t-Stat	Coefficient	t-Stat
ASC-AIR	-2.791	-4.09	-4.204	-5.23
ASC-BUS	-0.149	-0.17	-0.397	-0.42
TOTCOST	-0.0034	-5.31	-0.0037	-5.23
INVTT	-0.2100	-3.56	-0.205	-3.24
$HHINC_A$	0.198	1.92	0.235	2.14
$HHINC_B$	-0.374	-2.27	-0.228	-1.32
$DIST_C$	-0.0037	-4.17	-0.0041	-4.45
$DNCAR_B$	2.034	3.09	2.254	3.33
COMFORT	--	--	0.312	4.74
LL (β)	-136.90		-123.529	
LL (O)	-227.26		-227.260	
Rho-Sq ρ^2	0.398		0.456	
Rho-Bar Sq	0.386		0.445	

were not used for mode calibration. This process revealed that the calibrated models were able to predict approximately 70% of the travellers' choices correctly. The inclusion of the perceived variables resulted in a marginal improvement of the overall prediction ratio. The validity of the calibrated models was tested using a likelihood ratio test. The results of the test showed that there was no significant difference between the observed behavior and the predicted behavior of the travellers.

7.2 CONCLUSIONS

This research provided a better understanding of the behavior of intercity traveller in Saudi Arabia. The following conclusions can be drawn based on the findings of this research:

1) The perceptual items that have been tested in the pilot survey and confirmed using the main survey constituted the four different concepts that were hypothesized originally; however, privacy and convenience scales were found to be somewhat correlated. items.

2) The perceptions of travel modes were affected by the travellers's socioeconomic characteristics and the chosen mode.

3) The bus mode was rated lowest among all alternatives.

This can be attributed to the conditions of the buses. To improve the market share of this service, the operators should improve their marketing strategies since most of the people did not have sufficient information about the type and quality of services provided.

4) The behavior of the traveller was found to be affected by the purpose of the trip. For business and educational trips the air mode was preferred, whereas, private auto attracted the majority of social/recreational trips. Hence, building models for these trip purposes provided a better understanding of travellers' sensitivity towards variables used in calibrating mode-choice models.

5) Apart from the travel time and travel cost variables, it was found that household income, trip-length, car ownership and duration of stay at destination played a role in explaining the mode-choice behavior of the intercity traveller.

6) Among the four perceptual concepts that have been hypothesized in this study, only the perception of mode comfort played a significant role in the selection of an alternative by the traveller for business as well as social/recreational trips. Furthermore, perception of

mode convenience was significant for business trips.

7) It was, originally, believed that mode privacy would play a significant role in travellers' selection of mode, due to local customs in Saudi Arabia, however, this research revealed that it had no significant effect since the estimated coefficient of privacy variable was not significantly different from zero at 95% confidence level. However, privacy and convenience were found to be somewhat correlated and hence their effect might have been covered by convenience.

8) Although the amount of work involved in scale construction data collection and analysis of the perceptual variables was considerable; when compared to the effort put into the other variables, the inclusion of these variables in the mode-choice models resulted in a small increase in the rho-square value and a marginal improvement in the prediction capability of the models. Hence, it is recommended not to include these variables in the planning stages. However, the travellers' perception of the travel modes could be important for the operators of these services.

7.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Following recommendations are proposed for further research:

1) The survey for this study was carried out during the inter-semester break of schools and colleges when the demand for intercity trips is expected to be heavy. Hence it is recommended to collect data during different seasons.

2) The Kingdom of Saudi Arabia is considered as an arid region with hot weather during summer. It would be wise to investigate the effect of weather conditions on mode-choice for intercity trips.

3) The perception of mode safety can play a role in the selection of intercity modes. Therefore, a suggestion is to study the perception of mode safety together with the perceptual scales of comfort and convenience that were found to play a role in the intercity mode choice.

4) Captive riders were excluded from mode-choice model building and prediction. Investigation of how people become captive riders, whether it is possible to identify them using various models and, finally, investigating the effect of inclusion of captives as choice models would be interesting research topic.

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APPENDICES

APPENDIX - A

Questionnaire Form for Pilot Survey

(Arabic and English)

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

عزيزي المسافر :

السلام عليكم ورحمة الله وبركاته :

يقوم قسم الهندسة المدنية بجامعة الملك فهد للبترول والمعادن بدعم من مدينة الملك عبدالعزيز للعلوم والتقنية بإجراء بحثاً للتعرف على رغبات المسافرين بين المدن في المملكة العربية السعودية .

وهذا الاستفتاء الذي بين يديك هو للتعرف على أسباب إختيار المسافر لوسيلة السفر من مدينة إلى أخرى حيث أن هذه المعلومة مطلوبة في هذه الدراسة والتي سوف تفيد الأشخاص والجهات ذوات العلاقة .

إن إقتطاع جزءٍ من وقتك لهذا الاستفتاء سوف يكون له كل التقدير .

كما نرجو منكم الألتزام بالدقة في تعبئة هذا الاستفتاء حيث تعتبر هذه المعلومات أساسية في البحث الخاص بهندسة النقل .

أخيراً أشكركم على تعاونكم معنا في إنجاح هذا البحث ، والله الموفق .

الباحث الرئيسي
د/ حسن مساعد الأحمدي

رئيس قسم الهندسة المدنية
د/ غازي السليماني

الجزء الأول

في هذا الجزء سوف تقيم عدة وسائل تستخدم للنقل بين المدن في المملكة العربية السعودية . في هذا التقيم الرجاء وضع دائرة حول الجواب المناسب .
فمثلاً عندما تقارن بين وسائل السفر من حيث السرعة .

السرعة :

	الأسوء				الأفضل
[ ] الحافلة (الباص)	١	(٢)	٣	٤	٥
[ ] السيارة الخاصة .	١	٢	(٣)	٤	٥
[ ] الطائرة .	١	٢	٣	٤	(٥)
[ ] القطار .	١	(٢)	٣	٤	٥

حيث أعتبرت أن الطائرة أسرع وسائل النقل ثم بعدها السيارة ثم القطار أو الباص .

الآن الرجاء الاجابة على جميع الأسئلة التالية :

فضلاً ضع دائرة واحدة في كل سطر حول الإجابة المناسبة (يلاحظ أن رقم واحد هو الأسوء ورقم خمسة هو الأفضل)

فضلاً قارن بين وسائل النقل التالية من حيث :

١ -التمتع ببعض الخصوصية :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٢ - امكانية الوصول إلى وجهتك في الموعد المحدد :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٣ - إمكانية الوقوف حين وإينما تريد :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٤ - إمكانية السفر في أي وقت :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٥ - إمكانية الاسترخاء أثناء السفر :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٦ - سهولة الوصول إلى وسيلة السفر من منزلك :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٧ - إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحرية :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٨ - عدم التأخير والانتظار الطويل :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٩ - تجنب حالات الزحام :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٠ - البقاء مع أفراد عائلتك أو أصدقائك منفردين :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١١ - سهولة حمل حقائبك وأغراضك الأخرى بسهولة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

١٢ - عدم اعاقة حالة الطقس لسفرك .

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٣ - شعورك بأن المركبة أو الناقلة لن تتأخر بسبب الأعطال :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٤ - عدم احتياجك إلى تغيير المركبة للوصل إلى وجهتك النهائية :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٥ - نظافة المركبة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٦ - تجنب الجلوس بجانب شخص غريب

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

١٧ - إن مدة الرحلة نوعاً ما ثابتة ومعروفة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٨ - تجنب الازعاج الصادر من الناس الآخرين :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

١٩ - أنها لاتحتاج إلى جهد لبدء الرحلة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٠ - عدم الأعتماد على أناس آخرين :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢١ - أنها ملائمة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٢٢ - أنها مريحة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٣ - الشعور بالاستقلالية :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٤ - لأمكانية الأعتماد عليها :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٥ - سهولة وصولك إلى وجهتك بعد تركك المركبة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٦ - إنها لاتحتاج إلى تخطيط مسبق كالحجز مثلاً

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٢٧ - مدة الرحلة بهذه المركبة لاتتاثر بحالة الطقس :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٨ - الشعور بالتعب في نهاية الرحلة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٢٩ - إمكانية حدوث حادث أو خلل في هذه المركبة :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٣٠ - ان الوقت المستغرق لإنتظار الركاب الآخرين قليل :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

٣١ - تجنب التحدث إلى الغرباء :

	الأسوء				الأفضل
الحافلة (الباص)	١	٢	٣	٤	٥
السيارة الخاصة	١	٢	٣	٤	٥
الطائرة	١	٢	٣	٤	٥
القطار	١	٢	٣	٤	٥

الجزء الثاني

الرجاء الإجابة عن الأسئلة التالية بإختيار الجواب المناسب لكل سؤال مع العلم أن الإجابة عن هذه الأسئلة سوف تستخدم لأغراض إحصائية بحتة .

١ - أي من وسائل النقل التالية لم تستخدمها من قبل في النقل بين المدن في المملكة:

[ ] الحافلة (الباص)
[ ] السيارة الخاصة
[ ] الطائرة
[ ] القطار

٢ - كم تبلغ من العمر

[ ] أقل من ٢٠ سنة
[ ] ٢١ - ٣٠ سنة
[ ] ٣١ - ٤٠ سنة
[ ] ٤١ - ٥٠ سنة
[ ] ٥١ - ٦٠ سنة
[ ] أكثر من ٦٠ سنة

٣ - فضلاً حدد أعلى مستوى دراسي حصلت عليه :

[ ] الابتدائي .
[ ] المتوسط أو الثانوي .
[ ] في المرحلة الجامعية .
[ ] حاصل على شهادة جامعية .

٤ - كم عدد السيارات اللتي تملكها أسرتك ؟ .....

٥ -كم هو دخل أسرتك الشهري ؟

[ ] أقل من ١٠٠٠ ريال
[ ] ١٠٠١ - ٢٥٠٠ ريال
[ ] ٢٥٠١ - ٥٠٠٠ ريال
[ ] ٥٠٠١ - ٧٥٠٠ ريال
[ ] ٧٥٠١ - ١٠٠٠٠ ريال
[ ] ١٠٠٠١ - ١٢٥٠٠ ريال
[ ] ١٢٥٠١ - ١٥٠٠٠ ريال
[ ] أكثر من ١٥٠٠٠ ريال

نشكر لكم حُسن تعاونكم معنا في الإجابة على هذا الإستبيان .
فضلاً لاتنسى أن ترد هذا الاستفتاء للشخص الذي تسلمته منه أو إلى ص ب ٩٤٥ .

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

Dear Citizen or Saudi Arabian resident,

The civil engineering department of the King Fahd University of Petroleum and Minerals is conducting a research to understand the travel needs between the cities of the Kingdom of Saudi Arabia. This research is funded by the *King Abdulaziz City for Science and Technology*. This survey is part of this research and will be used by the University to develop improved planning methods for travel between cities all over the country.

You are selected at random to be part of this survey. The number of people being asked to participate is small, so your answers are very important. Please take this opportunity to have your needs and views represented.

You are asked not to put your name on the questionnaire and there is no way to link your answers to your name. The questionnaire has few questions about your most recent trip between the cities of Saudi Arabia and then asks your opinion about various means of travel between cities. It takes about ten minutes to complete.

We hope that you will take a few minutes to fill out this questionnaire. We greatly appreciate your cooperation. If you have any questions, you may call Dr. Hasan M. Al-Ahmadi at 860-4269 during weekdays.

Sincerely,

Dr. Ghazi J. Al-Sulaimani
Chairman, Civil Engineering Department

Dr. Hasan M. Al-Ahmadi
Principal Investigator

PART I

ON THE FOLLOWING PAGES YOU WILL BE ASKED TO EVALUATE ALTERNATIVE MEANS OF TRANSPORTATION FOR TRAVELING BETWEEN CITIES IN SAUDI ARABIA. THIS EVALUATION WILL BE MADE BY SELECTING THE MOST APPROPRIATE ANSWERS FOR CERTAIN STATEMENTS.

LET US SAY, FOR EXAMPLE, THAT YOU ARE EVALUATING DIFFERENT MEANS OF TRANSPORTATION WITH RESPECT TO SPEED. A POSSIBLE RESPONSE TO THIS WILL BE AS GIVEN BELOW. NOTE THAT THE RESPONSES ARE INDICATED BY CIRCLING NUMBERS, WHERE "1" INDICATE THE WORST, "5" INDICATE THE BEST AND OTHER NUMBERS INDICATE JUDGEMENT IN BETWEEN.

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO .....

SPEED

	WORST				BEST
BUS	1	(2)	3	4	5
PRIVATE CAR	1	2	(3)	4	5
PLANE	1	2	3	4	(5)
TRAIN	1	(2)	3	4	5

NOW PLEASE GO TO THE NEXT PAGE AND EVALUATE THE INDICATED MEANS OF TRAVEL WITH RESPECT TO ALL THE LISTED CHARACTERISTICS.

PLEASE TRY TO RESPOND FOR EACH STATEMENT.

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO ...

HAVING SOME PRIVACY.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

ARRIVING DESTINATION ON TIME.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

FREEDOM IN CHOOSING LOCATIONS AND TIME OF STOPS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

FREEDOM IN CHOOSING DEPARTURE TIME.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

RELAXING WHILE TRAVELING.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

ACCESSIBILITY FROM HOME.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO ...

TALKING FREELY WITH FAMILY MEMBERS OR FRIENDS

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

AMOUNT OF WAITING TIMES AND DELAYS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

AVOIDING CROWDED CONDITIONS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

BEING ALONE WITH FAMILY MEMBERS OR FRIENDS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

CARRYING LUGGAGE AND OTHER BELONGINGS EASILY.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE EFFECT OF WEATHER CONDITION ON THE TRIP.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO ...

THE FEELING THAT THE VEHICLE WOULD NOT BE DELAYED FOR REPAIR

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE NEED TO CHANGE VEHICLE IN REACHING THE FINAL DESTINATION.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

CLEANLINESS OF VEHICLE.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

AVOIDING SITTING NEXT TO A STRANGER.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE VARIATION IN TOTAL TRAVEL TIME.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

BEING BOTHERED BY OTHER PEOPLE.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO ...

THE EFFORTS REQUIRED TO START THE TRIP.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

TRAVELING WITHOUT DEPENDING ON OTHERS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

CONVENIENCE.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

COMFORT.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

FEELING OF INDEPENDENCE.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

RELIABILITY.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

PLEASE EVALUATE THE FOLLOWING MEANS OF TRANSPORTATION WITH RESPECT TO ...

THE EASINESS OF REACHING FINAL DESTINATION AFTER LEAVING THE VEHICLE.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE NEED FOR ADVANCE PLANNING.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE EFFECT OF WEATHER CONDITION ON TRAVEL TIME.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

FEELING TIRED AT THE END OF THE TRIP.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE LIKELIHOOD OF ACCIDENT OR BREAKDOWN DURING THE TRIP.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

THE AMOUNT OF TIME SPENT WAITING FOR OTHERS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

AVOIDING TALKING TO STRANGERS.

	WORST				BEST
BUS	1	2	3	4	5
PRIVATE CAR	1	2	3	4	5
PLANE	1	2	3	4	5
TRAIN	1	2	3	4	5

PART II

THE QUESTIONS BELOW ARE FOR STATISTICAL PURPOSES ONLY. THEY WILL BE USED TO DETERMINE THE DIFFERENCES AMONG GROUPS OF INDIVIDUALS WITH RESPECT TO THEIR PERCEPTIONS AND USE OF DIFFERENT ALTERNATIVE MEANS OF TRAVEL.

1. Which of the following modes you did not use before between cities in Saudi Arabia?

[ ] BUS
[ ] PRIVATE CAR
[ ] PLANE
[ ] TRAIN

2. Is your age [ ]under 20 [ ] 21 - 30 [ ] 31 - 40
[ ] 41 - 50 [ ] 51 - 60 [ ] over 60

3. Please indicate how many year of school you have completed.

[ ] 1-6 years
[ ] 7-12 years
[ ] University studies, no degree
[ ] University degree

4. How many automobiles are there in your household? _____

5. What is your household **monthly** income?

household income

[ ] less than 1,000 SR.
[ ] 1,000 -2,500 SR.
[ ] 2,501 -5,000 SR.
[ ] 5,001 -7,500 SR.
[ ] 7,501 -10,000 SR.
[ ] 10,001-12,500 SR.
[ ] 12,501-15,000 SR.
[ ] more than 15,000 SR

THANK YOU FOR YOUR COOPERATION

Please return the questionnaire to the person who distributed it.

APPENDIX - B

Questionnaire Form for Main Survey

(Arabic and English)

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

بسم الله الرحمن الرحيم

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

إستبانه للمسافرين بالطائرة

عزيزي المسافر

السلام عليكم ورحمة الله وبركاته

يقوم قسم الهندسة المدنية بجامعة الملك فهد للبترول والمعادن بدعم من مدينة الملك عبد العزيز للعلوم والتنقية بإجراء بحث للتعرف على رغبات المسافرين بين المدن في المملكة العربية السعودية . وهذه الإستبانه التي بين يديك هي للتعرف على أسباب إختيارك لوسيلة السفر من مدينة إلى أخرى حيث أن هذه المعلومات مطلوبة في هذه الدراسة التي سوف تفيد الأشخاص والجهات ذات العلاقة في تطوير النقل بين مدن المملكة .

إن إقتطاع جزء من وقتك لتعبئة هذه الإستبانه سوف يكون له كل التقدير .

نرجو منكم تحري الدقة في تعبئة هذه الإستبانه حيث تعتبر هذه المعلومات أساسية في اعداد البحث الخاص بهندسة النقل.

شاكرين تعاونكم معنا في إنجاح هذا البحث لما من شأنه خدمة المصلحة العامة .
والله الموفق .

الباحث الرئيسي

د./ حسن مساعد الأحمدي

رئيس قسم الهندسة المدنية

د. الفارابي شريف

قسم الهندسة المدنية
CIVIL ENGINEERING DEPT.

الجزء الأول : معلومات عن الرحلة

هذا الجزء من الاستبانه يحتوي على معلومات عن الرحلة التي قمت أو تنوي القيام بها

١ – ماهي المدينة التي بدأت منها سفرك ؟ (مدينة المغادرة) .....

٢ ـ ماهـــي وجهـــــتك ؟ (مدينة الوصول) .....

٣ ـ أين مكـــــان إقامتك الدائـم ؟ مدينـــــة .....

٤ – ماهو الغرض من هذه الرحلة ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ انهاء أعمال متعلقة بالعمل . ☐ الدراسة .

☐ انهاء أعمال خاصة . ☐ العمرة .

☐ زيارة الأهل والأصدقاء أو السياحة ☐ غرض آخر (الرجاء ذكره)

٥ – ماهي مدة الرحلة التي قمتَ و تنوي القيام بها ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ من يوم واحد إلى٣ أيام ☐ ٤ ـ ٧ أيام ☐ ٨ ـ ٣٠ يوم ☐ أكثر من ٣٠ يوم .

٦ – الرجاء وضع تقسيم للفترة الزمنية لهذه الرحلة بتعبئة الفراغات التالية :

دقائق	ساعات	
.....	.....	الفتره الزمنيه من مكان المغادره (المنزل مثلاً) حتى وصولك إلى المطار
.....	.....	الفتره الزمنيه المستغرقه في الإنتظار.
.....	.....	الزمن المتوقع استغراقه في الطائرة .
.....	.....	الفتره الزمنيه من المطار حتى وصولك إلى هدفك

٧ –كم فرد من أفراد اسرتك مسافر معك ؟

١ ـ عدد البالغين غيرك (تذكره كامله) ..... شخص ، (نصف تذكره) ..... شخص ٢ ـ عدد الأطفال .....طفل .

٨ – الرجاء وضع تقسيم لتكاليف هذه الرحلة [التكاليف تشمل من تعولهم من المسافرين معك]

هل التكاليف تشمل الرحله ☐ ذهاباً وإياباً ☐ أو إتجاه واحد

قيمة تذاكر السفـــــــــر .....ريال

التاكسي أو الليموزين إذا استخدم ..... ريال

تكاليـــف أخـــرى (أذكرهـــا) .....ريال

٩ – من دفع تكاليف هذه الرحلة ؟

☐ على حسابك الخاص ☐ الجهة التي تعمل بها ☐ غير ذلك (أذكرها) .....

١٠ – هل غادرت الطائرة في موعدها المحدد أم تأخرت ؟

☐ غادر ت في الموعد المحدد ☐ تأخرت ..... دقيقه .

الجزء الثاني : معلومات تتعلق بوسائل السفر الأخرى

١ ـ هل ستفكر بإستخدام وسائل السفر التالية لرحلة مماثلة للرحلة التي تقوم بها الآن ؟

	لن أستخدمها قط	قد أستخدمها	سأستخدمها بالتأكيد
الحافلة	☐	☐	☐
سيارتك الخاصة	☐	☐	☐

٢ ـ عندما ترغب بإستخدام وسيلة أخرى غير الطائرة لهذه الرحلة ، فكم من الزمن تعتقد سوف تستغرق كل وسيلة من الوسائل التالية :

الوقت	الحافلة	السيارة الخاصة
الوقت المستغرق للوصول إلى المحطة بالدقائق		
الوقت المستغرق في حالة الإنتظار أو الإستراحة بالدقائق		
وقت الرحلة داخل المركبة بالساعات		
الوقت المستغرق للوصول إلى هدفك من المحطة بالدقائق		

٣ ـ إذا رغبت بإستخدام وسيلة أخرى غير الطائرة لهذه الرحلة فكم تعتقد تكون تكلفة السفر لكل وسيلة من الوسائل التالية بالريال السعودي .

التكاليف	الحافلة	السيارة الخاصة
تكاليف التذاكر (إتجاه واحد)		
سيارة الأجرة (تكلفة الوصول إلى محطة المغادرة)		
سيارة الأجرة (تكلفة مغادرة محطة الوصول إلى الهدف)		
التكلفة الإجمالية للرحلة		

الجزء الثالث : معلومات عن المســـــافر

الرجـاء الإجابة عن الأسئلة التـالية بإختيار الجواب المناسب لكل سـؤال مع العلم أن الإجابة عن هذه الأسئلـة سوف تستخدم لاغراض إحصائية بحتة .

١ – كم عمرك ؟ ..... سنة

٢ ـ هل أنت متزوج ؟ ☐ نعم ☐ لا

٣ – كم سيارة تملك ؟ ..... سيارة

٤ – هل تملك رخصة قياده ؟ ☐ نعم ☐ لا

٥ – كم شخص في أسرتك يملك رخصة قيادة ؟..... شخص

٦ – ماهي مهنتك ؟
☐ طالب ☐ عاطـل عن العمل
☐ موظف حكومي ☐ متقاعـد
☐ أعمال حرة ☐ موظف قطاع خاص

٧ – ماهي جنسيتك ؟ ☐ سعودي ☐ غير سعودي حدد .....

٨ – ماهو مستوى تعليمك ؟ ☐ أبتدائي فما دون ☐ متوسط أو ثانوي ☐ جامعي

٩ – الرجاء ذكـر دخلك ودخل الأسره الشهري ؟

دخلك الشـــــهري	دخل الأسره الشهـري
☐ أقـــل من ١٠٠٠ ريال	☐ أقـــل من ١٠٠٠ ريال
☐ ١٠٠١ – ٢٥٠٠ ريال	☐ ١٠٠١ – ٢٥٠٠ ريـــال
☐ ٢٥٠١ – ٥٠٠٠ ريال	☐ ٢٥٠١ – ٥٠٠٠ ريـــال
☐ ٥٠٠١ – ٧٥٠٠ ريال	☐ ٥٠٠١ – ٧٥٠٠ ريـــال
☐ ٧٥٠١ – ١٠٠٠٠ ريال	☐ ٧٥٠١ – ١٠٠٠٠ ريـــال
☐ ١٠٠٠١ – ١٢٥٠٠ ريال	☐ ١٠٠٠١ – ١٢٥٠٠ ريال
☐ ١٢٥٠١ – ١٥٠٠٠ ريال	☐ ١٢٥٠١ – ١٥٠٠٠ ريال
☐ أكثر من ١٥٠٠٠ ريال	☐ أكثر من ١٥٠٠٠ ريـــال

الجزء الرابع : مقارنة بين وسائل السفر

في هذا الجزء سوف تقيّم عدة وسائل تستخدم للنقل بين المدن في المملكة العربية السعودية . الرجاء وضع دائرة حول الجواب المناسب في هذا التقييم .

فمثلاً عندما تقارن بين وسائل السفر من حيث السرعة .

السرعة :

	الأسوأ				الأفضل
■ الحافلة (الباص)	١	(٢)	٣	٤	٥
■ السيارة الخاصة .	١	٢	(٣)	٤	٥
■ الطـــــائرة .	١	٢	٣	٤	(٥)

حيث أُعتبرت الطائرة أسرع وسائل النقل ثم بعدها السيارة ثم الحافلة .

الآن الرجاء الاجابة عن جميع الأسئلة التالية :

فضلاً قارن بين وسائل النقل التالية من حيث :

ضع دائرة واحده في كل سطر حول الإجابة المناسبة (يلاحظ ان رقم واحد هو الأسوأ ورقم خمسة هو الأفضل)

١ - التمتع ببعض الخصوصية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٢ - إمكانية التوقف حينما وأينما تريد (حسب رغبتك) :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

نضـــلا قـــارن بين وســـائل النقل التـــاليـــة من حيث :

٣ ـ تأثير حالة الطقس على الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٤ - نظافة المركبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٥ - الشعور بالاستقلالية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٦ - شعورك بأن وسيلة السفر لن تتأخر بسبب الأعطال :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٧ - راحـة المركـبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٨ – تأثير حالة الطقس على مدة الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٩ –مدى الحاجة إلى التخطيط المسبق كالحجز مثلاً :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٠ – إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحرية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١١ – سهولة الوصول إلى وسيلة السفر من منزلك :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٢ – الشعور بالتعب في نهاية الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

الجزء الخامس : أهمية خصائص وسائل السفر

مامدى أهمية الخصائص التالية عند أختيارك وسيلة السفر لهذه الرحلة

فضلاً ضع دائرة واحده حول الإجابة المناسبة (يلاحظ ان رقم واحد يعني ليس له اهمية والرقم خمسة يعني مهم جداً)

	غير مهم				مهم جداً
١ – التمتع ببعض الخصوصية	١	٢	٣	٤	٥
٢ – إمكانية التوقف حينما وأينما تريد (حسب رغبتك)	١	٢	٣	٤	٥
٣ – تأثير حالة الطقس على الرحلة	١	٢	٣	٤	٥
٤ – نظافة المركبة	١	٢	٣	٤	٥
٥ – الشعور بالإستقلالية	١	٢	٣	٤	٥
٦ – شعورك بأن وسيلة الســـفر لن تتأخر بسبب الإعطال	١	٢	٣	٤	٥
٧ – راحة المركبة	١	٢	٣	٤	٥
٨ – تأثير حالة الطقس على مدة الرحلة	١	٢	٣	٤	٥
٩ – مدى الحاجة إلى التخطيط المسبق (كالحجز مثلاً)	١	٢	٣	٤	٥
١٠ –إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحّرية	١	٢	٣	٤	٥
١١ – سهولة الوصول إلى وسيلة السفر من منزلك	١	٢	٣	٤	٥
١٢ – الشعور بالتعب في نهاية الرحلة	١	٢	٣	٤	٥

نشكر لكم حُسن تعاونكم معنا في تعبئة هذه الإستبانه

ونرجو ردها للشخص الذي تسلمتها منه

بسم الله الرحمن الرحيم

وزارة التعليم العالي
جامعة الملك فهد للبترول و المعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

إستبانه للمسافرين بسيارتهم الخاصة

عزيزي المسافر

السلام عليكم ورحمة الله وبركاته

يقوم قسم الهندسة المدنية بجامعة الملك فهد للبترول والمعادن بدعم من مدينة الملك عبد العزيز للعلوم والتنقية بإجراء بحث للتعرف على رغبات المسافرين بين المدن في المملكة العربية السعودية . وهذه الإستبانه التي بين يديك هي للتعرف على أسباب إختيارك لوسيلة السفر من مدينة إلى أخرى حيث أن هذه المعلومات مطلوبة في هذه الدراسة التي سوف تفيد الأشخاص والجهات ذات العلاقة في تطوير النقل بين مدن المملكة .

إن إقتطاع جزء من وقتك لتعبئة هذه الإستبانه سوف يكون له كل التقدير .

نرجو منكم تحري الدقة في تعبئة هذه الإستبانه حيث تعتبر هذه المعلومات أساسية في اعداد البحث الخاص بهندسة النقل.

شاكرين تعاونكم معنا في إنجاح هذا البحث لما من شأنه خدمة المصلحة العامة .
والله الموفق .

الباحث الرئيسي

د./ حسن مساعد الأحمدي

رئيس قسم الهندسة المدنية

د. الفارابي شريف

قسم الهندسة المدنية
CIVIL ENGINEERING DEPT.

الجزء الأول : معلومات عن الرحلة

هذا الجزء من الاستبانه يحتوي على معلومات عن الرحلة التي تمت أو تنوي القيام بها

١ – ماهي المدينة التي بدأت منها سفرك ؟ (مدينة المغادرة) .....

٢ ـ ماهـــي وجهـــــــتك ؟ (مدينة الوصول) .....

٣ ـ أين مكـــــان إقامتك الدائـم ؟ مدينـــــة .....

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٤ – ماهو الغرض من هذه الرحلة ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ انهاء أعمال متعلقة بالعمل . ☐ الدراسـة .

☐ انهاء أعمال خاصة . ☐ العمرة .

☐ زيارة الأهل والأصدقاء أو السياحة ☐ غرض آخر (الرجاء ذكره) .....

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٥ –ماهي مدة الرحلة التي قمت أو تنوي القيام بها ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ من يوم واحد إلى٣ أيام ☐ ٤ ـ ٧ أيام ☐ ٨ ـ ٣٠ يوم ☐ أكثر من ٣٠ يوم .

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٦ – الرجاء وضع تقسيم للفترة الزمنية لهذه الرحـلة بتعبئة الفراغات التالية :

دقائق	ساعات	
.....	.....	الفترة الزمنية للإستراحة .
.....	.....	الزمن المتوقع أستغراقه في السفر بالسيارة سياقةً .

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٧ –كم فرد من أفراد اسرتك مسافر معك ؟

١ ـ عدد البالغين غيرك (غير طلاب) ..... شخص ، (طلاب) ..... شخص ٢ ـ عدد الأطفال ..... طفل .

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٨ – الرجاء وضع تقسيم لتكاليف هذه الرحلة [التكاليف تشمل من تعولهم من المسافرين معك]

هل التكاليف تشمل الرحله ☐ ذهاباً وإياباً ☐ أو إتجاه واحد

تكاليف السفر (بما في ذلك الوقود والزيت الخ) ..... ريال

تكاليـف أخـــرى (أذكرهـــا) ..... ريال

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٩ – من دفع تكاليف هذه الرحلة ؟

☐ على حسابك الخاص ☐ الجهة التي تعمل بها ☐ غير ذلك (أذكرها) .....

الجزء الثاني : معلومات عن وسائل السفر الأخرى

١ ـ هل ستفكر بإستخدام وسائل السفر التالية لرحلة مماثلة للرحلة التي تقوم بها الآن ؟

	لن استخدمها قط	قد أستخدمها	سأستخدمها بالتأكيد
الطـــــائرة	☐	☐	☐
الحافلـــــة	☐	☐	☐

٢ ـ عندما ترغب في إستخدام وسيلة أخرى غيرسيارتك الخاصة لهذه الرحلة ، فما الزمن الذى تعتقد أنه سوف يستغرق لكل وسيلة من الوسائل التالية :

الوقـــــــت	الطائرة	الحافلة
الوقت المستغرق للوصول إلى المحطة أو المطار بالدقائق		
الوقت المستغرق في حالة الإنتظار أو الإستراحة بالدقائق		
مدة السفر داخل المركبة بالساعات		
الوقت المستغرق للوصول إلى هدفك من المطار أوالمحطة بالدقائق		

٣ ـ إذا رغبت بإستخدام وسيلة أخرى غير سيارتك الخاصة لهذه الرحلة فكم تعتقد تكون تكلفة السفر لكل وسيلة من الوسائل التالية بالريال السعودي .

التكاليف	الطائرة	الحافلة
تكاليف التذاكر (إتجاه واحد)		
سيارة الأجرة (تكلفة الوصول إلى محطة المغادرة)		
سيارة الأجرة (تكلفة مغادرة محطة الوصول إلى الهدف)		
التكلفة الإجمالية للرحلة		

الجزء الثالث : معلومات عن المســـــافر

الرجـاء الإجابة عن الأسئلة التـالية بإختيار الجواب المناسب لكل سـؤال مع العلم أن الإجابة عن هذه الأسئلـة سوف تستخدم لاغراض إحصائية بحتة .

١ – كم عمرك ؟ ..... سنة

٢ ـ هل أنت متزوج ؟ ☐ نعم ☐ لا

٣ – كم سيارة تملك ؟ ..... سيارة

٤ – هل تملك رخصة قياده ؟ ☐ نعم ☐ لا

٥ – كم شخص في أسرتك يملك رخصة قيادة ؟..... شخص

٦ – ماهي مهنتك ؟
☐ طالب ☐ عاطـل عن العمل
☐ موظف حكومي ☐ متقاعـد
☐ أعمال حرة ☐ موظف قطاع خاص

٧ – ماهي جنسيتك ؟ ☐ سعودي ☐ غير سعودي حدد .....

٨ – ماهو مستوى تعليمك ؟ ☐ ابتدائي فما دون ☐ متوسط أو ثانوي ☐ جامعي

٩ – الرجاء ذكـــر دخلك ودخل الأسره الشهري ؟

دخلك الشـــــــهري	دخل الأسره الشهـــري
☐ أقـــل من ١٠٠٠ ريال	☐ أقـــل من ١٠٠٠ ريال
☐ ١٠٠١ – ٢٥٠٠ ريال	☐ ١٠٠١ – ٢٥٠٠ ريـــال
☐ ٢٥٠١ – ٥٠٠٠ ريال	☐ ٢٥٠١ – ٥٠٠٠ ريـــال
☐ ٥٠٠١ – ٧٥٠٠ ريال	☐ ٥٠٠١ – ٧٥٠٠ ريـــال
☐ ٧٥٠١ – ١٠٠٠٠ ريال	☐ ٧٥٠١ – ١٠٠٠٠ ريـــال
☐ ١٠٠٠١ – ١٢٥٠٠ ريال	☐ ١٠٠٠١ – ١٢٥٠٠ ريال
☐ ١٢٥٠١ – ١٥٠٠٠ ريال	☐ ١٢٥٠١ – ١٥٠٠٠ ريال
☐ أكثر من ١٥٠٠٠ ريال	☐ أكثر من ١٥٠٠٠ ريـــال

الجزء الرابع : مقارنة بين وسائل السفر

في هذا الجزء سوف تقيّم عدة وسائل تستخدم للنقل بين المدن في المملكة العربية السعودية . الرجاء وضع دائرة حول الجواب المناسب في هذا التقييم .

فمثلاً عندما تقارن بين وسائل السفر من حيث السرعة .

السرعة :

	الأسوأ				الأفضل
■ الحافلة (الباص)	١	(٢)	٣	٤	٥
■ السيارة الخاصة .	١	٢	(٣)	٤	٥
■ الطـــــائرة .	١	٢	٣	٤	(٥)

حيث أُعتبرت الطائرة أسرع وسائل النقل ثم بعدها السيارة ثم الحافلة .

الآن الرجاء الاجابة عن جميع الأسئلة التالية :

فضلاً قارن بين وسائل النقل التالية من حيث :

ضع دائرة واحده في كل سطر حول الإجابة المناسبة (يلاحظ أن رقم واحد هو الأسوأ ورقم خمسة هو الأفضل)

١ - التمتع ببعض الخصوصية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٢ - إمكانية التوقف حينما وأينما تريد (حسب رغبتك) :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٣ ـ تأثير حالة الطقس على الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٤ – نظافة المركبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٥ – الشعور بالاستقلالية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٦ – شعورك بأن وسيلة السفر لن تتأخر بسبب الأعطال :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٧ – راحة المركبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٨ - تأثير حالة الطقس على مدة الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٩ -مدى الحاجة إلى التخطيط المسبق كالحجز مثلاً :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٠ - إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحرية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١١ - سهولة الوصول إلى وسيلة السفر من منزلك :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٢ - الشعور بالتعب في نهاية الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

الجزء الخامس : أهمية خصائص وسائل السفر

مامدى أهمية الخصائص التالية عند أختيارك وسيلة السفر لهذه الرحلة

فضلاً ضع دائرة واحده حول الإجابة المناسبة (يلاحظ ان رقم واحد يعني ليس له اهمية والرقم خمسة يعني مهم جداً)

	غير مهم				مهم جداً
١ – التمتع ببعض الخصوصية	١	٢	٣	٤	٥
٢ – إمكانية التوقف حينما وأينما تريد (حسب رغبتك)	١	٢	٣	٤	٥
٣ – تأثير حالة الطقس على الرحلة	١	٢	٣	٤	٥
٤ – نظافة المركبة	١	٢	٣	٤	٥
٥ – الشعور بالإستقلالية	١	٢	٣	٤	٥
٦ – شعورك بأن وسيلة الســـفر لن تتأخر بسبب الإعطال	١	٢	٣	٤	٥
٧ – راحة المركبة	١	٢	٣	٤	٥
٨ – تأثير حالة الطقس على مدة الرحلة	١	٢	٣	٤	٥
٩ – مدى الحاجة إلى التخطيط المسبق (كالحجز مثلاً)	١	٢	٣	٤	٥
١٠ –إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحّرية	١	٢	٣	٤	٥
١١ – سهولة الوصول إلى وسيلة السفر من منزلك	١	٢	٣	٤	٥
١٢ – الشعور بالتعب في نهاية الرحلة	١	٢	٣	٤	٥

نشكر لكم حُسن تعاونكم معنا في تعبئة هذه الإستبانه
ونرجو ردها للشخص الذي تسلمتها منه

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول و المعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

إستبانه للمسافرين بالحافلة

عزيزي المسافر

السلام عليكم ورحمة الله وبركاته

يقوم قسم الهندسة المدنية بجامعة الملك فهد للبترول والمعادن بدعم من مدينة الملك عبد العزيز للعلوم والتنقية بإجراء بحث للتعرف على رغبات المسافرين بين المدن في المملكة العربية السعودية . وهذه الإستبانه التي بين يديك هي للتعرف على أسباب إختيارك لوسيلة السفر من مدينة إلى أخرى حيث أن هذه المعلومات مطلوبة في هذه الدراسة التي سوف تفيد الأشخاص والجهات ذات العلاقة في تطوير النقل بين مدن المملكة .

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نرجو منكم تحري الدقة في تعبئة هذه الإستبانه حيث تعتبر هذه المعلومات أساسية في اعداد البحث الخاص بهندسة النقل.

شاكرين تعاونكم معنا في إنجاح هذا البحث لما من شأنه خدمة المصلحة العامة .

والله الموفق .

الباحث الرئيسي

د./ حسن مساعد الأحمدي

رئيس قسم الهندسة المدنية

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الجزء الأول : معلومات عن الرحلة

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١ – ماهي المدينة التي بدأت منها سفرك ؟ (مدينة المغادرة) .....

٢ ـ ماهـــي وجهـــــتك ؟ (مدينة الوصول) .....

٣ ـ أين مكـــــان إقامتك الدائـم ؟ مدينـــــة .....

٤ – ماهو الغرض من هذه الرحلة ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ انهاء أعمال متعلقة بالعمل . ☐ الدراسة .

☐ انهاء أعمال خاصة . ☐ العمرة .

☐ زيارة الأهل والأصدقاء أو السياحة ☐ غرض آخر (الرجاء ذكره)

٥ – ماهي مدة الرحلة التي قمتَ و تنوي القيام بها ؟ [الرجاء وضع علامة ✓ أمام الجواب المناسب]

☐ من يوم واحد إلى٣ أيام ☐ ٤ ـ ٧ أيام ☐ ٨ ـ ٣٠ يوم ☐ أكثر من ٣٠ يوم .

٦ – الرجاء وضع تقسيم للفترة الزمنية لهذه الرحلة بتعبئة الفراغات التالية :

دقائق	ساعات	
.....	.....	الفتره الزمنيه من مكان المغادره (المنزل مثلاً) حتى وصولك إلى محطة الحافلة .
.....	.....	الفتره الزمنيه المستغرقه في الإنتظار .
.....	.....	الزمن المتوقع استغراقه في الحافلة .
.....	.....	الفتره الزمنيه من محطة الحافلة حتى وصولك إلى هدفك .

٧ –كم فرد من أفراد اسرتك مسافر معك ؟

١ ـ عدد البالغين غيرك (تذكره كامله) ..... شخص ، (نصف تذكره) ..... شخص ٢ ـ عدد الأطفال .....طفل .

٨ – الرجاء وضع تقسيم لتكاليف هذه الرحلة [التكاليف تشمل من تعولهم من المسافرين معك]

هل التكاليف تشمل الرحله ☐ ذهاباً وإياباً ☐ أو إتجاه واحد

قيمة تذاكر السفـــــــــر ..... ريال

التاكسي أو الليموزين إذا استخدم ..... ريال

تكاليـــف أخـــرى (أذكرهـــا) ..... ريال

٩ – من دفع تكاليف هذه الرحلة ؟

☐ على حسابك الخاص ☐ الجهة التي تعمل بها ☐ غير ذلك (أذكرها) .....

١٠ – هل غادرت الحافلة في موعدها المحدد أم تاخرت ؟

☐ غادر ت في الموعد المحدد ☐ تأخرت ..... دقيقه .

الجزء الثاني : معلومات تتعلق بوسائل السفر الأخرى

١ ـ هل ستفكر بإستخدام وسائل السفر التالية لرحلة مماثلة للرحلة التي تقوم بها الآن ؟

	لن أستخدمها قط	قد أستخدمها	سأستخدمها بالتأكيد
الطـــــائرة	☐	☐	☐
سيارتك الخاصة	☐	☐	☐

٢ ـ عندما ترغب بإستخدام وسيلة أخرى غير الحافلة لهذه الرحلة ، فما الزمن الذي تعتقد أنه سوف يستغرق لكل وسيلة من الوسائل التالية :

الوقـــــــــت	الطائرة	السيارة الخاصة
الوقت المستغرق للوصول إلى المطار بالدقائق		
الوقت المستغرق في حالة الإنتظار أو الإستراحة بالدقائق		
وقت الرحلة داخل المركبة بالساعات		
الوقت المستغرق للوصول إلى هدفك من المطار بالدقائق		

٣ ـ إذا رغبت في استخدام وسيلة أخرى غير الحافلة لهذه الرحلة فكم تعتقد تكون تكلفة السفر لكل وسيلة من الوسائل التالية بالريال السعودي .

التكاليف	الطائرة	السيارة الخاصة
تكاليف التذاكر (إتجاه واحد)		
سيارة الأجرة (تكلفة الوصول إلى محطة المغادرة)		
سيارة الأجرة (تكلفة مغادرة محطة الوصول إلى الهدف)		
التكلفة الإجمالية للرحلة		

الجزء الثالث : معلومات عن المســـــافر

الرجـاء الإجابة عن الأسئلة التـالية بإختيار الجواب المناسب لكل سـؤال مع العلم أن الإجابة عن هذه الأسئلـة سوف تستخدم لاغراض إحصائية بحتة .

١ – كم عمرك ؟ ..... سنة

٢ ـ هل أنت متزوج ؟ ☐ نعم ☐ لا

٣ – كم سيارة تملك ؟ ..... سيارة

٤ – هل تملك رخصة قياده ؟ ☐ نعم ☐ لا

٥ – كم شخص في أسرتك يملك رخصة قيادة ؟..... شخص

٦ – ماهي مهنتك ؟
☐ طالب ☐ عاطـل عن العمل
☐ موظف حكومي ☐ متقاعـد
☐ أعمال حرة ☐ موظف قطاع خاص

٧ – ماهي جنسيتك ؟ ☐ سعودي ☐ غير سعودي حدد .....

٨ – ماهو مستوى تعليمك ؟ ☐ أبتدائي فما دون ☐ متوسط أو ثانوي ☐ جامعي

٩ – الرجاء ذكـر دخلك ودخل الأسره الشهري ؟

دخلك الشـــــــهري	دخل الأسره الشهـري
☐ أقـــل من ١٠٠٠ ريال	☐ أقـــل من ١٠٠٠ ريال
☐ ١٠٠١ – ٢٥٠٠ ريال	☐ ١٠٠١ – ٢٥٠٠ ريـــال
☐ ٢٥٠١ – ٥٠٠٠ ريال	☐ ٢٥٠١ – ٥٠٠٠ ريـــال
☐ ٥٠٠١ – ٧٥٠٠ ريال	☐ ٥٠٠١ – ٧٥٠٠ ريـــال
☐ ٧٥٠١ – ١٠٠٠٠ ريال	☐ ٧٥٠١ – ١٠٠٠٠ ريـــال
☐ ١٠٠٠١ – ١٢٥٠٠ ريال	☐ ١٠٠٠١ – ١٢٥٠٠ ريال
☐ ١٢٥٠١ – ١٥٠٠٠ ريال	☐ ١٢٥٠١ – ١٥٠٠٠ ريال
☐ أكثر من ١٥٠٠٠ ريال	☐ أكثر من ١٥٠٠٠ ريـــال

الجزء الرابع : مقارنة بين وسائل السفر

في هذا الجزء سوف تقيّم عدة وسائل تستخدم للنقل بين المدن في المملكة العربية السعودية . الرجاء وضع دائرة حول الجواب المناسب في هذا التقييم .

فمثلاً عندما تقارن بين وسائل السفر من حيث السرعة .

السـرعة :

	الأسوأ				الأفضل
■ الحافلة (الباص)	١	(٢)	٣	٤	٥
■ السيارة الخاصة .	١	٢	(٣)	٤	٥
■ الطـــــائرة .	١	٢	٣	٤	(٥)

حيث أُعتبرت الطائرة أسرع وسائل النقل ثم بعدها السيارة ثم الحافلة .
الآن الرجاء الاجابة عن جميع الأسئلة التالية :

فضـلاً قـارن بين وسـائل النقل التـاليـة من حيث :

ضع دائرة واحده في كل سطر حول الإجابة المناسبة (يلاحظ أن رقم واحد هو الأسوأ ورقم خمسة هو الأفضل)

١ - التمتع ببعض الخصوصية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٢ - إمكانية التوقف حينما وأينما تريد (حسب رغبتك) :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٣ ـ تأثير حالة الطقس على الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٤ – نظافة المركبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٥ – الشعور بالاستقلالية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٦ – شعورك بأن وسيلة السفر لن تتأخر بسبب الأعطال :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٧ – راحة المركبة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

فضلاً قارن بين وسائل النقل التالية من حيث :

٨ – تأثير حالة الطقس على مدة الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

٩ –مدى الحاجة إلى التخطيط المسبق كالحجز مثلاً :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٠ – إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحرية :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١١ – سهولة الوصول إلى وسيلة السفر من منزلك :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

١٢ – الشعور بالتعب في نهاية الرحلة :

	الأسوأ				الأفضل
* الحافلة (الباص)	١	٢	٣	٤	٥
* السيارة الخاصة .	١	٢	٣	٤	٥
* الطـــــائرة .	١	٢	٣	٤	٥

الجزء الخامس : اهمية خصائص وسائل السفر

مامدى أهمية الخصائص التالية عند أختيارك وسيلة السفر لهذه الرحلة

فضلاً ضع دائرة واحده حول الإجابة المناسبة (يلاحظ ان رقم واحد يعني ليس له اهمية والرقم خمسة يعني مهم جداً)

	غير مهم				مهم جداً
١ – التمتع ببعض الخصوصية	١	٢	٣	٤	٥
٢ – إمكانية التوقف حينما وأينما تريد (حسب رغبتك)	١	٢	٣	٤	٥
٣ – تأثير حالة الطقس على الرحلة	١	٢	٣	٤	٥
٤ – نظافة المركبة	١	٢	٣	٤	٥
٥ – الشعور بالإستقلالية	١	٢	٣	٤	٥
٦ – شعورك بأن وسيلة السفر لن تتأخر بسبب الإعطال	١	٢	٣	٤	٥
٧ – راحة المركبة	١	٢	٣	٤	٥
٨ – تأثير حالة الطقس على مدة الرحلة	١	٢	٣	٤	٥
٩ – مدى الحاجة إلى التخطيط المسبق (كالحجز مثلاً)	١	٢	٣	٤	٥
١٠ –إمكانية التحدث مع أفراد عائلتك أو أصدقائك بحّرية	١	٢	٣	٤	٥
١١ – سهولة الوصول إلى وسيلة السفر من منزلك	١	٢	٣	٤	٥
١٢ – الشعور بالتعب في نهاية الرحلة	١	٢	٣	٤	٥

نشكر لكم حُسن تعاونكم معنا في تعبئة هذه الإستبانه

ونرجو ردها للشخص الذي تسلمتها منه

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول و المعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

AIR TRIPMAKER'S QUESTIONNAIRE

Dear Traveller,

The civil engineering department of the King Fahd University of Petroleum and Minerals is conducting a research to understand the travel needs between the cities of the Kingdom of Saudi Arabia. This research is funded by the *King Abdulaziz City for Science and Technology*.

You are asked not to put your name on the questionnaire and there is no way to link your answers to your name. It takes about ten minutes to complete.

We greatly appreciate your cooperation. If you have any questions, you may call Dr. Hasan M. Al-Ahmadi at 860-4269 during weekdays.

Sincerely,

Dr. Alfarabi Sharif
Chairman, Civil Engineering Department

Dr. Hasan M. Al-Ahmadi
Principal Investigator

PART I. THE FOLLOWING QUESTIONS ARE ABOUT THIS TRIP.

1. **Where did you begin this trip?** City _____

2. **Where is your destination?** City _____

3. **Where is your place of residence?** City _____

4. **What is the purpose of your trip? Check only one answer:**

[ ] Work
[ ] Personal business
[ ] Social/Recreation
[ ] Educational/Study
[ ] Aumra
[ ] Other (specify)_____

5. **How long did you stay or are you planning to stay away from your home? Check only one answer:**

[ ] one -3 days [ ] 4-7 days [ ] 8-30 days [ ] more than 30 days

6. **Please give your travel time in the following categories:**

Time to get to the airport	_____ hours	_____ minutes
Time spent waiting at the airport	_____ hours	_____ minutes
Travel time spent in plane	_____ hours	_____ minutes
Estimated time from airport to final destination	_____ hours	_____ minutes

7. **How many people from your <u>family</u> are travelling with you? (Please do not count yourself)**

_____ Adults (full ticket) _____ Adults (half ticket) _____ Children

8. **Please give your travel costs in the following categories including family members if they are travelling with you (only fill in those that are appropriate):**

Please indicate if costs are for: [ ] round-trip [ ] one way

Ticket (fare)	SR._____
Limousine or Taxi (if used)	SR._____
Other (specify) _____	SR._____

9. **Who paid for this trip?**

[ ] Yourself [ ] The Goverment or your company [ ] Others (specify) ----------

10. **Indicate if the plane was on time or late?**

[ ] on time [ ] late, How late? _____ hours _____ minutes

PART II. THE FOLLOWING QUESTIONS RELATE TO OTHER MEANS OF TRAVEL.

1. Would you consider using the following means of travel for the trip you are making now?

	Would never use it	May consider using it	Definitely consider using it
BUS	[ ]	[ ]	[ ]
AUTO	[ ]	[ ]	[ ]

2. If you are to choose a means of travel other than plane for this trip, what would be your estimates of time for the listed categories?

TIME CATEGORY	AUTO	BUS
Time to get to bus (or train) station in minutes.		
Time spent waiting at bus (or train) station or rest areas in minutes.		
Total travel time spent in the vehicle in hours.		
Time from bus (or train) station to the final destination (your estimate) in minutes.		

3. If you are to choose a means of travel other than plane for this trip, what would be the cost for each category in Saudi Riyals?

COST CATEGORY	AUTO	BUS
Ticket cost (one way).		
Total taxi (or limousine) costs at the origin and destination.		
Total cost (one way).		

PART III. THE QUESTIONS BELOW ARE FOR STATISTICAL PURPOSES ONLY. THEY WILL BE CONFIDENTIAL AND NO INDIVIDUAL WILL BE IDENTIFIED IN THE RESEARCH

1. **What is your age?** _____

2. **Are you married?** [ ] Yes [ ] No

3. **How many cars are there in your household?** _____

4. **Do you have a driver's license?** [ ] Yes [ ] No

4. **How many persons in your household have a driver's license?** _____

5. **What is your occupation?**

[ ] Student
[ ] Employee
[ ] Businessman
[ ] Unemployed
[ ] Retired
[ ] Others (specify) _____

6. **What is your nationality?** [ ] Saudi [ ] non Saudi, Pls. specify _____

7. **Indicate your level of education**

[ ] Elementary
[ ] Intermediate or Secondary
[ ] University degree

8. **What is your personal and household monthly income? Tick one in each category.**

Personal Income	**Household Income**
[ ] less than 1,000 SR.	[ ] less than 1000 SR.
[ ] 1,000-2,500 SR.	[ ] 1,000-2,500 SR.
[ ] 2,501-5,000 SR.	[ ] 2,501-5,000 SR.
[ ] 5,001-7,500 SR.	[ ] 5,001-7,500 SR.
[ ] 7,501-10,000 SR.	[ ] 7,501-10,000 SR.
[ ] 10,001-12,500 SR.	[ ] 10,001-12,500 SR.
[ ] 12,501- 15,000 SR.	[ ] 12,501 - 15,000 SR.
[ ] more than 15,000 SR.	[ ] more than 15,000 SR.

PART IV. EVALUATION OF VARIOUS MEANS OF TRAVEL WITH RESPECT TO THEIR CHARACTERISTICS.

In the following page you will be asked to evaluate alternative means of travel for **the trip you are making now.** This evaluation will be made by selecting the most appropriate answers for certain statements.

Let us say, for example, that you are evaluating different means of travel with respect to **speed** and **safety**. A possible response to this for bus, auto, air and train is given below. Note that the responses are indicated by circling numbers, where "1" indicates the worst and "5" indicates the best and other numbers indicate judgement in between.

Please evaluate the following means of travel (for this trip) with respect to...

MEANS OF TRAVEL	Speed	Safety
	WORST BEST	WORST BEST
Bus	1 (2) 3 4 5	1 2 (3) 4 5
Auto	1 2 (3) 4 5	1 (2) 3 4 5
Air	1 2 3 4 (5)	1 2 3 (4) 5

Now please go to the next page and evaluate the indicated means of travel with respect to ALL the listed characteristics.

PLEASE TRY TO RESPOND FOR EACH STATEMENT.

Please evaluate the following means of travel (for this trip) with respect to ...

MEANS OF TRAVEL	1. Having Some Privacy.	2. Freedom in choosing location and time of stops.
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	3. The effect of weather condition on the trip.	**4. Cleanliness of vehicle.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	5. Feeling of independence.	**6. Feeling that vehicle would not be delayed for repair.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	7. Comfort.	**8. The effect of weather condition on travel time.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	9. The need for advance planning.	**10. Talking freely with family members or friends.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	11. Accessibility from home.	**12. Feeling tired at the end of trip.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5

PART V. IN SELECTING THE MEANS OF TRAVEL FOR THIS TRIP, HOW IMPORTANT TO YOU WERE THE FOLLOWING CHARACTERISTICS. WE HAVE PROVIDED A SCALE WHICH RANGES FROM "EXTREMELY IMPORTANT" TO "OF NO IMPORTANCE". FOR EACH CHARACTERISTIC PLEASE ENCIRCLE THE NUMBER WHICH YOU FEEL BEST INDICATES THE IMPORTANCE.

	Of no importance				Extremely important
Having Some Privacy	1	2	3	4	5
Freedom in Choosing Locations and Time of Stops	1	2	3	4	5
The Effect of Weather Condition on the Trip	1	2	3	4	5
Cleanliness of Vehicle	1	2	3	4	5
Feeling of Independence	1	2	3	4	5
The Feeling that the Vehicle would not be Delayed for Repair	1	2	3	4	5
Comfort	1	2	3	4	5
The Effect of Weather Condition on Travel Time	1	2	3	4	5
The Need for Advance Planning	1	2	3	4	5
Talking Freely with Family Members or Friends	1	2	3	4	5
Accessibility from Home	1	2	3	4	5
Feeling Tired at the End of the Trip	1	2	3	4	5

THANK YOU FOR YOUR COOPERATION

Please return the questionnaire to the person who distributed it

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول و المعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

AUTO TRIPMAKER'S QUESTIONNAIRE

Dear Traveller,

The civil engineering department of the King Fahd University of Petroleum and Minerals is conducting a research to understand the travel needs between the cities of the Kingdom of Saudi Arabia. This research is funded by the *King Abdulaziz City for Science and Technology*.

You are asked not to put your name on the questionnaire and there is no way to link your answers to your name. It takes about ten minutes to complete.

We greatly appreciate your cooperation. If you have any questions, you may call Dr. Hasan M. Al-Ahmadi at 860-4269 during weekdays.

Sincerely,

Dr. Alfarabi Sharif
Chairman, Civil Engineering Department

Dr. Hasan M. Al-Ahmadi
Principal Investigator

PART I. THE FOLLOWING QUESTIONS ARE ABOUT THIS TRIP.

1. **Where did you begin this trip?** City _____

2. **Where is your destination?** City _____

3. **Where is your place of residence?** City _____

4. **What is the purpose of your trip? Check only one answer:**

   [ ] Work
   [ ] Personal business
   [ ] Social/Recreation
   [ ] Educational/Study
   [ ] Aumra
   [ ] Other (specify)_____

5. **How long did you stay or are you planning to stay away from your home? Check only one answer:**

   [ ] one -3 days [ ] 4-7 days [ ] 8-30 days [ ] more than 30 days

6. **Please give your travel time in the following categories:**

   Estimated time spent at the rest areas and gas stations: _____ hours _____ minutes

   Total time spent travelling in the vehicle: _____ hours _____ minutes

7. **How many people from your <u>family</u> are travelling with you? (Please do not count yourself)**

   _____ Adults (full ticket) _____ Adults (half ticket) _____ Children

8. **Please give your travel costs in the following categories including family members if they are travelling with you (only fill in those that are appropriate):**

   Please indicate if costs are for: [ ] round-trip [ ] one way

   Gas and oil SR._____
   Other (specify) _____ SR._____

9. **Who paid for this trip?**

   [ ] Yourself [ ] The Goverment or your company [ ] Others (specify) ----------

PART II. THE FOLLOWING QUESTIONS RELATE TO OTHER MEANS OF TRAVEL.

1. Will you consider using the following means of travel for a trip similar to the one you are making now?

	Will never use it	May consider using it	Definitely consider using it
AIR	[ ]	[ ]	[ ]
BUS	[ ]	[ ]	[ ]

2. If you are to choose a means of travel other than car for this trip, what would be your estimates of time for the listed categories?

TIME CATEGORY	AIR	BUS
Time to get to bus (or train) station or airport in minutes.		
Time spent waiting at bus (or train) station or airport in minutes.		
Total travel time spent in the vehicle in hours.		
Time from bus (or train) station or airport to the final destination (your estimate) in minutes.		

3. If you are to choose a means of travel other than car for this trip, what would be the cost for each category in Saudi Riyals?

COST CATEGORY	AIR	BUS
Ticket cost (one way).		
Taxi (or limousine) cost from origin to airport or bus station.		
Taxi (or limousine) cost from airport or bus station to your destination.		
Total cost (one way).		

PART III. THE QUESTIONS BELOW ARE FOR STATISTICAL PURPOSES ONLY. THEY WILL BE CONFIDENTIAL AND NO INDIVIDUAL WILL BE IDENTIFIED IN THE RESEARCH

1. **What is your age?** _____

2. **Are you married?** [ ] Yes [ ] No

3. **How many cars are there in your household?** _____

4. **Do you have a driver's license?** [ ] Yes [ ] No

4. **How many persons in your household have a driver's license?** _____

5. **What is your occupation?**

[ ] Student
[ ] Employee
[ ] Businessman
[ ] Unemployed
[ ] Retired
[ ] Others (specify) _____

6. **What is your nationality?** [ ] Saudi [ ] non Saudi, Pls. specify _____

7. **Indicate your level of education**

[ ] Elementary
[ ] Intermediate or Secondary
[ ] University degree

8. **What is your personal and household monthly income? Tick one in each category.**

Personal Income	Household Income
[ ] less than 1,000 SR.	[ ] less than 1000 SR.
[ ] 1,000-2,500 SR.	[ ] 1,000-2,500 SR.
[ ] 2,501-5,000 SR.	[ ] 2,501-5,000 SR.
[ ] 5,001-7,500 SR.	[ ] 5,001-7,500 SR.
[ ] 7,501-10,000 SR.	[ ] 7,501-10,000 SR.
[ ] 10,001-12,500 SR.	[ ] 10,001-12,500 SR.
[ ] 12,501- 15,000 SR.	[ ] 12,501 - 15,000 SR.
[ ] more than 15,000 SR.	[ ] more than 15,000 SR.

PART IV. EVALUATION OF VARIOUS MEANS OF TRAVEL WITH RESPECT TO THEIR CHARACTERISTICS.

In the following page you will be asked to evaluate alternative means of travel for **the trip you are making now.** This evaluation will be made by selecting the most appropriate answers for certain statements.

Let us say, for example, that you are evaluating different means of travel with respect to **speed** and **safety**. A possible response to this for bus, auto, air and train is given below. Note that the responses are indicated by circling numbers, where "1" indicates the worst and "5" indicates the best and other numbers indicate judgement in between.

Please evaluate the following means of travel (for this trip) with respect to...

MEANS OF TRAVEL	Speed	Safety
	WORST BEST	WORST BEST
Bus	1 (2) 3 4 5	1 2 (3) 4 5
Auto	1 2 (3) 4 5	1 (2) 3 4 5
Air	1 2 3 4 (5)	1 2 3 (4) 5

Now please go to the next page and evaluate the indicated means of travel with respect to ALL the listed characteristics.

PLEASE TRY TO RESPOND FOR EACH STATEMENT.

Please evaluate the following means of travel (for this trip) with respect to ...

MEANS OF TRAVEL	1. Having Some Privacy.	2. Freedom in choosing location and time of stops.
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	3. The effect of weather condition on the trip.	**4. Cleanliness of vehicle.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	5. Feeling of independence.	**6. Feeling that vehicle would not be delayed for repair.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	7. Comfort.	**8. The effect of weather condition on travel time.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	9. The need for advance planning.	**10. Talking freely with family members or friends.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	11. Accessibility from home.	**12. Feeling tired at the end of trip.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5

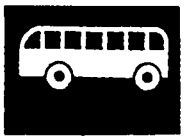
PART V. IN SELECTING THE MEANS OF TRAVEL FOR THIS TRIP, HOW IMPORTANT TO YOU WERE THE FOLLOWING CHARACTERISTICS. WE HAVE PROVIDED A SCALE WHICH RANGES FROM "EXTREMELY IMPORTANT" TO "OF NO IMPORTANCE". FOR EACH CHARACTERISTIC PLEASE ENCIRCLE THE NUMBER WHICH YOU FEEL BEST INDICATES THE IMPORTANCE.

	Of no importance				Extremely important
Having Some Privacy	1	2	3	4	5
Freedom in Choosing Locations and Time of Stops	1	2	3	4	5
The Effect of Weather Condition on the Trip	1	2	3	4	5
Cleanliness of Vehicle	1	2	3	4	5
Feeling of Independence	1	2	3	4	5
The Feeling that the Vehicle would not be Delayed for Repair	1	2	3	4	5
Comfort	1	2	3	4	5
The Effect of Weather Condition on Travel Time	1	2	3	4	5
The Need for Advance Planning	1	2	3	4	5
Talking Freely with Family Members or Friends	1	2	3	4	5
Accessibility from Home	1	2	3	4	5
Feeling Tired at the End of the Trip	1	2	3	4	5

THANK YOU FOR YOUR COOPERATION

Please return the questionnaire to the person who distributed it

بسم الله الرحمن الرحيم



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Ministry of Higher Education

King Fahd University of Petroleum & Minerals

COLLEGE OF ENGINEERING SCIENCES

CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي

جامعة الملك فهد للبترول والمعادن

كلية العلوم الهندسية

قسم الهندسة المدنية

BUS TRIPMAKER'S QUESTIONNAIRE

Dear Traveller,

The civil engineering department of the King Fahd University of Petroleum and Minerals is conducting a research to understand the travel needs between the cities of the Kingdom of Saudi Arabia. This research is funded by the *King Abdulaziz City for Science and Technology*.

You are asked not to put your name on the questionnaire and there is no way to link your answers to your name. It takes about ten minutes to complete.

We greatly appreciate your cooperation. If you have any questions, you may call Dr. Hasan M. Al-Ahmadi at 860-4269 during weekdays.

Sincerely,

Dr. Alfarabi Sharif
Chairman, Civil Engineering Department

Dr. Hasan M. Al-Ahmadi
Principal Investigator

PART I. THE FOLLOWING QUESTIONS ARE ABOUT THIS TRIP.

1. **Where did you begin this trip?** City _____

2. **Where is your destination?** City _____

3. **Where is your place of residence?** City _____

4. **What is the purpose of your trip? Check only one answer:**

   [ ] Work
   [ ] Personal business
   [ ] Social/Recreation
   [ ] Educational/Study
   [ ] Aumra
   [ ] Other (specify)_____

5. **How long did you stay or are you planning to stay away from your home? Check only one answer:**

   [ ] one -3 days [ ] 4-7 days [ ] 8-30 days [ ] more than 30 days

6. **Please give your travel time in the following categories:**

   Time to get to the bus station _____ hours _____ minutes
   Time spent waiting at the bus station _____ hours _____ minutes
   Travel time spent in bus _____ hours _____ minutes
   Estimated time from bus station to final destination _____ hours _____ minutes

7. **How many people from your <u>family</u> are travelling with you? (Please do not count yourself)**

   _____ Adults (full ticket) _____ Adults (half ticket) _____ Children

8. **Please give your travel costs in the following categories including family members if they are travelling with you (only fill in those that are appropriate):**

   Please indicate if costs are for: [ ] round-trip [ ] one way

   Ticket (fare) SR._____
   Limousine or Taxi (if used) SR._____
   Other (specify) _____ SR._____

9. **Who paid for this trip?**

   [ ] Yourself [ ] The Goverment or your company [ ] Others (specify) ----------

10. **Indicate if the bus was on time or late?**

    [ ] on time [ ] late, How late? _____ hours _____ minutes

PART II. THE FOLLOWING QUESTIONS RELATE TO OTHER MEANS OF TRAVEL.

1. Would you consider using the following means of travel for the trip you are making now?

	Would never use it	May consider using it	Definitely consider using it
AUTO	[ ]	[ ]	[ ]
AIR	[ ]	[ ]	[ ]

2. If you are to choose a means of travel other than bus for this trip, what would be your estimates of time for the listed categories?

TIME CATEGORY	AUTO	AIR
Time to get to train station or airport in minutes.		
Time spent waiting at train station, airport or rest areas in minutes.		
Total travel time spent in the vehicle in hours.		
Time from train station or airport to the final destination (your estimate) in minutes.		

3. If you are to choose a means of travel other than bus for this trip, what would be the cost for each category in Saudi Riyals?

COST CATEGORY	AUTO	AIR
Ticket cost (one way).		
Total taxi (or limousine) costs at the origin and destination.		
Total cost (one way).		

PART III. THE QUESTIONS BELOW ARE FOR STATISTICAL PURPOSES ONLY. THEY WILL BE CONFIDENTIAL AND NO INDIVIDUAL WILL BE IDENTIFIED IN THE RESEARCH

1. **What is your age?** _____

2. **Are you married?** [ ] Yes [ ] No

3. **How many cars are there in your household?** _____

4. **Do you have a driver's license?** [ ] Yes [ ] No

4. **How many persons in your household have a driver's license?** _____

5. **What is your occupation?**

[ ] Student
[ ] Employee
[ ] Businessman
[ ] Unemployed
[ ] Retired
[ ] Others (specify) _____

6. **What is your nationality?** [ ] Saudi [ ] non Saudi, Pls. specify _____

7. **Indicate your level of education**

[ ] Elementary
[ ] Intermediate or Secondary
[ ] University degree

8. **What is your personal and household monthly income? Tick one in each category.**

Personal Income	**Household Income**
[ ] less than 1,000 SR.	[ ] less than 1000 SR.
[ ] 1,000-2,500 SR.	[ ] 1,000-2,500 SR.
[ ] 2,501-5,000 SR.	[ ] 2,501-5,000 SR.
[ ] 5,001-7,500 SR.	[ ] 5,001-7,500 SR.
[ ] 7,501-10,000 SR.	[ ] 7,501-10,000 SR.
[ ] 10,001-12,500 SR.	[ ] 10,001-12,500 SR.
[ ] 12,501- 15,000 SR.	[ ] 12,501 - 15,000 SR.
[ ] more than 15,000 SR.	[ ] more than 15,000 SR.

PART IV. EVALUATION OF VARIOUS MEANS OF TRAVEL WITH RESPECT TO THEIR CHARACTERISTICS.

In the following page you will be asked to evaluate alternative means of travel for **the trip you are making now.** This evaluation will be made by selecting the most appropriate answers for certain statements.

Let us say, for example, that you are evaluating different means of travel with respect to **speed** and **safety**. A possible response to this for bus, auto, air and train is given below. Note that the responses are indicated by circling numbers, where "1" indicates the worst and "5" indicates the best and other numbers indicate judgement in between.

Please evaluate the following means of travel (for this trip) with respect to...

MEANS OF TRAVEL	Speed	Safety
	WORST BEST	WORST BEST
Bus	1 (2) 3 4 5	1 2 (3) 4 5
Auto	1 2 (3) 4 5	1 (2) 3 4 5
Air	1 2 3 4 (5)	1 2 3 (4) 5

Now please go to the next page and evaluate the indicated means of travel with respect to ALL the listed characteristics.

PLEASE TRY TO RESPOND FOR EACH STATEMENT.

Please evaluate the following means of travel (for this trip) with respect to ...

MEANS OF TRAVEL	1. Having Some Privacy.	2. Freedom in choosing location and time of stops.
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	3. The effect of weather condition on the trip.	**4. Cleanliness of vehicle.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	5. Feeling of independence.	**6. Feeling that vehicle would not be delayed for repair.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	7. Comfort.	**8. The effect of weather condition on travel time.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	9. The need for advance planning.	**10. Talking freely with family members or friends.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5
	11. Accessibility from home.	**12. Feeling tired at the end of trip.**
	WORST BEST	WORST BEST
Bus	1 2 3 4 5	1 2 3 4 5
Auto	1 2 3 4 5	1 2 3 4 5
Air	1 2 3 4 5	1 2 3 4 5

PART V. IN SELECTING THE MEANS OF TRAVEL FOR THIS TRIP, HOW IMPORTANT TO YOU WERE THE FOLLOWING CHARACTERISTICS. WE HAVE PROVIDED A SCALE WHICH RANGES FROM "EXTREMELY IMPORTANT" TO "OF NO IMPORTANCE". FOR EACH CHARACTERISTIC PLEASE ENCIRCLE THE NUMBER WHICH YOU FEEL BEST INDICATES THE IMPORTANCE.

	Of no importance				Extremely important
Having Some Privacy	1	2	3	4	5
Freedom in Choosing Locations and Time of Stops	1	2	3	4	5
The Effect of Weather Condition on the Trip	1	2	3	4	5
Cleanliness of Vehicle	1	2	3	4	5
Feeling of Independence	1	2	3	4	5
The Feeling that the Vehicle would not be Delayed for Repair	1	2	3	4	5
Comfort	1	2	3	4	5
The Effect of Weather Condition on Travel Time	1	2	3	4	5
The Need for Advance Planning	1	2	3	4	5
Talking Freely with Family Members or Friends	1	2	3	4	5
Accessibility from Home	1	2	3	4	5
Feeling Tired at the End of the Trip	1	2	3	4	5

THANK YOU FOR YOUR COOPERATION

Please return the questionnaire to the person who distributed it

APPENDIX - C

Coding Manual

CODING MANUAL
Card No. 1

Field	Question No.	Variables and Codes
1-4	none	Questionnaire ID. Give a consecutive number to each questionnaire.
5	none	Card Number (write 1 or 2)
6	none	Availability of Train (if train is included in the questionnaire put 1, if not put 2)
7	none	Survey mode (indicated in the first page). Give the following codes 1 = AIR 2 = AUTO 3 = BUS 4 = TRAIN
8-10	1	Trip origin city (take it from the booklet)
11-13	2	Trip destination city (take it from the booklet)
14-16	3	Residence zone (from the booklet)
17-20	none	O-D ground distance in (km) (from the table)
21	4	Trip purpose (Give the following codes) 1 = Work 2 = Personal/Business 3 = Social/Recreation 4 = Educational/Study 5 = Aumra 6 = Others 9 = missing data
22	5	Duration of stay (Give the following codes) 1 = 1-3 days 2 = 4-7 days 3 = 8-30 days 4 = more than 30 days 9 = missing data
23-25	6 or II/2	Access time for Air mode hrs. in field 23 minutes in fields 24-25 999 = missing data

Field	Question No.	Variables and Codes
26-28	6 or II/2	Waiting time for Air mode hrs. in field 26 minutes in fields 27-28 999 = missing data
29-31	6 or II/2	Line Haul time for Air mode hrs. in field 29 minutes in fields 30-31 999 = missing data
32-34	6 or II/2	Egress time for Air mode hrs. in field 32 minutes in field 33-34 999 = missing data
35-37	6 or II/2	Rest time for Auto mode hrs. in field 35 minutes in fields 36-37 999 = missing data
38-41	6 or II/2	Line Haul time for Auto mode hrs. in fields 38-39 minutes in fields 40-41 9999 = missing data
42-44	6 II/2	Access time for Bus mode hrs. in field 42 minutes in field 43-44 999 = missing data
45-47	6 or II/2	Waiting time for Bus mode hrs. in field 45 minutes in field 46-47 999 = missing data
48-51	6 or II/2	Line Haul time for Bus mode hrs. in fields 48-49 minutes in fields 50-51 9999 = missing data
52-54	6 or II/2	Egress time for Bus mode hrs. in field 52 minutes in fields 52-54 999 = missing data

Field	Question No.	Variables and Codes
55-57	6 or II/2	Access time for Train mode hrs in field 55 minutes in fields 56-57 999 = missing data
58-60	- do -	Waiting time for Train mode hrs. in field 58 minutes in fields 59-60 999 = missing data
61-63	- do -	Line Haul time for Train mode hrs. in field 61 minutes in fields 62-63 9999 = missing data
64-66	- do -	Egress time for Train mode hrs. in field 64 minutes in fields 65-66 999 = missing data
67	7	No. of Family Adults (Full Ticket) input number (for taxi just indicate the # of adults)
68	7	No. of Family Adults (Half Ticket) input number (for auto this will be zero)
69	7	No. of Family Children input number
70-73	8 or II/3	One Way Ticket fare in SR for Air (= Total ticket cost for the whole family ⇒ Check) If two way is given divide by 2 9999 = missing data
74-76	- do -	Taxi or Limousine in SR for Air For chosen mode, if not indicated put 0 0 0 For other modes if not indicated put 9 9 9 = missing data Add taxi cost to and from airport
77-80	- do -	Total Cost in SR for Air For chosen mode add ticket fare, taxi and others For other modes write the indicated total cost. It should be ≥ sum of ticket fare + taxi cost Total cost should be the addition of all the costs.

Field	Question No.	Variables and Codes
81-84	8 or II/3	Total Cost in SR for Auto (One-way) (If cost is given for two-way calculate 1/2 of the cost) 9999 = missing data
85-88	- do -	One Way Ticket fare in SR for Bus (Total ticket cost for the whole family ⇒ Check) If two way is given divide by 2 9999 = missing data
89-91	- do -	Taxi or Limousine in SR for Bus For chosen mode if not indicated put 0 0 0 For other modes if not indicated put 9 9 9 = missing data
92-95	- do -	Total Cost in SR for Bus For chosen mode add ticket fare, taxi and others For other modes write the indicated total cost. It should be ≥ the sum of ticket fare + taxi cost.

Card No. 2

Field	Question No.	Variables and Codes
6-8	8 or II/3	One Way Ticket fare in SR for Train If two way is given divide by 2 999 = missing data
9-11	- do -	Taxi or Limousine in SR for Train For chosen mode if not indicated put 0 0 0 For other modes if not indicated put 9 9 9 = missing data
12-14	- do -	Total Cost in SR for Train For chosen mode add ticket fare, taxi and others For other modes write the indicated total cost. It should be ≥ the sum of ticket fare + taxi cost.
15	9	Who paid the trip 1 = Self 2 = Government or company 3 = Others 9 = missing data
16-19	10	Delay hrs. in fields 16-17 minutes in fields 18-19 For Auto put 0 0 0 0 If missing put 0 0 0 0
20-23	II-1	Consideration of Other Modes AIR in field 20 AUTO " " 21 BUS " " 22 TRAIN " " 23 Use the following codes in each field 1 = Never 2 = May Definitely 3 = Use it (use this code for the selected mode also) 8 = Invalid mode 9 = Missing data

Field	Question No.	Variables and Codes
		PART III
24-25	III-1	Age - write the indicated age 99 = missing data
26	2	Civil Status put 1 = married 2 = not married 9 = missing data
27	3	Car ownership (input number of cars) if missing 9
28	4	Driver license 1 = have 2 = does not have 9 = missing data
29	5	Number of people with driver license put number of 9 if missing
30	6	Occupation 1 = Student 2 = Government Employee 3 = Businessman 4 = Unemployed 5 = Retired 6 = Private Sector Employee 9 = missing data
31	7	Nationality 1 = Saudi 2 = Americans (North & South) 3 = Europeans, Australians, New Zealand 4 = Asians and Far Easterners 5 = Other Arab Countries 6 = Africans 7 = Non-Saudi (unspecified) 9 = missing data

Field	Question No.	Variables and Codes
32	III-8	Level of Education 1 = Primary 2 = Intermediate or Secondary 3 = University 9 = missing data
33	9	Personal Income 1 = less than 1000 SR 2 = 1000-2500 SR 3 = 2501-5000 SR 4 = 5001-7500 SR 5 = 7500-10,000 SR 6 = 10,001-12,500 SR 7 = 12,501-15,000 SR 8 = more than 15,000 SR 9 = missing data
34	9	Household Income 1 = less than 1000 SR 2 = 1000-2500 SR 3 = 2501-5000 SR 4 = 5001-7500 SR 5 = 7500-10,000 SR 6 = 10,001-12,500 SR 7 = 12,501-15,000 SR 8 = more than 15,000 SR 9 = missing data Household income should be $\geq$ Personal income

Field	Question No.	Variables and Codes
		PART IV **PERCEPTIONS**
35-38	IV 1.	35 Privacy Bus put 1-5 36 " Auto 37 " Air 38 " Train
39-42	2.	Location of Stops Bus in 39 " " " Auto in 40 " " " Air in 41 " " " Train in 42
43-46	3.	Effect of Weather on trip Bus in 43 " " " " Auto in 44 " " " " Air in 45 " " " " Train in 46
47-50	4.	Cleanliness of Bus input 1-5 in 47 " " Auto in 48 " " Air in 49 " " Train in 50
51-54	5.	Feeling Independence Bus in 51 " " Auto in 52 " " Air in 53 " " Train in 54
55-58	6.	Delay for Repair Bus in 55 " " " Auto in 56 " " " Air in 57 " " " Train in 58
59-62	7.	Comfort of Bus in 59 " " Auto in 60 " " Air in 61 " " Train in 62
63-65	8.	Effect of Weather on Travel time Bus in 63 " " " " " " Auto in 64 " " " " " " Air in 65 " " " " " " Train in 66

Field	Question No.	Variables and Codes
67-70	IV. 9.	Advanced Planning Bus in 67 " " Auto in 68 " " Air in 69 " " Train in 70
71-74	10.	Talking with Family Bus in 71 " " " Auto in 72 " " " Air in 73 " " " Train in 74
75-78	11.	Accessibility of Bus in 75 " " Auto in 76 " " Air in 77 " " Train in 78
79-82	12.	Feel Tired Bus in 79 " " Auto in 80 " " Air in 81 " " Train in 82

Field	Question No.	Variables and Codes
83-94		**PART V** Input 1-5 for level of importance 9 = missing data for the following 12 questions
83	1	Privacy
84	2	Location of Stops
85	3	Effect of Weather Condition on Trip
86	4	Cleanliness of Vehicle
87	5	Feeling of Independence
88	6	Delay for Repair
89	7	Comfort
90	8	Effect of Weather on Travel time
91	9	Need for Advanced Planning
92	10	Talking Freely with Family
93	11	Accessibility from Home
94	12	Feeling Tired